7th Biennial ISAKOS Congress
April 5-9, 2009 • Osaka, Japan

Paper Abstracts
Gene Expression in Calcific Tendinopathy of Human Rotator Cuff

Purpose
Calcific tendinopathy is a common disease of uncertain aetiology. Two different pathogenetic theories have been developed. According to one, degeneration of tendon fibres precedes calcium deposition; the other states that a viable environment allows a cell-mediated active process of calcification. It is now known whether there is an association of calcium deposits with the pathological process of tendon degeneration.

Material and Methods
We studied biopsies of calcific rotator cuff tendons, and specimens harvested from an apparently healthy area in the same tendon of 10 patients. A control group was constituted by 10 normal tendons from patients operated on for anterior shoulder instability. All patients signed a specific consent form to permit biopsies and further studies. RNA was extracted from snap-frozen biopsies using a modification of the guanidium-thiocyanate method (Trizol reagent), and retrotranscribed using random primer hexamer (CDNA Archive kit, Applied Biosystems). RNA levels were measured using quantitative PCR; BMP2, 4 and 6 were analyzed using the Taqman Gene Expression Assays, whereas collagen V, VEGF, Cathepsin K, osteopontin and osteonectin were evaluated using the Sybr green method. Relative quantification was performed using the 2-??Ct method.

Results
There was greater gene expression of osteopontin and Cathepsin K in calcific tendons, while collagen V, VEGF and BMP 2 do not show any significant differences. BMP 4 and 6 show lower level in pathological tendon compared with the healthy area.

Conclusion
The tissue in the area of rupture undergoes marked rearrangement at molecular levels, and support the role of the Cathepsin K and osteopontin during the phases of formation and resorption of calcific tendinopathy lesions.
An In Vivo Application of Interleukin-1 Receptor Antagonist Inhibits Deterioration of Mechanical Properties of the Stress-shielded Patellar Tendon Without Significant Changes in the Fascicle Properties

INTRODUCTION
Disuse of diarthrodial joints is accompanied not only by many musculoskeletal problems, but also as an adverse outcome of treatments for various disorders, such as immobilization. Stress deprivation has been regarded as the most essential causative factor in joint disuse [1]. In a series of our previous studies [2,3], we have developed a stress-shielding model for the patellar tendon without joint immobilization and demonstrated that stress deprivation dramatically deteriorates the mechanical properties of the rabbit patellar tendon, depending on the degree of shielded stress. However, the mechanism of the tendon deterioration caused by stress deprivation has not been clarified as of yet. Recently, the authors have found that interleukin (IL)-1-beta is over-expressed in the fibroblasts of the stress-shielded patellar tendon using the stress-shielding model [4]. It is known that IL-1-beta induces matrix metalloproteinases (MMPs)-1, -3, and -13 in tendon fibroblasts [5] and that IL-1beta inhibits collagen synthesis in tendon fibroblasts [6]. Therefore, there is a possibility that IL-1-beta plays a role in the tendon deterioration in response to stress deprivation. Then, we have conducted a study in which the IL-1 functions are inhibited with IL-1 receptor antagonist (IL-1ra) in the stress-shielding model. We have hypothesized that a local administration of IL-1-ra may inhibit the deterioration of the stress-shielded patellar tendon. On the other hand, the tendon tissues have a hierarchical structure composed of bundles, fascicles, fibrils and fibers [7]. Yamamoto et al [8] found that the effect of stress shielding on the mechanical properties of patellar tendon fascicles is much smaller than that of bulk tendons. They suggested that the stress shielding predominantly affects mechanical interaction among collagen fascicles or among collagen fascicles and other minor matrix proteins in the patellar tendon rather than affects the mechanical properties of collagen fascicles themselves. Therefore, we have made the second hypothesis that the effect of the IL-1-ra application on mechanical properties of the fascicles harvested from the stress-shielded patellar tendon may not be significant. The purpose of this study is to test these two hypotheses.

MATERIALS AND METHODS
A total of 30 mature female Japanese White rabbits with a body weight of 3.5 ± 0.2 kg were used in this study. In all animals, the right patellar tendon was completely released from stress by stretching a flexible steel wire installed between the patella and the tibial tubercle [2]. After the stress shielding procedure, the animals were divided into the following two groups of 15 rabbits each. In Group I, 5-µg recombinant human IL-1ra (Peprotech EC) with 0.2-ml phosphate buffered saline (PBS) solution was injected between the patellar tendon and the infra-patellar fat pad. In Group II, 0.2-ml PBS alone was injected in the same manner as Group I. All rabbits were sacrificed 3 weeks after the surgery [2,3]. We considered that the 3-week period was suitable for detecting the effect of a local application of IL-1-ra on the mechanical properties of the stress-shielded patellar tendon. In each group, eight animals were used for biomechanical evaluation of the patellar tendon in the bundle level having a width of 2.5 mm and five were used for biomechanical evaluation of the patellar tendon in the fascicle level having a diameter of 300 micrometers. The remaining two were used for histological observation. Statistical analyses were performed using unpaired t-tests to compare the tissue dimension and the mechanical properties of the patellar tendons between Groups I and II. A significance level was set at p= 0.05.
RESULTS
The averaged stress-strain relation curves are shown in Fig. 1. The tangent modulus of Group I was significantly greater (p=0.0163) than that of Group II, while the tensile strength of Group I was significantly greater (p=0.0063) than that of Group II. There were no significant differences in strain at failure between Groups I and II. All fascicle specimens failed between the two gauge-length markers drawn on a specimen. We could not detect any significant differences in the tangent modulus (p=0.558), the tensile strength (p=0.764), and the strain at failure (p=0.235) between Groups I and II. Histologically, the number of fibroblasts in the patellar tendons of Groups I and II was significantly higher than that of the normal patellar tendon. In the patellar tendons of Group I, fibroblasts with spindle-shaped nuclei were predominantly observed, while cells with round or oval nuclei were scattered in the patellar tendons of Group II. In addition, splitting tendon fibers in the patellar tendon appeared to be less remarkable in Group I than in Group II.

DISCUSSION
This study demonstrated that a local administration of IL-1ra significantly inhibits the reduction of the mechanical properties of the PT caused by stress-shielding at 3 weeks. This result implied that the over-expressed IL-1ß [4] plays an important role in the deterioration mechanism of the mechanical properties of the PT. This study also showed that the effect of the IL-1ra application on tendon fascicles in the stress-shielded PT was not significant at 3 weeks. Yamamoto et al [8] reported that stress deprivation reduces mechanical interactions among the collagen fascicles or among other minor matrix proteins such as proteoglycan and fascicles in the PT. The results in the present study suggested a strong possibility that the IL-1ß over-expressed in the stress-shielded PT [4] does not affect the fascicles themselves but the mechanical interactions among the collagen fascicles or among other minor matrix and fascicles of the PT. As to clinical relevance, an anti-IL-1 strategy has recently attracted notice as a clinical therapy for inflammatory diseases such as a rheumatoid arthritis [9]. The present study highlights a possible application of anti-IL-1 strategies for reducing the mechanical deterioration of tendons and ligaments in response to stress deprivation.

Prospective Randomized Study to Compare Single Bundle Versus Double Bundle ACL Reconstruction in Restoring Rotational 3D Kinematics of the Knee

Biomechanical studies have shown increased rotational stability with double bundle compared to single bundle ACL reconstruction. The aim of this study was to evaluate the difference in rotational kinematics after single and double bundle ACL reconstruction.

40 Subjects undergoing ACL reconstruction was prospectively randomized to DB (n=20) and SB (n=20) groups. Exclusion criteria included meniscal pathology, collateral ligament instability, previous injury and previous surgery. All surgery was performed by one surgeon using Semitendinosus and gracilis as graft and Endobutton and BioRCI screw as fixation. Demographics data were comparable between the 2 groups. Passive laxity was measured by determining the 6-degree-of-freedom position and orientation of the femur and tibia under a known torsional load using MRI. Each subject underwent 3 studies one on the uninjured knee that served as the control one pre operative and one post operative.

Results: Rotational stability increased after ACL injury and improved after surgery but not to normal. There was no statistical difference between single and double bundle Reconstruction in restoring rotational stability. AP translation in the medial compartment was also measured during rotational loading and there was a statistical difference between DB and SB reconstruction with DB being superior. The axis of rotation was different for DB and SB reconstruction although this was not statistically significant.

The subjective IKDC score was the same for both groups but the objective IKDC score was significantly better for the DB group

Conclusions:
Our study shows that although there was no difference in the overall rotational stability between single and double bundle ACL reconstruction, medial AP translation and rotational axis differences might explain the better objective score. Further studies are necessary to determine if abnormal translation in the medial compartment lead to increased risk for OA.
Prospective randomized study on Double Bundles ACL Reconstruction (Out-In technique) versus Single Bundle (STG) ACL reconstruction (Trans Antero-Medial portal)

Purpose:
The purpose of this study is to compare in a prospective randomized study, the clinical outcome and radiographic results between Double Bundle Out-In technique and Trans Antero-Medial portal Single Bundle (STG) technique in a 2 years follow-up.

Materials and methods:
From March 2005 to March 2006, 70 patients were operated and involved in a prospective randomized clinical study, 35 of these had an anatomical ACL reconstruction using Out-In technique (group A) and 35 had Trans Antero-Medial portal Single Bundle technique (STG 4 strands) (group B).
In both group anatomical insertion areas were evaluated and measured arthroscopically, notch-plasty was not performed and patients with associated meniscal, peripheral lesions and condral problems were excluded.
In the group A, the tunnels were drilled over the anatomical areas in a convergent Out-In manner, and the new bundles fixed by 4 absorbable screws at femoral and tibial levels. In the Group B the femoral tunnel was done drilling through medial portal in order to obtain a new insertion at 10/2 o'clock. All the cases were evaluated by an external observer: ROM evaluation was done at 1, 3, 6 and 12 months, IKDC score and a standard X-Ray was performed at 24 months.

Results:
The average ROM at 1 month was 0°-125° in the Group A, and 0°-100° in the Group B and respectively 0°-135 and 0°-125 at 3 months, and not significantly different at 12 and 6 months.
The IKDC score at 24 months follow-up evidenced 82% grade A, 10% grade B and 8% grade C for group A, while group B showed 76% grade A, 14% grade B, 10% grade C. The residual pivot shift (glide) was 4% in group A and 8% in group B.
Standard X rays at 24 months post-op showed a mild enlargement for both the groups A and B obviously in respect of the initial tunnel diameters.

Conclusions:
Out-in technique in anatomical double bundle ACL reconstruction gave us better results compared to Trans Antero-Medial portal Single Bundle ACL reconstruction in early ROM, A-P stabilization and in residual pivot shift test.
Prospective Clinical Comparisons of Anatomic Double Bundle Versus Single Bundle Anterior Cruciate Ligament Reconstruction Procedures in 328 Consecutive Patients

INTRODUCTION:
Single-bundle ACL reconstruction has been a standard option to treat symptomatic ACL deficient knees. However, recent studies reported that the single-bundle reconstruction cannot completely restore the normal anterior laxity, and that it is not effective for the rotatory instability.[1] The normal ACL consists of the anteromedial (AM) and posterolateral (PL) bundles, having different functions. Recently, authors reported the first clinical procedure for ‘anatomic’ double-bundle ACL reconstruction.[2] Most recently, several prospective clinical trials have been conducted to compare the clinical results between anatomic double-bundle and single-bundle procedures.[3-6] In these studies, however, the number of patients, 20 to 35 patients, was insufficient to compare the over-all clinical results including the complications between the two procedures. We have conducted a prospective comparative cohort study using more than 300 patients to compare our anatomic double-bundle and single-bundle procedures. Based on our foregoing studies,[2,6-8] we hypothesized that the anatomic double-bundle procedure may be significantly better concerning the anterior laxity and the pivot-shift test than the single-bundle procedure, while there may be no significant differences in the intra- and post-operative complications between the 2 procedures. The purpose of this study is to test this hypothesis.

METHODS:
A prospective comparative cohort study was carried out in 328 consecutive patients who underwent ACL reconstruction with the hamstring tendon autograft between 1999 and 2002. Each patient showed chronic ACL-deficiency in the unilateral knee at the time of surgery. The first 157 patients (Group S) underwent single-bundle ACL reconstruction using a 6-strand hamstring tendon autograft between 1999 and 2000. The second 171 patients (Group D) underwent the anatomic double-bundle reconstruction using 4- and 2-strand hamstring tendon autografts between 2001 and 2002. We identified no statistical differences between the 2 groups with regard to age, gender, height, weight, or time to surgery. One senior orthopaedic surgeon performed all operations using the same procedure for each group. Each reconstruction procedure was performed using the arthroscopically-assisted one-incision (trans-tibial tunnel) technique. In the single-bundle reconstruction, the tibial tunnel that passed through the posterior aspect of the normal ACL attachment was created using a guide-wire navigator. Then, the femoral tunnel was drilled into the centre of the AM bundle attachment using the trans-tibial tunnel technique. The graft was simultaneously fixed at 30° of knee flexion, applying an initial tension of 80 N. In the double-bundle reconstruction, the 4 tunnels that passed through the anatomical attachment of the AM and PL bundles on the tibia and the femur, respectively, were created using a specially designed wire navigator. The 2 grafts were simultaneously fixed at 30° of knee flexion, applying an initial tension of 30 or 40 N to each graft. Each graft was secured with EndoButtons (S&N) on the femur and with two staples on the tibia. All patients underwent postoperative management with the same rehabilitation protocol. Each patient underwent clinical examinations 2 years after surgery. Statistical comparison among the 2 groups was performed using the Chi-square test and unpaired Student’s t-test.
RESULTS:
The postoperative side-to-side anterior laxity measured with KT-2000 averaged 2.5+/-2.5 mm and 1.2+/-1.9 mm in Groups S, and D, respectively. The anterior laxity was significantly less in Group D than in Group S (p<0.0001). Eighteen knees and 5 knees showed the laxity greater than 5 mm in Groups S and D, respectively. The Chi-square test showed a significant difference between Groups S and D (p=0.0025). Regarding the pivot-shift test, 58 and 19 patients were rated as + and ++, respectively, in Group S, while 27 and 5 patients were rated as + and ++, respectively, in Group D. The Chi-square test showed a significant difference between Groups S and D (p<0.0001). Concerning the postoperative loss of terminal knee motion, the Lysholm knee score, the IKDC evaluation, and the peak muscle torque, there were no significant differences between the 2 groups. However, 10 and 2 knees were rated as C and D ranks, respectively, in Groups S, while only 3 knees were rated as C rank with no D-rank knees. During surgery, there were no serious complications, such as iatrogenic cartilage injuries, malposition of the tunnels, graft fixation failure, and etc. As for minor intra-operative troubles, an EndoButton was flipped within the lateral vastus muscle in 5 and 9 knees of Groups S and D, respectively. In the 9 buttons of the Group D, 7 and 2 buttons were used to fix the PL and AM bundles, respectively. The malposition of an EndoButton was clinically suspected immediately after flipping the button and reduced to an appropriate position during surgery. There were no post-operative serious complications including fractures, deep vein thrombosis, and infections in each group.

DISCUSSION:
The present study demonstrated that the clinical results of both the anterior laxity and the pivot-shift test were significantly better after the anatomic double-bundle reconstruction than after the single-bundle reconstruction in our procedures. On the other hand, there were no significant differences in the other clinical evaluations between the 2 procedures. The present study also showed that there are no significant differences concerning the intra- and post-operative complications between the 2 procedures. Although the present study showed the promising results of the anatomic double-bundle ACL reconstruction procedure, further clinical studies, including quantitative evaluation of the effects on the rotatory stability, long-term survival of the graft functions, comparisons with other procedures involving the reconstruction with the bone–patellar tendon–bone graft, and so on, are needed to establish the clinical utility of the anatomic double-bundle ACL reconstruction for the ACL-deficient knee.

REFERENCES:
The Comparison of Impingement Pressure in Anatomical and Non Anatomical Anterior Cruciate Ligament Reconstruction: Cadaver Study

(Introduction)
Anterior Cruciate Ligament (ACL) against the intercondylar notch roof or the posterior cruciate ligament (PCL) has been considered to be one of the main reasons for graft deterioration and postoperative range of motion deficiency. To avoid ACL - roof impingement, posterior tibial tunnel(1) placement and notchplasty have been recommended, though, little is known about the amount of ACL impingement pressure. Although some authors have pointed out the possibility of ACL impingement against PCL, there is no report about PCL impingement pressure. While studies have been published on tunnel placement and graft tensioning, there is still no scientific evidence to show whether an anatomical or non-anatomical ACL reconstruction will better restore normal kinematics of the knee. Furthermore, there is no documentation on the difference of impingement pressure between anatomical and non-anatomical ACL reconstructions. The purpose of this study was to determine the amount of impingement pressure against the roof and PCL.

(Materials and Methods)
Fifteen fresh-frozen non-paired human cadaver knees were used in this study. The knees were first tested with the ACL intact, after this the ACL was transected and single bundle reconstruction was performed with an open technique using a hamstrings autograft, and again tested following reconstruction. Two femoral tunnels one in the antero-medial (AM) position and one in the high antero-medial (High-AM) position were drilled in each knee. The femoral high-AM tunnel was made at higher position in the notch than the anatomical femoral AM insertion site. Two tibial tunnels were drilled in each knee, one in the antero-medial and one in the postero-lateral (PL) positions. Using these tunnels, three separate ACL reconstructions were performed in each knee: 1) tibial AM tunnel to femoral AM tunnel (AM to AM: representing anatomical ACL reconstruction), 2) tibial PL tunnel to femoral High-AM tunnel (PL to High-AM: representing non-anatomical ACL reconstruction) and 3) tibial AM tunnel to femoral High-AM tunnel (AM to High-AM: also representing non-anatomical ACL reconstruction).

Pressure measuring films (Ultra-super-low Range Prescale, Fuji Film, Japan) were then inserted between the ACL and the intercondylar notch. Knees were then moved from their maximum flexion to their maximum extension with 40 N of force. The pressure measuring films were scanned after the experiment and the images evaluated by specific software. After all surgical procedure, tunnel positions were evaluated by x-ray imaging. Radiographic analyses were performed using the techniques of Bernald and Hertel at the femur as well as the method by Staubli and Rauschning at the tibia.

(Results)
There were no significant differences between the values of roof impingement pressure in the intact ACL, in the AM to AM ACL and the PL to High-AM ACL reconstructed knees. Only the AM to High AM ACL reconstructed knees showed significantly higher impingement pressure compared with other groups (p< 0.05). There was no significant difference in PCL impingement pressure between the intact ACL and any of the reconstructed groups. In the x-ray evaluation, the center of the femoral AM tunnel was placed at 15 % in a shallow-deep direction and at 26.2 % in a high-low direction. The High-AM was found at 33.8 % in a shallow-deep direction, and 7.8 % in a high-low direction. On the tibial side, the center of the AM tunnel was placed at 30.9 % from the anterior edge of the tibia, and the PL tunnel at 49.7 %.
(Discussion)
This study showed that anatomical ACL reconstruction did not cause roof or PCL impingement similar to the ACL intact knees. In this study, tibial AM tunnel was made at 30.9% from its anterior edge, this position is similar to previous reports(7). And PL tunnel was placed 49.7%, this position is close to the traditional tibial tunnel in the single bundle reconstruction. We revealed that, even when the tibial tunnel was placed anteriorly, an anatomically placed femoral tunnel could prevent the incidence of roof or PCL impingement.
In conclusion, anatomical ACL reconstruction does not cause roof or PCL impingement.

(References)
The Effectiveness of Supplementing a Standard Rehabilitation Program with Neuromuscular Electrical Stimulation After Anterior Cruciate Ligament Reconstruction

Background: Rehabilitation interventions following surgical repair of the anterior cruciate ligament (ACL) are key determinants affecting patient return to usual activity levels. Studies show that neuromuscular electrical stimulation (NMES) can counteract loss of strength in the quadriceps and is a beneficial enhancement to traditional forms of therapy.

Purpose: This study compared the effect of adding traditional NMES or garment integrated NMES to a standard post-surgery rehabilitation program. The effect on the strength of the extensors of the quadriceps, the ability of patients to perform the single leg hop test, the shuttle run and other measures of proprioception were assessed.

Study Design: Prospective, randomised, single-blind study in patients undergoing rehabilitation following anterior cruciate ligament reconstruction.

Methods: Ninety-six patients who underwent surgical reconstruction of the anterior cruciate ligament (ACL) were randomly assigned to one of three post-surgery rehabilitation treatment groups. All patients followed a standard rehabilitation program of voluntary exercises. Additionally, the PS group, (n=29), trained with a traditional NMES device and the KH group (n=33) trained with a garment integrated NMES device with multipath activation, (n=33). The additional training for the PS and KH groups consisted of twenty-minute quadriceps muscle stimulation sessions, three times per day, five days per week for twelve weeks. The control group (CO), n=34) performed only volitional maximum quadriceps muscle contraction according to the same timed training session. Relative maximum strength of the extensors and the flexors of the injured and uninjured leg at 90 degrees/sec and 180 degrees/sec, along with functional tests of proprioception were assessed at baseline and at 6 weeks, 12 weeks and 6 months post-operatively.

Results: The KH group achieved statistically significant results over the PS and CO groups for measurements of the strength of the extensors of the injured leg at an angular velocity of 90°/second in Nm/kg for time effect (p<0.001), for treatment effect between the groups (p=0.044) and when examination times are considered (p<0.05). At an angular velocity of 90°/second, strength values for the KH group after 6 months were 30.2% higher than before the surgery, compared with 5.1% (PS) and 6.6% (CO) groups. At an angular velocity of 180°/second, measurement of the strength of the extensors of the injured leg, the KH achieves significance (p<0.05) compared with the CO group at 12 weeks and 6 months, and compared with the PS group, achieved significance (p<0.05) for the entire duration of the study. At the angular velocity of 180°/second, strength values for the KH group were 27.8% higher than before the surgery compared with 5% (PS) and 3.7% (CO) groups. For the single-leg hop (SLH) with the injured leg, the KH group achieved significantly better results for the entire period of the investigation compared with the PS group (p=0.038) and compared with the CO group (p=0.002). At the times of all three examinations after surgery the KH group achieved significantly better values (all p<0.05) than the PS and CO groups. The time effect (Pillai Spur) gives a significant change (p<0.001) in the course of the investigation, and in the treatment effect (F test) there is also a significant difference (p=0.001) between the groups in favour of the KH group. Patients in the KH group achieved full weight bearing and return to usual work activities 7 days before either the PS or CO groups.
Conclusions and Clinical Relevance: The results of this study confirm that garment integrated neuromuscular electrical stimulation devices, designed for use by patients at home, are a beneficial addition to rehabilitation therapy following anterior cruciate ligament reconstruction, strengthening the quadriceps, increasing range of motion and accelerating recovery.
Lower Extremity Neuromuscular Compensations During Instrumented Single Leg Hop Five Years Following ACL Reconstruction

Anterior cruciate ligament (ACL) injury may lead to neuromuscular activation changes long after surgical reconstruction and rehabilitation. This study compared bilateral lower extremity EMG and kinematic characteristics during the performance of a single leg hop. Our hypothesis was that lower extremity neuromuscular activation characteristics would differ between the lower extremity that had undergone ACL reconstruction and the noninvolved contralateral lower extremity. Seventy subjects at a mean of 5 years (range = 2-10 years) following unilateral ACL reconstruction using allograft tissue participated in this study. All subjects had complied with rehabilitation program recommendations. Active knee range of motion was bilaterally equivalent and knee laxity was within 2 mm. Most subjects (66%) displayed normal or nearly normal 2000 IKDC Self-Reported Knee Evaluation scores. EMG (1000 Hz) and two-dimensional sagittal plane kinematic (60 Hz) data were collected as subjects performed 3 single leg hops with each lower extremity. Gluteus maximus, vastus medialis, medial hamstring, and gastrocnemius EMG amplitudes were standardized to levels attained during single repetition, maximal volitional effort isometric contractions (%MVIC) using conventional manual muscle tests. Paired t-tests were used to compare side-to-side differences (P < .05). Peak bilateral lower extremity joint displacement (noninvolved, involved) did not differ at the knee (56.7 ± 13° vs. 57.8 ± 14°) or ankle (13.8 ± 5° vs. 13.3 ± 5°) during single leg hop performance. Hip displacement however was increased (63.9 ± 17° vs. 67.2 ± 16°, P = .03) and single leg hop distance was decreased at the involved side (42.3 ± 15 cm vs. 40.0 ± 15 cm, P = .001). EMG activation sequence and duration did not differ between extremities. Vastus medialis and medial hamstring EMG amplitudes did not display differences during single leg hop propulsion or landing. Gluteus maximus EMG amplitudes did not display differences during single leg hop propulsion. Gastrocnemius EMG amplitudes during both single leg hop propulsion (1.2 ± .4 %MVIC vs. 1.3 ± .3 %MVIC, P = .04) and landing (1.2 ± .5 %MVIC vs. 1.3 ± .5 %MVIC, P = .01), and gluteus maximus muscle EMG amplitudes during landing (1.3 ± .5 %MVIC vs. 1.5 ± 1 %MVIC, P = .04) were increased at the involved lower extremity compared to the noninvolved lower extremity. Despite predominantly satisfactory self-reported knee outcome scores evidence of side-to-side neuromuscular differences were observed. Increased gluteus maximus and gastrocnemius muscle activation amplitudes and increased hip displacement magnitude at the involved lower extremity at a mean 5 years post-ACL reconstruction suggest long-term compensatory changes toward a hip and ankle joint bias to decrease knee joint loading forces. ACL reconstruction corrects knee joint ligamentous laxity, however compensatory neuromuscular changes still occur.
What Can We Really Do Following TKA, UKA and HTO?

GOAL
Evaluate function and sport participation following TKA, UKA and HTO

MATERIAL AND METHOD
551 patients operated on between 2002 and 2004 in 6 centers answered a self-administered questionnaire: 369 TKA, 141 HTO and 41 UKA: mean age 71 years (24 to 95) [TKA 74.8, UKA 72.8, HTO 59]. Mean Follow-up: 46 months (13 to 73) [TKA 44.4, UKA 45.6, HTO 49.7]. BMI: 27.6kg/m² (18.5 to 39.9) [TKA 27.9 UKA 26.7 HTO 27.0]. Sport participation was analyzed using Weiss and Noble scoring scale (0 to 10), taking account of participation, motivation and pain at sport.

RESULTS
SF12 score at FU was 62.3±28 for TKA; 64.8±24.6 for UKA and 72.7±25 for HTO. 81% of patients were satisfied or very satisfied with the procedure (TKA 82.9%, UKA 90.2% and HTO 76.5%). (p<0.05)
65% of TKA, 75% of UKA and 57% of HTO were active as they expected to be preoperatively. (p<0.05). 68% of TKA, 63% of UKA and 63% of HTO considered their knee as “Normal”. (NS)
WOMAC™ scores Pain, Stiffness and Function were 3.1±3.5; 1.7±1.6 and 15.5±13.6 for TKA; 2.15±3; 1.38±1.3 et 9.1±10.2 for UKA and 4.0±3.6; 1.78±1.9 et 11.56±11 for HTO.
Regular participation (>once a week or >one week per season) for TKA, UKA and HTO were respectively(%): 25, 19, 27 (stationary bicycle); 12, 0, 40 (bicycle); 25, 44, 56 (hiking); 5, 2.5, 17 (swimming); 4, 2.5, 7 (dancing); 1,2.5, 2 (tennis); 3, 0, 25 (running); 4, 0, 25 (downhill skiing) and 3, 2.5, 10 (cross country skiing).
Pain or difficulties during participation for TKA, UKA, HTO were respectively (%): 7.4, 2.5, 10 (stationary bicycle); 8, 0, 19 (bicycle); 16, 12, 36 (hiking); 0,9,10 (swimming); 10, 9, 16 (dancing); 6, 0, 13 (tennis); 8, 0, 16 (running); 7, 0, 31 (downhill skiing); and 6, 5, 18 (cross country skiing).
Global Weiss score was 4.63 for TKA, 4.62 for UKA and 4.76 for HTO.
Weiss score were respectively: 4.44; 4.9 and 4.13 for bicycle; 4.22; 4.18 and 4.7 for hiking; 5.2; 5.0 and 4.9 for tennis; 4.87; 5.0 and 4.9 for running and 4.7; 4.94 and 4.68 for downhill-skiing.

CONCLUSION
Sport participation was higher following HTO than knee prosthesis but level of satisfaction was significantly worse because patient expectancies were much higher. If one takes account of the motivation of the patients, the scores were similar for most activities.
Judo After Total Hip and Kne Arthroplasty

Objective:
Today there are more and more candidates for arthroplasty among people participating in a regular sport. These patients are demanding a high level of functional performance from their prosthesis. Many epidemiological studies have shown that regular participation in a sport after total hip and knee replacement is possible, particularly as far as golf, skiing and tennis are concerned. On the other hand no studies have yet been undertaken on judo. We wanted to know if continuing judo was compatible with a prosthesis.

Methods:
We sent a questionnaire to members of the French Judo Federation to identify sportsmen with total hip and knee replacements. We sent out 212 questionnaires to sportsmen of over 60 who were at least 6th Dan, black belt level. Out of 83 replies, 36 men of a mean 72 years old (60-86 years of age) had at least one prosthesis.

Results:
We found 36 total hip replacements on 27 patients, 10 total knee replacements on 8 patients and 3 total shoulder replacements on 3 patients.
Out of 27 patients with a total hip replacement, mean age 63 (60 to 82 years) at the time of the operation; Fifteen (55%) said they had been operated so as to continue judo. Twenty two patients (81%) had taken up judo again on a regular mean basis 2.5 times a week (1 to 4) a short time afterwards, 3.9 months (2 to 10). But they had all, apart from one, changed exercises (theme randori or demonstration).
Finally, their surgeons had recommended that they give up judo in 65% of the cases.
Twenty five patients (92%) declared they were satisfied with their prosthesis.
Only 2 patients out of 26 with a hip replacement had had another total hip replacement because of wear. We found no dislocation or fracture.
Among the 8 patients with a total knee replacement, mean age 72 years old (60 to 77) at the time of the operation; Four patients (50%) said they had had the operation to continue judo.
Five patients (62%) had taken up judo again on a regular basis, 2.3 times a week (1 to 3) a short time after, 5.2 months (3 to 6). They had all changed exercises; (theme randori or demonstration). Their surgeons had recommended they give up judo in 75% of the cases.
Only 5 patients (62%) were satisfied with their prosthesis.
Among the three patients with a total shoulder replacement; Two had take up judo again;

Conclusion:
A total hip replacement does not appear to limit participation in judo. The functional results are satisfactory. A clinical and radiological study appears necessary to confirm these results. The results after total knee replacement are more reserved, it appears that continuing judo might present more difficulties for older sportsmen.
Which Patients Can Expect to Play Sports After Total Knee Arthroplasty?

Introduction
Traditional goals such as pain relief are no longer the only expectations surgeons have, when performing modern arthroplasty. An increasing group of patients want to have an active sporting and professional life. They do not want to be restricted by their biological age. So as the goalposts are shifting surgeons need a way by which we can help predict realistically which patients can expect to play sports.

Method
This is a prospective cohort study of 150 patients.
Patients were recruited from Jan 2001 till June 2003.
Pre operative data was:
1. clinical and radiological International Knee Score (IKS)
2. Sports activity questionnaire
3. Patient Expectations
4. Patient Clinical Data (Eg: BMI, Operative technique)
5. full radiological data including long standing axes, Merchant views etc
The average follow up was 3.5 years
The follow up period for the study included 3 months, 6 months then yearly.

Standard post op review obtained the following information:
1. Clinical Examination and complete radiological data
2. IKS
3. VAS Pain
4. Post op sporting questionnaire
5. LEAS (Lower Extremity Ambulatory Score)

Results
M:F - 45%:55%
Average age 70
BMI 28.5
Pre-operatively 45 patients/ 150 wished to return to sport if possible
All these 45 patients returned to sport post operatively.
The average LEAS was Level 11-2
The sports played by these people were: (some people had more than one sport activity)
1. golf(18),
2. mountain hiking(21),
3. bike riding(12),
4. downhill skiing(19),
5. tennis(7),
6. gymnastics(19),
7. windsurfing(4),
8. rollerblading(2),
9. karate(2),
10. parasailing (1)

In our study the factors that had significant high predictive value of returning to sport were the following.
1. Preoperative desire to return to sport
2. BMI <28 vs >33(non sport group)
3. Males > Females

The data that had no influence on the ability to play sport were
1. Pre op IKS - Average 44 (sport group = non sport group)
2. Post op IKS (97(sport) vs 93(non sport))
3. Pre-op range of flexion (120 deg)
4. Post op range of Flexion(128deg)
5. Neither pre op VAS(8.2/10) nor postOp VAS (0.45/10)
6. The stage of arthritis
7. Patella resurfacing
8. Subvastus vs medial parapatellar
40% of the 45 did more than one sporting activity. 45% of 45 performed sporting activities >2/week. The average time to return to sport was 6 months.
The were no radiolucent lines, no wear nor effusions in the sporting group.

Conclusion
This study demonstrates that patients who express a desire to return to sports have the highest chance of being able to do so.
Neither the severity of preoperative pain, preoperative range of flexion, the preoperative IKS score or the preoperative stage of arthritis were not significative limiting factors to the return to sports. Other factors are also predictive and should be used with more caution as these are not independent variables.
There were no complications due to the sport activities in this patient group at this follow up in comparison with the non sport patient group.
Biomechanical Analysis of Total Knee Arthroplasty Patients and Controls During Comfortable and Fast Walking

BACKGROUND:
Previous studies using motion analysis to assess level walking following total knee arthroplasty (TKA) have shown that patients walk with biomechanical deficiencies compared to healthy controls. The aim of this study was to determine whether these deficits change with more demanding tasks and whether the deficits during level walking are indicative of greater deficits in tasks closer to the maximum capacity of patients.

METHODS:
40 patients who had undergone a successful TKA more than 12 months previously and 40 age and sex-matched control subjects were evaluated. There were 22 females and 18 males in each group. Three dimensional motion analysis was performed using 2 force plates and 8 infrared cameras. Patients performed 6 walks at a self-selected comfortable speed and 3-5 walks at their maximum safe speed. Comparisons of spatiotemporal parameters and peak lower limb kinematics and kinetics were made between control and TKA subjects and between comfortable and fast walking trials.

RESULTS:
During comfortable walking the TKA and control groups walked at similar speeds although the TKA group had a significantly reduced cadence (p=0.005). The TKA group had a reduced knee flexion angle during both loading (p<0.001) and swing (p=0.001), reduced internal tibial rotation (p<0.001), and increased external tibial rotation (p<0.001). Kinetically, 87% of patients walked with a biphasic sagittal knee moment pattern that is associated with normal gait. Despite this, the TKA group had reduced maximum flexion (p=0.012), adduction (p<0.001) and external rotation (p=0.022) moments at the knee compared to the controls. Similar differences between patients and controls for these parameters were seen at the fast speed.

Compared to comfortable walking, the TKA and control groups increased their cadence during fast walking by 23% and 20% respectively, and both groups increased their stride length by 17%. Both groups demonstrated similar changes in knee angles when walking at fast speed compared to comfortable speed. However, despite similar increases in the ground reaction force for both groups, the knee flexion and adduction moments of the TKA group did not increase during fast walking at the same rate as the control group. The increase in flexion and adduction moments by the TKA group was 51% and 23% compared to the control group increases of 66% and 37%.

DISCUSSION:
The TKA patients in this study were able to make appropriate temporospatial adjustments to enable walking at a faster speed, indicating that they were not at their functional limit during comfortable walking. However, the reduced knee flexion moment during fast walking indicated a reduced ability to adapt to the greater functional challenge of this task. The reduced knee flexion angle during loading in the TKA group may reduce the ability of the limb to absorb impact and may have implications for loosening. On the other hand, the reduction in knee adduction moment seen in this group is encouraging in terms of loading of the prosthesis.
UKR or TKR: A Randomised Control Trial

Between 1989 and 1992 102 knees adjudged suitable for Unicompartmental replacement (UKR) were randomised to receive either a St Georg Sled UKR or a Kinematic modular total knee replacement (TKR). The early results demonstrated that the UKR group had less complications, and more rapid rehabilitation. At 5 years there were equal failures but the UKR group had more excellent results and a greater range of movement. Despite this doubt persisted about whether these advantages would be maintained these cases have been followed regularly by a research nurse at 8, 10, 12 years. We now report the final outcome at 15 years. 43 patients (45 knees) have died with all their knees intact. Throughout the review period the Bristol Knee Scores (BKS) of the UKR group have been better and at 15 years 77% and 53% of the surviving UKRs and TKRs achieve an excellent score. 6 TKRs and 4 UKRs have failed during the 15 years of the review.

Conclusion:
The better early results with UKR are maintained at 15 years with no greater failure rate. The median BKS scores of the UKR group was 91.1 at five years and 92 at 15 years suggesting little functional deterioration in either the prosthesis or remainder of the joint. These results would seem to justify the increased use of UKR.
Sports and Everyday Life Activity After Unicondylar Knee Arthroplasty vs. Total Knee Arthroplasty

Introduction: In Germany 80,000 knee arthroplasties are performed per year, with a major increase during the last five years. The aim of this study was to evaluate sports activity, activity of leisure time and everyday life activity changes after unicondylar and total knee arthroplasty. In addition we compared activity after total knee arthroplasty (TKA) versus unicondylar knee arthroplasty (UKA). Furthermore we analysed subjective items like pain and knee function.

Material & Methods: In a retrospective study we used the „German PAQ-50+ Questionnaires“, which was developed to analyse sports and everyday activity of elderly people by the Sports Institute, University of Stuttgart. The questionnaire includes every-day activity like homework, gardening, occupation, activity of leisure time and sport activity in hours per week. MET-values for energy use in kilocalories were applied. Additionally subjective items were evaluated with the Visual Analog Scale (VAS): For the pre- and post-operative status we collected data for pain, function of the knee, endurance, distance of walking and climbing stairs. In order to evaluate the post-op status we analyzed the level of activity, limitation and satisfaction with the surgical procedure.

200 patients were included in this study, which have been operated between 2004 and 2005 (95 female, 105 male). Due to exclusion criteria 96 patients dropped out. With the rest of the patients (n=104; n=48 female, n=56 male) we performed an interview by telephone. The average follow-up: 32.3 months.

51 patients (average age 66.8 y; 20f, 31m) underwent TKA (25 PROFIX, 16 INNEX, 9 GENESIS, 1 SCORPIO type).

53 patients (average age 65.0; 28f, 25m) underwent UKA (28 ACCURIS, 19 EIUS, 5 REPLICCI, 1 OXFORD type). Statistic analysis was done bivariate with unpaired t-tests. Because of the explorative nature of this study we didn’t do Alpha-Adjustment. Significance level was defined as p<0.05. SPSS for Windows was used for statistical analysis.

Results: In the UKA group knee function in the VAS has increased post-op 4.6 (+/-2.9) points versus 3.3 (+/-2.8) points in the TKA group. The post-op knee function (VAS) of the UKA group is significantly higher than the knee function (VAS) of the TKA group (p=0.029). Concerning the total activity score the UKA group has a higher active score post-operatively than the TKA group, with no significant difference (UKA: 47.9 +/-21.7 h/week physical activity vs. TKA: 42.0 +/-24.8 h/week; p=0.199). By explicit analysis of the partial activity score we did not find a significant difference between both groups. Leisure time activity: p=0.742, sport activity: p=0.100 and occupation activity: p=0.294. We also did not find any significant difference comparing the delta increase of score values from of pre- to post-op of both procedures (all data: p=0.050). The same is applicable for energy use. In both groups pain (VAS) decreases clearly, but not significantly (UKA: -3.4 +/-3.4 vs. TKA: 3.7 +/-2.8 points at VAS; p=0.565). Also satisfaction with the surgical procedure shows no significant difference between both groups (UKA: 8.6 +/-2.1 vs. TKA: 7.9 +/-2.5 points at VAS; p=0.099).

Conclusion: The validity of this data is supported by the fact that the operative procedure of all patients was performed in the same clinic by one single surgeon (senior author) and of the structural consistency of both groups (sex, age, follow up; all data p>0.05). The comparison of UKA and TKA showed no significant differences of post-op activity, pain and satisfaction with the surgical procedure. After implantation of a unicondylar knee arthroplasty (UKA) we found significant higher subjective knee function in the VAS than after implantation of a total knee arthroplasty (TKA). This post-op outcome favors the minimally invasive surgical technique which is less invasive and has lower risk and complication.
Surgical Treatment of Chronic Stress Fractures in Athletes

During 25 years (1982-2007) 170 chronic, painful, risk or nonunion stress fractures in athletes and dancers were treated surgically. The patients represented several sports events, mainly track and field athletics. Endurance athletes, as runners, cross-country skiers, orienteers and triathletes were represented with the biggest number of these stress fractures (appr. 65 % of all operations). There were 131 stress fracture operations in males (77 %) and 39 in females (23 %) in the series. The mean age of the patients was 23 years (14 - 37 years). The number of operations / bones in the material were: anterior mid-tibia 49, tarsal navicular 25, sesamoid bones of the first MTP joint 16, metatarsal bones 15, tarsal bones 14, medial malleolus 12, and patella 7 cases. There were from 1 to 5 stress fracture operations in the following bones / sites: proximal tibia, femoral shaft, femoral neck, pubis, olecranon, humeral shaft, distal fibula, first rib, calcaneal bone, cuboid bone, pisiform bone and hamulus ossis hamati of the wrist. The fracture caused local pain and training / competing was usually not possible. The diagnosis was done by radiographs (100 %). It was confirmed by Technetium scan (30 %) and MRI (23 %). CT examination was used in a few cases. All patients were treated at first conservatively by rest from causative training, non weight- bearing, crutches, casts, local ultrasound, magnetotherapy, osteoporosis medicines, D-vitamin and extra calcium. Delayed or non-union developed in 125 cases (76 %). The risk for a complete fracture was estimated in 21 cases (12.5 %) and in the rest of the cases, persistent pain and non healing was indication for surgery. A complete fracture had occurred 14 times, during training or competition. Different surgical techniques were used in the treatment. High risk stress fractures, as femoral neck, distal femoral shaft, mid-tibia, patella, tarsal navicular and MT V basis were treated with internal fixation (nail, screws, plates or tension band method). Pseudoarthrosis surgery included sometimes curettage and bone grafting. Some stress fractures were treated with drilling of the fracture site. Postoperative treatment consisted of short immobilization, non weight-bearing and rest, followed by early isometric exercises, swimming, water training, bicycling, weight training and gym training. The patients were followed clinically and by radiographs as long as the healing had occurred and the end result was clear. The training pause depended on the bone and surgical treatment method. The patients were able to return to there sports 2-12 months after surgery. The patients were followed appr. for 2 years. The result from surgery was good or excellent in 86 per cent of the cases. All these athletes were able to come back to the same level as before. There were some complications and recurrences in the series. A reoperation was needed in 9 cases. Removal of the osteosynthesis material was done in 91 cases.
Risk Factors for Stress Fractures, Orthopaedic Acute and Overuse Injuries in Female Infantry Recruits

Introduction:
5-30% of infantry recruits suffer stress fractures. 20% suffer ankle sprains and approximately 30% suffer anterior knee pain. In this study we followed up a group of female infantry recruits in order to define the risk factors for acute and overuse injuries.

Material and Methods:
83 female infantry recruits were prospectively followed up during a 4-month course of basic training. On commencing the course, a questionnaire was filled concerning previous skeletal pain or injury, previous physical activity and menstrual history. A detailed orthopaedic examination was performed. Footprints were taken using the Harris Mat. During the course, follow up of injuries was done by interview twice a month and all clinic visits were documented.

Results:
60 of 83 recruits completed the course. Of the total 83 recruits, 15 suffered LBP, 21 suffered AKP, 27 had an ankle sprain and 16 suffered stress fracture with a total of 33 fractures and 31 ankle sprains. 11 complained of foot pain and 22 of shin pain.
The recruits suffering stress fractures had no more LBP than those not suffering a stress fracture. However, they had nearly a double number of ankle sprains, three times the number of AKP and over three times the number of complaints of foot pain.
Of the stress fractures, ten were grade 2 and six were grade 3. Twenty were considered “dangerous” according to location. 39% were located in the tibia and 15% in the femur.
Ankle sprains occurred in 27 recruits with a total of 31 sprains. 10 had recurrent sprains.
Stress fractures were not affected by height, weight, BMI or the arch of the foot. Irregular menstruation (p=0.17, and for dangerous SF, p=0.05) and an older age of menarche (p=0.14) showed a tendency for a higher occurrence of stress fractures. A mild tendency for less “dangerous” stress fracture was shown in higher use of milk products (p=0.25) and birth control pills showed a mild tendency for stress fracture reduction (p=0.24).
Scoliosis seemed to cause “dangerous” stress fracture (p=0.06) and a valgus heel showed a possible mild tendency for the same (p=0.09-0.22) as more so did ankle instability (p=0.03-0.15). (The 2 numbers represented right and left).

Conclusions:
Amenorrhea, late menarche and possibly irregular menstruation, unstable ankles and heel valgus seem to be related to stress fractures in female infantry recruits, especially the “dangerous” fractures, occurring in the shaft of the long bones. The footprint, hip rotation, height, weight and BMI were not shown to affect stress fracture occurrence.
In our study of female Infantry recruits 20% to 30% suffered LBP, AKP and acute ankle sprains. Further research should probably be directed to reduction of this unacceptable high rate.
Stress Fractures Reduction by Equipment Modification in Border Police Female Fighters Recruits

Introduction: Stress Fractures (SFx) are common among female fighters. In this study female fighters have been followed for SFx incidence during basic combat training (BCT) in the Border Police for the previous 11 years. Both internal and external risk factors were studied and various interventions were implemented in order to reduce SFx incidence with only a trend disclosed in their reduction. The aim of this study was to assess whether combat equipment modification, by mildly reducing weight and approximating the gear to the body center of gravity could reduce SFx incidence.

Methods: 216 Border Police Female Recruits, ages 18-19 years, undergoing BCT of 16 weeks, were followed prospectively for SFx incidence using modified fighting gear: A short M16 rifle and a lighter and closely fitted combat vest. Follow-up included questionnaires and bi-monthly assessment by the research team. SFx were diagnosed by bone scintigraphy when clinically indicated. Seven SF were diagnosed only clinically. The incidence of SFx in the intervention group was compared to a control group of 229 female fighter recruits who used the traditional equipment and whom were followed by the same research group along previous years from 2003 onward.

Results: Equipment modification was associated with a significant reduction in SFx from 18.3% in the control group to 7.9% in the intervention group. The incidence of "dangerous" SFx (fighters suffering SFx of long bones or foot Navicular) reduced from 15.3% to 5.6%. The incidence of fighters suffering SFx of the Tibial Shaft, Fibular Shaft, Femoral Shaft or Femoral Neck decreased from 12.2% to 4.2%. The incidence of fighters suffering Femoral SFx decreased from 5.7% to 2.3%. Excluding femoral SF, which had border line significance because of the lower number of injured fighters, all these data were strongly significant. The total average number of SFx per fighter was reduced from 0.38 fractures to 0.23, while the average number of "dangerous" SFx per fighter was reduced from 0.27 to 0.15. SFx of the Femur, Tibia or Fibula were reduced from 0.21 fractures per fighter to 0.09 and Femoral Fractures from 0.09 per fighter to 0.04. Training days lost per fighter for reason of SFx was reduced from 2.8 days per fighter to 1.4 days.

Conclusions: Study results suggest that emphasis should be put on external modifications rather than early screening and pre-selection of recruits. A significant effect was achieved by reducing equipment weight and changing configuration of the combat gear so as to approximate it to the body center of gravity. This last intervention is promising and should be further evaluated. Our results seem to suggest the need of preparing fighting gear designed for females, and refraining from using the male fighting gear for female recruits.
Stress Fractures in Female Border Police Recruits During Basic Training

Introduction:
Female recruits are known to have a relatively high incidence of stress fractures (SF). This has been apparent also when female fighters entered the Israel Border Police training program.

Material & Methods:
From February 1996 to February 1998, five courses of female recruits were held with a total of 229 participants. The four later courses were controlled and strictly documented. Due to the high incidence of SF, 35% total and 27% "dangerous" SF, four modifications were gradually introduced. Shoes were replaced, nutrition was modified, a training scale was programmed, and preselection of candidates was eventually added.

Results:
For 229 female fighters taking part in the five courses the following data were recorded:
1) The incidence of fighters suffering stress fractures affecting the shaft of the long bones ("dangerous" Stress Fractures), reduced gradually from 27% to 15%.
2) The incidence of fighters suffering of grade II or higher dangerous stress fractures reduced gradually from 19% to 8.3%.
3) The total average number of dangerous stress fractures per fighter (all grades) reduced gradually from 0.54 to 0.35.

Discussion:
The above data seem to suggest a tendency for gradual reduction in the rate and severity of SF in female recruits following various modes of intervention. The differences are not statistically significant as the total numbers and differences are low, but the trend seems to be stable and consistent.

Conclusions:
Various interventions including shoe modification, nutrition, controlled training program and a pre-recruitment course seems to have a certain effect in reducing the incidence and severity of SF, especially those termed “dangerous stress fractures”.
Continued Sports Activity, Using a Pain-Monitoring Model, During Rehabilitation in Patients with Achilles Tendinopathy - A Randomized Controlled Study

Background:
Achilles tendinopathy is a common overuse injury, especially among athletes involved in activities that include running and jumping. Often an initial period of rest from the pain provoking activity is recommended.

Purpose:
To prospectively evaluate if continued running and jumping during treatment with an Achilles tendon loading strengthening program would have an effect on the outcome.

Study design:
Randomized controlled clinical trial; Level of evidence, 1.

Methods:
Thirty-eight patients with Achilles tendinopathy were randomly allocated to two different treatment groups. The Exercise training Group (n=19) was allowed, with the use of a pain monitoring model, to continue Achilles tendon loading activity, such as running and jumping, whereas the Active rest Group (n=19) had to stop such activities during the first 6 weeks. All patients were rehabilitated according to an identical rehabilitation program. The primary outcome measures were the Swedish version of the Victorian Institute of Sports Assessment – Achilles questionnaire and the pain level during tendon loading activity.

Results:
No significant differences in the rate of improvements were found between the groups. Both groups showed, however, significant (p<0.01) improvements, compared with baseline, on the primary outcome measure at all the evaluations. The Exercise Group had a mean (SD) VISA-A-S score of 57 (15.8) at baseline and 85 (12.7) at the 12 month follow-up (p<0.01). The Active rest Group had a mean (SD) VISA-A-S score of 57 (15.7) at baseline and 91 (8.2) at the 12 month follow-up (p<0.01).

Conclusions:
No negative effects could be demonstrated from continuing Achilles tendon loading activity, with the use of a pain monitoring model, such as running and jumping during treatment. Our treatment protocol for patients with Achilles tendinopathy, which gradually increases the load on the Achilles tendon and calf muscle, demonstrated significant improvements. A training regimen of continued, pain monitored, tendon loading physical activity might therefore represent a valuable option for patients with Achilles tendinopathy.
Insertional Achilles Tendinopathy - Eccentric Loading vs. Radial Shock Wave Treatment

Nonoperative management of chronic tendinopathy of the Achilles tendon insertion is poorly studied. With demonstrated effectiveness of eccentric loading and of repetitive low-energy shock wave treatment in patients with midsubstance Achilles tendinopathy recently, this randomized controlled trial aimed at verifying effectiveness of both procedures exclusively in patients with insertional Achilles tendinopathy.

Fifty patients with chronic recalcitrant (> 6 months) insertional Achilles tendinopathy were enrolled in a randomized controlled study. All patients had been treated unsuccessfully for at least 3 months, including local injections and non-steroidal anti-inflammatory drugs and physiotherapy. A computerized random-number generator was used to draw up an allocation schedule. Twenty-five patients were allocated to Group 1 (eccentric loading), 25 patients were allocated to Group 2 (repetitive low-energy shock wave treatment). Analysis was on an intention-to-treat basis. Primary follow-up was at 4 months, afterwards patients were allowed to cross over. The last follow-up was at one year after completion of the initial treatment. The patients were assessed for pain, function and activity using a validated questionnaire (the VISA-A).

At 4 months from baseline, the VISA-A score had increased in both groups, from 53 to 62 points in Group 1, and from 53 to 80 points in Group 2. The pain rating decreased in both groups, from 7 to 5 points in Group 1, and from 7 to 3 points in Group 2. Seven patients (28%) in Group 1, and sixteen patients (64%) in Group 2 reported that were “completely recovered” or “much improved”. For all outcome measures, Group 1 and 2 differed significantly in favour of shock wave treatment. At 4 months, 18 of 25 patients from Group 1 opted to cross over, as did 9 of 25 patients from Group 2. The favorable results after shock wave treatment at 4 months were stable at 1-year follow-up.

Eccentric loading as applied showed inferior results to low-energy shock wave therapy as applied in patients with chronic recalcitrant tendinopathy of the insertion of the Achilles tendon at 4 months of follow-up.
Abnormal Eccentric Neuromuscular Control of the Quadriiceps Muscle Lead to Infrapatella Tendonitis

Infrapatella tendonitis (runners knee /jumpers knee) occur predominantly in sports where the Quadriceps muscle works eccentrically. Our hypothesis is that abnormal neuromuscular function causes abnormal high strains that lead to micro tears and the syndrome of Infra patella tendonitis. These forces are present for micro seconds which make it very difficult to measure in vivo. We therefore used the LifemodR system previously validated to measure joint forces to simulate abnormal eccentric forces and then calculate the strain created in the infra-patella tendon. We used this data to design a novel Eccentric Ergometer to test in vivo if eccentric neuromuscular control is worse in people suffering from infrapatella tendonitis.

Method: In order to evaluate the influence different eccentric muscle forces on the infrapatella tendon, a three-dimensional dynamic computer model of a human subject pedalling an eccentric exercise cycle (GrucoxR) was constructed with the LifemodR software package. One knee of the modelled human subject was detailed by importing 3D models of the patella, distal femoral head and proximal head of the tibia, all of which were constructed from segmentations of MRI scans of the test subject’s knee, including the articular cartilage. The MRI data are also used to orientate the modelled ligaments. Actual recorded motion and pedal force data from the same human test subject pedalling our eccentric exercise cycle are used to drive the model during the inverse dynamic simulation phase. Validation of the final model is provided by using electromyography (EMG) data recorded from the subject. The model comes into its own when used in forward dynamics mode to investigate the effects of poor muscular control on infrapatella tendon strain. We used this data to design a new ergometer where the amount of force generated can be measured and controlled. Our study includes 20 subjects with infrapatella tendonitis confirmed with MRI scans, and 20 matched controls with no history or signs of infrapatella tendonitis on MRI. Eccentric control was measured with the GRUCOX ergometer.

Results: Simulating abnormal eccentric neuromuscular control with LifemodR we calculated that the forces created in the infrapatella tendon is higher than can be physiological tolerated. Subjects with infrapatella tendonitis showed a statistically significant decrease in eccentric neuromuscular control.

Conclusion: Abnormal eccentric neuromuscular control of the quadriceps muscle contributes to infrapatella tendonitis.
Arthroscopic Treatment of the Iliotibial Band Syndrome

Objective
Iliotibial Band Syndrome (ITBS) is an overuse injury mainly affecting runners. The initial treatment is conservative therapy. In recalcitrant cases surgery is indicated. The conventional technique is lengthening of the iliotibial tract (ITT) and removing a section of the posterior aspect of the ITT. The aim of this study was to evaluate the results of an arthroscopic technique to treat ITBS.

Methods
Thirty six patients with an ITBS resistant to conservative therapy were managed arthroscopically. Thirty three were available for follow up. All patients had at least 6 months follow up with an average of 2 years 4 months. All the patients were recreational or professional athletes: long distance running (22), triathlon (5), soccer (1), rugby (3), athletics (3), swimming (1), fencing (1), basketball (1). There were 15 women and 21 men. The mean age was 31,1 years (range 19 to 44). All the patients had suffered from the ITBS for at least one year before passing to surgery. In all patients the diagnosis was confirmed by ultrasonography or magnetic resonance imaging.

We used a standardized arthroscopic technique. The patient is placed in supine position with the leg in 30 degrees of flexion. The joint space is inspected through the anteromedial and anterolateral portals. The lateral synovial recess is resected through a superolateral portal. A drain is placed during 24 hours.

Results
The procedure was well tolerated in all patients. In two patients a meniscal lesion was found, which required treatment. All patients went back to sports after 2 to 3 months. In 32 patients the results were good or excellent (no pain or much less pain in activity, complete return to preoperative sport level). One patient with only a fair result had associated cartilage lesions of the femoral condyle.

Discussion and conclusion
In cadaveric studies it was found that the ITBS was associated with inflammation of fibrous strands anchored to the distal femur. Based on these findings an arthroscopic technique was developed. Our results show that arthroscopic treatment of resistant ITBS is a valid option with a consistently good outcome. In addition, this arthroscopic approach allows excluding or treating other intra-articular pathology.
Biomechanical Comparison of two Double-Row Rotator Cuff Repair Techniques Utilizing Bioabsorbable Anchors (Corkscrew with Fiberwire vs SwiveLock with Fibertape): Cyclic Loading and Failure Behavior

Background: Double-row fixation for rotator cuff repairs has been gaining popularity because of its reported superior biomechanical properties and improved footprint reconstruction. However, the optimal configuration of double-row fixation has yet to be determined.

Hypothesis: A newly developed double-row configuration utilizing a novel suture material and bioabsorbable anchors will have biomechanical properties superior to a standard double-row configuration using bioabsorbable anchors.

Study Design: Controlled laboratory study.

Materials and Methods: In ten matched pair sheep shoulders, the infraspinatus tendons were re-attached. Repairs utilized either a double-row technique with Bio-CorkscrewTM FT2 anchors for the medial row and SwiveLockTM anchors for the lateral row, or a double-row technique utilizing a new ultra-high strength tape material (FibertapeTM) with SwiveLockTM anchors for both the medial and lateral rows. Each specimen underwent cyclic loading from 10 to 150N for 100 cycles, followed by ultimate unidirectional failure testing. Gap formation and strain within the repair area for the first and last cycles were analyzed using a video digitizing system (ViconTM) while stiffness and failure load were determined from the load/elongation curve (ZwickTM). For statistical analysis, a paired t-test with significance level of P<0.05 was performed.

Results: Overall, the results were similar for the two repair types. There was no significant difference between the ultimate failure loads of the two techniques (Anchor 421+150N (mean+-SD); SwiveLock 408+66N, p=0.31) or the stiffness of the two techniques (Anchor 84+-26N/mm; SwiveLock 99+20N/mm, p=0.07). In addition, gap formation was not different between the repair types (Anchor - first cycle 1.37+-0.6mm, last cycle 2.22+-0.7mm, SwiveLock - first cycle 1.16+-0.5mm, last cycle 2.14+-0.8mm; first cycle p=0.40, last cycle p=0.83). Strain over the repair area was also not different between the repair types (Anchor - first cycle 6.40+-3.4, last cycle 2.13+-0.7; SwiveLock - first cycle 6.84+-2.5, last cycle 2.11+-0.8; first cycle p=0.76, last cycle p=0.94).

Conclusion: Both double-row repair configurations exhibited superior biomechanical properties compared to previously published biomechanical studies with high failure loads, limited gap formation and acceptable strain patterns even with the use of bioabsorbable fixation systems. However, no significant difference was found between the novel and the conventional double-row repair types. Since there is a statistical trend of a higher stiffness in the novel double-row repair technique, this may be relevant in the clinical setting were the human tendon quality is inferior compared to the animal model.
Biomechanical Analysis of Transosseous versus Suture Anchor Repairs of Subscapularis Tendons: A Real-Time Contact Area Measurement Under Rotational Load

Background: Arthroscopic subscapularis tendon repair has become more popular with injury recognition and improvement in arthroscopic techniques. In this study, we compared the biomechanical properties of open transosseous versus arthroscopic suture anchor repairs of the subscapularis tendon. We performed real-time measurement of contact area and pressure of the repair site under rotational loads.

Methods: Six paired human cadaveric shoulders were subjected to rotational loading of the subscapularis tendon repairs. The right and left shoulders were randomized to transosseous and suture anchor repairs. Realtime pressure sensors were placed between the subscapularis tendon and lesser tuberosity. The repair was subjected to cyclical rotational loading and load-to-failure testing. Paired t-tests were performed with statistical significance set at p<0.05.

Results: No significant difference was detected in initial pressurized contact area between transosseous repairs, 1.70 ± 0.99 cm², 57.88 ± 30.02 % footprint; and suture anchor repairs, 1.08 ± 0.58 cm², 34.26 ± 17.32% footprint. Under cyclical loading, the conditioning elongation of transosseous repairs (0.64 ± 0.40 mm) was significantly lower (p < 0.05) than that of suture anchor repairs (2.38 ± 1.58 mm). No significant difference was found in mean pressurized contact area between the transosseous (2.72 ± 1.25 cm², 94.2 ±37.4 % footprint) and suture anchor repairs (2.01 ± 0.89 cm², 65.9 ± 27.9 % footprint). For suture anchor repairs, repair-site contact area was significantly (p < 0.05) smaller than the area of corresponding native insertional footprints; for transosseous repairs, no significant difference was detected. In the load-to-failure tensile test, there was no significant difference between transosseous (453.2 ± 66.1 N) and suture anchor repairs (392.6 ± 78.0 N).

Conclusions: Transosseous and suture anchor repairs have comparable biomechanical properties in subscapularis tendon repair. Despite increased conditioning elongation in suture anchor repairs, there was no difference in mean contact area between the two repairs under cyclical loading. Real-time pressure measurements enabled accurate mapping of the repair site throughout cyclical loading.

Clinical Relevance: Rotational loading of the subscapularis tendon may provide a more accurate representation of subscapularis tendon injuries. Both techniques demonstrated adequate repair strength; however, improvement in surgical techniques may be required to better reproduce normal insertional behavior.
Circulating Substance P Levels and Shoulder Joint Contracture After Arthroscopic Repair of the Rotator Cuff

Objective: To determine the plasma levels of substance P (SP) in patients with postoperative stiffness after arthroscopic rotator cuff repair.

Design: Plasma samples were obtained at 15 months from surgery from 2 groups of patients who underwent arthroscopic repair of a rotator cuff tear. In Group 1, 30 subjects (14 men and 16 women, mean age: 64.6 years, range 47 to 78) with shoulder stiffness 15 months after arthroscopic rotator cuff repair were recruited. In Group 2, 30 patients (11 men and 19 women, mean age: 57.8 years, range 45 to 77) were evaluated 15 months after successful arthroscopic rotator cuff repair. Immunoassays were performed with commercially available assay kits to detect the plasma levels of SP.

Results: The mean plasma levels of SP in patients with postoperative stiffness were significantly greater than those in the control group (81.06 ± 27.76 versus 23.49 ± 5.64, P < 0.05).

Conclusions: The plasma concentrations of substance P in patients with shoulder stiffness after arthroscopic rotator cuff repair are higher compared to plasma levels of SP in patients with a good postoperative outcome. The neuronal up-regulation of SP shown in the plasma of patients with post operative shoulder stiffness may underlay not only the symptoms of adhesive capsulitis, but also its development.
No Differences Between Arthroscopic Single Row and Double Row Suture Anchor Repair for Rotator Cuff Tears

Background: Restoring of anatomic footprint may improve the healing and mechanical strength of repaired tendons. A double row of suture anchors increases the tendon-bone contact area, reconstituting a more anatomic configuration of the rotator cuff footprint.

Hypothesis: No difference in clinical and imaging outcome between single row and double row suture anchor technique repairs of rotator cuff tears.

Study Design: Randomized controlled clinical trial. Level of evidence 1.

Methods: We recruited 60 patients. In 30 patients, rotator cuff repair was performed with single row suture anchor technique (Group 1). In the other 30 patients, rotator cuff repair was performed with double row suture anchor technique (Group 2). 8 patients (4 in the single row anchor repair group and 4 in the double row anchor repair group) were lost at follow up.

Results: 8 patients did not return at the final follow up. At the 2 year follow-up, no statistically significant differences were seen with respect to the UCLA score and ROM values. Post-operative MR arthrography at 2 years of follow up in group 1 showed intact tendons in 14 patients, partial thickness defects in 10 patients and full thickness defects in 2 patients. In group 2, MR arthrography showed an intact rotator cuff in 18 patients, partial thickness defects in 7 patients, and full thickness defects in 1 patient.

Conclusions: Single and double row technique provide comparable clinical outcome at 2 years. A double row technique produces a mechanically superior construct compared to the single row method in restoring the anatomic footprint of the rotator cuff, but these mechanical advantages do not translate in superior clinical performance.
The Subcoracoid Space: An Anatomical Study

Objective: To evaluate the amplitude of the subcoracoid space under maximum internal and external rotations of the humeral head and measure the distance between the apex of the coracoid process (ACP) and the following anatomical structures: (a) point of entry of the musculocutaneous nerve (MCN) and its branches into the coracobrachial muscles (CBM) and into the short head of the biceps brachii muscle; (b) acromial artery (AA); (c) lesser tubercle of the humerus (LTH).

Relevance: Knowledge of the anatomical relationships between these structures and the ACP is important not only for understanding the etiology of coracoid impingement, but also to prevent vasculonervous injuries, particularly during arthroscopic surgical approaches.

Material and method: Thirty shoulders from of fresh cadavers (nine male and 6 female), without of any kind of shoulder disease, were dissected and the distances (in mm) were measured between the anatomical structures defined above and the ACP.

Results: The mean distance between the ACP and the MCN was 49.2 mm (in all specimens a proximal branch of the nerve was identified 34.2 mm away from the ACP), which was not significantly different between the sexes or body sides. The mean distance between the ACP and the AA was 12.4 mm, which was not significantly different between the sexes and body sides. The mean distance between the ACP and the LTH, with the humeral head under internal rotation, was 10.6 mm in men and 8.6 mm in women, thus presenting a significant difference between the sexes.

Conclusions: The smaller distance between the ACP and the LTH in internal rotation of the arm suggests that there is a higher chance of impingement between those bone structures among women.
The Usefulness of Multidetector CT Arthrography in the Diagnosis of Shoulder Pathology
- Comparison with MR Arthrography and Operative Finding in the Same Patients -

Purpose: The purpose of the present study was to evaluate the usefulness of CT arthrography (CTA) by making a comparative study of CTA and MR arthrography (MRA) with the operative finding in the same patients.

Materials and methods: 34 patients suspected of shoulder disease had MRA and CTA simultaneously. Through each image, 4 total lesions of supraspinatus tendon (SST) full thickness tear, PASTA lesion, SST bursal side partial tear and SLAP lesion were diagnosed, and the sensitivity and specificity of CTA were evaluated in comparison to MRA. Also the accuracy of CTA was evaluated by analyzing the arthroscopic finding of 22 patients among total 34 patients. Additionally, this study was done to know, whether the size of the lesion is predictable through CTA or not. Also any shoulder pathology which may be easily diagnosed with CTA have been investigated.

Results: CTA, compared to MRA, has shown sensitivity of 86.7%, specificity of 100% in diagnosis of SST full thickness tear, and those in diagnosis of SLAP lesion have shown 100% and 96.1%, respectively. Thereby, CTA is useful equivalent to MRA. In diagnosis of PASTA lesion, some have shown usefulness with sensitivity of 66.7% and specificity of 100%. However, in diagnosis of SST bursal side partial tear, the sensitivity was as low as 0%. Besides, CTA has shown to be relatively accurate when the diagnoses were verified with the arthroscopic finding; SST full thickness tear and SLAP lesion have shown 90.9% and 83.3% of high accuracy respectively and 60% accuracy in PASTA lesion. CTA and MRA came out to be similar in predicting the size of lesion. And CTA was more helpful for assessing acromial bony spur and bone lesions such as secondary cystic change.

Conclusion: CTA was a useful tool as equivalent as MRA in assessment of SST full thickness tear, SLAP lesion and PASTA lesion, except for the diagnosis of bursal side partial tear. Thus, it may be used preferably to diagnose shoulder pathology and to follow up after operation as an inexpensive tool.

Key Words: Shoulder, CT arthrography, MR arthrography
The Contribution of Posteroinferior Capsule Tightness to Subacromial Impingement During Pitching Motion

Introduction:
Loss of internal rotation as well as excessive external rotation has been recognized in baseball pitchers. Tightness of the posteroinferior capsule including the posterior band of the inferior glenohumeral ligament is assumed to be the cause of this loss (Burkhart, 2003). Previously, the posterior capsule tightness was speculated to lead to subacromial impingement during shoulder flexion and horizontal adduction (Harryman, 1990). Although intra-articular (internal) impingement during the pitching motion is well accepted, the relationship between the posterior capsule tightness and subacromial (external) impingement is unclear. The purpose of this study was to determine the effect of posteroinferior capsule tightness on contact pressure and area of the coracoacromial arch and humeral head during the pitching motion.

Materials and Methods:
Seven fresh cadaveric glenohumeral joints were harvested and used for the study. Specimens with rotator cuff tears or radiographic evidence of acromial spurs and glenohumeral osteoarthritis were excluded. All tissues except the rotator cuff muscles and coracoacromial ligament were removed. The specimen was secured in a custom-designed shoulder experimental device which allows 6 degree-of-freedom motion of the glenohumeral joint. Flexible tactile force sensors (K-SCAN model 4000; Tekscan Inc, South Boston, Mass) were utilized to measure the contact pressure and area on the undersurface of the acromion and coracoacromial ligament. Simultaneously, an electromagnetic tracking device (FASTRAK, Colchester, VT) and motion capture software (MotionMonitor, Innovative Sports Training, Chicago, IL) were used to digitize and animate the surfaces of the scapula and humeral head and observe the contact area on them from various angles. The posteroinferior capsule tightness was simulated by clamping the capsule in the region from 6 to 8 o’clock. The static testing positions in the study correlated to the early cocking, late cocking, acceleration, deceleration, and follow-through phases of the pitching motion. In each phase, the forces applied through the rotator cuff muscles were based on the muscle’s cross-sectional areas and muscle activations during pitching. A paired t-test was used to compare all the parameters between the intact and posterior capsule tightness conditions.

Results:
In the posteroinferior capsule tightness condition, the peak contact pressure during the deceleration (0.58±0.26MPa) and follow-through (0.85±0.43MPa) phases were almost twice that of the intact condition (0.30±0.26 and 0.37±0.21MPa, respectively) (p<0.05), whereas there was no difference in the other phases. After clamping the posteroinferior capsule, the contact area on the coracoacromial arch shifted posteriorly and was located on the undersurface of the acromion from early cocking to the acceleration phases, however, the area shifted anteriorly and was located underneath the coracoacromial ligament during the deceleration and follow-through phases. In almost all specimens, the contact area on the humeral head was at the greater tuberosity during each phase, but, in a specimen, lesser tuberosity during the follow-through phase. Unlike the coracoacromial arch, the contact areas did not shift after clamping.
Discussion:
Previously, posteroinferior capsule tightness has been recognized as a factor which causes SLAP lesion in the late cocking phase (Burkhart, 2003) and subacromial impingement during the elevation motion (Meister, 2000). However, our findings demonstrate an increase in contact pressure on the subacromial arch during the deceleration and follow-through phases. An anterior shift of the contact area and high contact pressure on the coracoacromial arch during the follow-through phases could be explained by anterior translation of the humeral head with horizontal adduction due to posterior capsule tightness (Harryman, 1990). Although internal impingement during the late cocking phase has been recognized to be a cause of injury of the rotator cuff and its surrounding tissues, posteroinferior capsule tightness could also lead to higher pressure on the coracoacromial arch and increase risk of injury.

References:
Functional Outcomes Following Anatomic Coracoclavicular Ligament Reconstruction (ACCR): A Prospective Study

Background: Anatomic coracoclavicular ligament reconstruction (ACCR) has been shown to be an effective procedure from both an anatomic and biomechanical perspective. There has been no clinical outcome data on this procedure to date.

Purpose: To evaluate the clinical outcomes in patients who underwent an anatomic coracoclavicular ligament reconstruction.

Methods: Prospective case series of a single surgeon’s practice. All patients with an AC joint dislocation from the start of a single surgeon’s practice (ADM) August 2002 to October 2006 were eligible for inclusion into the study (IRB # 06-069-01). Inclusion criteria: acute Grade IV and VI AC separations, and Grade III and V who had continued pain for greater than three months, failure to return to prior level activity, and pain with forward elevation and horizontal adduction. Exclusion criteria: Grade I and II separations or successful conservative management of Grade III and V AC joint separation. All patients underwent ACCR using a 2 bundle semitendinosus allograft with interference screw fixation. Patients were evaluated pre and post operatively with the American Shoulder and Elbow Surgeons score (ASES), the Simple Shoulder Test (SST), and the Constant Murley score. Additional post operative measures included the Self Assessment Numeric Evaluation score (SANE), reported pain with a posterior directed force, forward elevation and horizontal adduction, and coracoclavicular distance (CCD) which was defined as the distance between the tip of the coracoid and the undersurface of the clavicle compared bilaterally and expressed as a difference.

Results: There were 132 AC joint dislocation cases coded from August 2002 to October 2006. 10 patients underwent an ACCR. Complete follow-up exams were performed in 9 of 10 (90%). One patient was lost to follow up secondary to incarceration. There were 2 women and 7 men (mean age, 41 +/- 13 years). Follow up averaged 24 months (12-40). There were 7 Grade III and 2 Grade V separations. There was one revision case for a failed ACCR secondary to non compliance. The mean pre- to post-operative scores for the four clinical outcome measures were all statistically significant (p>.001): ASES (52.6 +/- 15.0 to 92.2 +/- 5.14); SST (7.1 +/- 2.9 to 11.8 +/- 0.441); Constant Murley (66.6 +/- 12.7 to 94.7 +/- 5.02). The mean post operative SANE score was 94.4 +/- 5.55. All patients reported no pain with a posterior directed force, forward elevation and horizontal adduction. On radiographic analysis the mean difference in CCD was 0.96 +/- 1.2 cm. Linear regression was used to explore whether pre operative findings affected post operative outcome. No clinically or statistically significant difference was found indicating the patients were able to achieve the same level function regardless of differences in severity or nature of injury.

Conclusion: Anatomic coracoclavicular ligament reconstruction was effective in restoring AC joint stability and function in patients with Grade III and V separations.
Arthroscopic Management of First-time Traumatic Anterior Shoulder Dislocation in Young Athletes: Evaluation and Results in 100 Cases with 7.4 years Follow-up

Introduction: In the literature several publications show the advantages of the early arthroscopic stabilization after the first episode of traumatic shoulder dislocation. Nevertheless it is still considered by some authors a controversial topic. The purpose of this paper is a retrospective evaluation of our first 100 cases treated with arthroscopic stabilization.

Methods: Between September 1989 and May 2005 100 arthroscopic stabilization of first time dislocation were performed in athletes. Mean age at surgery moment was 22 years. 78% of the patients were rugby players. Until October 1995 we used the Transglenoid suture technique in 23 cases and the others 77 cases were stabilized with Suture Anchor technique.

Results: The mean follow-up was 7.4 years (range: 3 - 19 years). Capsular tear with complete labrum detachment (type III lesion) was the most frequent surgical finding. Minor Bony Bankart lesions (<25%) were found in 19 cases. 75 cases (75%) of osteochondral Hill-Sachs lesions and 15 cases (15%) of bone Hill Sachs lesions were identified. We treated 2 cases of Humeral Avulsion of Glenohumeral ligament (HAGL) with arthroscopic and mini open technique. According to the Rowe scale we obtained excellent and good results for 96% (74 cases) of the patients treated with the Suture Anchor Technique and in 87% (20 cases) of the patients treated with the Transglenoid technique. Return to sport was allowed after the 4th month, being at pre-injury level for all cases. The average time was 5.3 months (4-7).

Discussion and Conclusion: Many studies have shown a high percentage of redislocation after non-surgical treatment. Younger patients and practicing contact sports, over head sports or sports of high speed (snow skiing, motocross) increase this risk. The best time to treat shoulder instability is after the first episode; tissues are in better condition, which allows for anatomic repair. Technically it is easier to liberate and reduce the structures with minimal capsular plication. Excellent results are obtained, with early return to sport at pre-injury level. There is a clear tendency to better results with the Suture Anchor Technique.
Posterior Traumatic Shoulder Instability in Athletes

Introduction: The posterior shoulder instability is not so frequent but often as a part of the multidirectional instability. In these cases conservative treatment provides good results. In cases of trauma associated with posterior labral lesion, isolated posterior instability can occur, and the surgical treatment may be necessary.

Purpose: Evaluate the results of arthroscopic treatment for traumatic posterior shoulder instability.

Material and methods: 21 shoulders/20 patients with traumatic posterior instability of the shoulder were treated arthroscopically. The mean age was 29.38 years (20-53), two patients were females and 18 males. All patients were involved in sports activities. The main complaint was the sensation of pain and giving way of the shoulder during sports activity. All patients had posterior labral injuries confirmed by MRI. The surgery was performed after failure of conservative treatment for three months. The patients underwent arthroscopic treatment on beach chair. The rehabilitation program consisted of postoperative immobilization for 3 weeks in sling in neutral rotation followed by physiotherapy. The return to sport was allowed after 5 months.

Results: We used an average of 2.76 anchors (2-4) for repair. The average follow-up was 28.47 months (12-70). There was improvement in symptoms of pain and feeling of instability in all patients. We found limited external rotation of 5 degrees in two patients, and 10 degrees in two other patients. One of the patient (4.76%) with 10 degrees of external rotation deficit presented light sports limitations (Rowe Score - 90). All the others patients(95.24%) returned to the sport without limitations.

Conclusion: The arthroscopic treatment for traumatic posterior shoulder instability offers satisfactory results in the majority of cases (95.24%), with improvement of symptoms and allowing the return to activities. The limitation of external rotation (less than 10 degrees) does not cause significant functional activities deficits.
Shoulder Instability in the Collision Athlete – The ‘Collision Shoulder’

Introduction
The spectrum of pathoanatomy in collision athletes with shoulder instability is wide, with a high incidence of extended labral lesions and associated intra-articular injuries. The ‘collision shoulder’ describes an injury sustained by direct impact to the braced shoulder without dislocation, often accompanied by neurologic symptoms, which can result in extensive (often posterior) labral damage with a high incidence of other significant intra-articular pathology.

Methods
183 collision athletes (rugby and rugby league) including 72 ‘elite’ players were treated for labral injuries related to their sport in 3 different centres. Details of the mechanism of injury and findings at arthroscopy were recorded. Only 65% of athletes in the series presented following a documented dislocation or subluxation episode of the shoulder, of which only 62.5% required a formal reduction. An additional pattern of injury was recognized in the remaining athletes involving a direct impact injury to the braced shoulder (the ‘collision shoulder’). In these athletes the clinical symptoms and signs were less specific but there was a high incidence of ‘dead arm’ at the time of injury (72%). Over 40% of the ‘elite’ athletes were included in this group.

Results
The spectrum of pathology in the entire series was wide with a high incidence of associated intra-articular lesions. In those athletes with an impact type of injury without dislocation there was more extensive labral pathology with a high incidence of posterior labral tears (50%). The incidence of associated chondral lesions was similarly very high (50%) but significant bony pathology (bony Bankart) was less common than in the dislocation group (11% versus 26%). The ‘elite’ athletes had less frank dislocations but were more likely to sustain neurologic injury, posterior labral tears, SLAP lesions and cartilaginous and capsular injuries.

Discussion
The incidence of all lesions in this series of collision athletes is higher than those previously published. These lesions often occurred in the absence of a frank dislocation (the ‘collision shoulder’), especially in the ‘elite’ players. It is important to anticipate additional pathology when planning definitive management in these patients, with surgery being tailored to the specific lesions found. However the collision athlete who sustains an impact type of shoulder injury without dislocation can do well following arthroscopic treatment, with a high rate of successful return to their sport, even at the ‘elite’ level.
Normal Shoulder Outcome Score Values in the Young, Active Adult

Objectives: Although numerous shoulder scores are available to assess pain, function, symptoms, and athletic activities for a variety of shoulder conditions, the majority of shoulder scores have not been tested in a normal subset of patients. The purpose of our study is to determine baseline, normative values for multiple shoulder outcomes scores in a young, active population without shoulder symptoms.

Methods: A total of 206 patients were recruited to complete a battery of shoulder outcomes scores. Participants were first screened to exclude anyone with a current or prior shoulder condition, or who presented with any shoulder pain. Fourteen patients were excluded based on these criteria or failure to complete the majority of the battery. One hundred ninety-two participants completed the Single Assessment Numeric Evaluation (SANE), modified American Shoulder and Elbow Society Score (ASES), Western Ontario Shoulder Instability Index (WOSI), Simple Shoulder Test (SST), and the Disabilities of the Arm, Shoulder, and Hand (DASH) score. The mean age was 28.79 (range, 17 to 50, SD 7.4 years), and there were 148 males (77%), 38 females (20%), and 6 undeclared (3%).

Results: A total of 59 participants (31%) scored no deficiencies on all of the outcomes instruments (a score of zero, or 100% function). The majority of participants (133 or 69%) demonstrated some level of abnormal shoulder score. The mean scores for all participants were SANE= 97.7 (+/- 5.2), ASES=98.9 (+/- 3.3), WOSI = 82.7 of 2100 (+/- 153.5), SST = 11.79 (+/- 0.60), and DASH = 1.85 (+/- 5.99). The relative scores from a perfect result in descending order were the WOSI (3.9%), the SANE (2.3%), the DASH (1.8%), the SST (1.7%) and the ASES (1.1%).

Conclusions: Our results demonstrate, even in a completely asymptomatic population, that the best possible shoulder score may not be equivalent to a perfect score on the outcomes scale. Clinicians and researchers should be aware that normal outcomes scores in a young population may be in the 96 to 98% range of a perfect score. These numbers may be used by future researchers and surgeons to accurately assess outcomes in a young, active adult population.

Key Words: outcomes scores; shoulder pain; correlation
Rotator Cuff Repair: Suture Spanning Anatomic Footprint Restoration Technique is Superior to Standard Dual-Row Repair

Introduction: In rotator cuff surgery, dual-row suture anchor fixation is gaining popularity because of its ability to create a broad, anatomic healing surface as well as a high strength and rigid repair. Many concerns exist with this new technique, however, because it may prolong surgical time and increase the cost of the procedure. There are also questions as to whether as crowding the tuberosity with multiple implants and formation of many prominent knots may be problematic. Furthermore, the possibility of overtensioning the myotendinous unit is of utmost concern. The purpose of this study was to describe a modified anatomic repair technique that addresses these issues.

Materials and Methods: A prospective clinical study was performed on 30 subjects and a basic science portion was performed using 12 pairs of cadaveric shoulders. On Group I (n=15) a typical arthroscopic dual-row rotator cuff repair was performed. In Group II (n=15) a suture-spanning technique was performed. Adequacy of footprint restoration was assessed with a calibrated probe in the glenohumeral and subacromial spaces. Time to complete each procedure was recorded. The paired cadaveric specimens were randomized into 3 groups and suture-spanning repair performed: in Group I the medial sutures were placed 14 mm from the tendon edge, in Group II the medial sutures were placed 10mm from the tendon edge, and Group III was a single-row repair. Footprint area was measured in the basic science portion with a Microscribe.

Results: Both repair techniques in the clinical Group I and II allowed full restoration of the insertional footprint. The suture-spanning technique in Group II, however, eliminated prominent knots by making them flush with the surface of the tendon and allowed the overall surgical time to be an average of 20 minutes shorter (P < 0.001). Group I revealed 13.1mm of footprint coverage, Group II had 9.5mm of coverage and Group III had 5.6mm.

Conclusion: Suture-spanning anatomic footprint restoration for rotator cuff repair appears to provide the benefits of a traditional dual-row anchor repair while addressing some of the concerns. The procedure is simplified and surgical time is decreased. There is less crowding of the tuberosity with use of the smaller 2.9mm RC Loop anchors in the lateral cortex and knots are no longer prominent. The procedure also lends itself to be performed in such a way to minimize the chance of over-tensioning the rotator cuff since the amount of tendon lateralization is determined by the size of the medial row suture bite and can be adjusted according to surgeon discretion.
Outcomes Following Arthroscopic Revision Rotator Cuff Repair

BACKGROUND: Although failure of repair is the most common complication following rotator cuff surgery, there are limited reports of outcomes following revision arthroscopic rotator cuff repair.

OBJECTIVES: To report the outcomes and identify prognostic factors following revision arthroscopic repair of full-thickness rotator cuff tears.

METHODS: A retrospective cohort of 53 patients (mean age 54.9 +/- 10.1 years) was evaluated at minimum 1 year following arthroscopic revision of full-thickness rotator cuff tears. Exclusion criteria included partial-thickness or irreparable tears, or open repair. Average follow-up was 31.1 months (SD, 11.9 months) at which time range of motion, American Shoulder and Elbow Surgeons Score (ASES), Simple Shoulder Test (SST) and dynamometer (Isobex) strength testing were measured. Multiple variables including age, preoperative work level, workers' compensation status, the number of prior ipsilateral shoulder surgeries, medical comorbidities, tobacco use, and tear size were recorded from chart review. Contingency table analysis was used to identify significant associations between these variables and return to work at preoperative levels, time to maximum medical improvement (MMI) and failure of repair requiring additional surgery.

RESULTS: 78.3% of patients returned to work at their preoperative level, at an average 7.7 +/- 2.7 months. 11.3% of patients had failure of their revision repair requiring additional surgery. Workers’ compensation status (p=0.0002), heavier preoperative work levels (p=0.009), current smoking (p=0.019), a prior open surgical approach (p=0.032) and a simultaneous biceps procedure (tenotomy or tenodesis) (p=0.0043) were all associated with a full recovery occurring more than 6 months after surgery. A very heavy preoperative work level was associated with failure requiring additional surgery (p=0.02), while a history of only one prior ipsilateral shoulder operation was associated with a lower failure rate (p=0.036). Tear size was not predictive of postoperative failure (p=0.1). Among the large component of workers’ compensation patients in this study (72%), a lower intensity preoperative work level (p=0.04), non-smoking status (p=0.014), and smaller tear size (p=0.033) were all associated with an increased return to work at full duty.

CONCLUSIONS: Arthroscopic revision rotator cuff repair can result in the majority of patients returning to their preoperative level of function, with a relatively low rate of failure. Workers’ compensation status, current smoking and heavier preoperative work levels predict a longer recovery and a less likely return to premorbid level of function. Heavy laborers may be at an increased risk of failure following arthroscopic revision, while those with only one prior operation are less likely to require additional surgery.
Outcome of Worker's Compensation Patients Following Arthroscopic Full-Thickness Rotator Cuff Repair

OBJECTIVES: Outcomes following rotator cuff repair in workers compensation patients are generally reported to be inferior to the general population. The purpose of this study is to evaluate the outcome of arthroscopic rotator cuff repair in workers compensation patients and to identify prognostic factors which may help predict the ability to return to pre-injury level of work.

METHODS: A retrospective cohort of 78 consecutive adult patients (mean age 54.9 +/- 8.2 years) was evaluated at a minimum 1 year follow-up following arthroscopic repair of full-thickness rotator cuff tears. Exclusion criteria included patients presenting with partial-thickness or irreparable tears, subscapularis involvement and/or revision surgery. Multiple variables including preoperative work level, gender, medical comorbidities, alcohol or tobacco use, and tear size were recorded. Contingency table analysis was used to identify significant associations between these variables and return to work at preoperative levels, time to maximum medical improvement (MMI) and failure of repair requiring revision.

RESULTS: Patients were evaluated at an average follow-up of 2.5yrs (range 1.0-6.4, sd 1.1). 89.7% of patients returned to their preoperative level of work, at an average time to MMI of 7.6 +/- 2.6 months. 5.1% of patients had failure of their repairs requiring revision. Preoperative work level, smoking status, gender and tear size did not influence return to work status, MMI or failure rate in this population. A history of preoperative alcohol use (>6 beers/wk) was significantly associated with not returning to preoperative work levels following surgery (p=0.011). Nondiabetics and patients who did not drink alcohol (<6 beers/wk) were significantly less likely to have repair failure requiring revision (p=0.012 and 0.009, respectively).

CONCLUSIONS: Compensable patients undergoing arthroscopic full-thickness rotator cuff repair return to preoperative levels of work in the majority of cases, regardless of preoperative work level, smoking status, gender or tear size. Diabetes and reported alcohol use may predict a less likely return to work and a higher failure rate in these patients.
Effects of Subacromial Decompression in Arthroscopic Rotator Cuff Repair

Introduction: Subacromial decompression including acromioplasty is routinely performed in rotator cuff repair. However, many studies revealed that the cause of rotator cuff tear is more closely related to internal factors than external factors, which makes it worthwhile to investigate further the effectiveness of subacromial decompression. This study prospectively compared the clinical results of arthroscopic rotator cuff repair with and without acromioplasty.

Materials and methods: Forty-one patients with arthroscopic subacromial decompression and coracoacromial ligament resection with rotator cuff repair (group 1) and 43 patients with arthroscopic rotator cuff repair without acromioplasty (group 2) were included. Patients with the rotator cuff repair caused by massive rotator cuff tear or partial tear and patients with subacromial decompression due to osteophytes under the acromion were excluded in this study. The mean age at the operation was 56 years old (38-76 years old) in group 1 and 57 years old (45-75 years old) in group 2. Degenerative rotator cuff tear was the most common cause of injury in both groups. The duration of symptom was 14 months in group 1 and 16 months in group 2. The shape of acromion was type 2 in 32 patients (78% of group 1) and 35 patients (81% of group 2). All rotator cuff repairs were done arthroscopically and postoperative pain was managed using patient controlled analgesia system. The pain was measured by visual analogue scale (VAS) every 6 hours for 3 days after the operation, then subsequently measured in 1, 3, 6 and 12 months postoperatively. Clinical evaluation was done using Constant score and UCLA score. Average follow up period was 22 months.

Results: The mean size of rotator cuff tear was 2.2 cmX1.6 cm in group 1 and 1.9 cmX1.4 cm in group 2. VAS was higher in group 1 for 3 days postoperatively, but there were no significant differences statistically between the two groups. VAS at final follow up was similar in two groups. The mean range of forward elevation improved from 127° preoperatively to 162° postoperatively in group 1 and 130° preoperatively to 167° postoperatively in group 2. Constant scores in both groups improved significantly to 79 in group 1 and 83 in group 2 at final follow up. In group 1, 34 patients revealed good or excellent results in UCLA score and 38 patients in group 2. One patient in each group had postoperative adhesive capsulitis.

Conclusion: Clinical results revealed similar pain score, range of motion and strength regardless of acromioplasty. Although this study requires a long term follow up, acromioplasty does not seem to affect clinical results in rotator cuff repair.
Acetabular Labral Tear in Japanese Patients

Introduction
The acetabular labral tear normally develops in a hip with some form of bony structural abnormality such as acetabular retroversion or decreased offset of head-neck junction. Most tears have been observed laterally and anteriorly in western countries. However, 70~90% of osteoarthritis in Japanese patients develop from acetabular dysplasia. Literature from Japan reported posterior labral tears were common. These factors suggest that there could be some different clinical feature between acetabular labral tears in Japanese and the ones in western people. Furthermore, to the best of our knowledge, quantitative assessment of intermediate term postoperative clinical results of arthroscopic partial limbectomy has not been reported.

The purpose of this paper was to reveal frequency of bony structural abnormality, the most frequent portion of the acetabular labral tear, and quantitative intermediate term clinical results of the arthroscopic partial limbectomy in Japanese patients.

Cases and Methods
We performed arthroscopic partial limbectomy in 63 hip joints of 63 patients (7 joints of 7 males and 56 joints of 56 females) aged between 13 and 86 (mean; 47.8) years at examination. The follow up period ranged between 48 months and 72 months (mean; 62).

The radiographical findings, arthroscopic findings, and clinical results of these patients were investigated. Modified Harris’ hip scoring system (mHHS)by Byrd were obtained for preoperative and postoperative clinical assessment.

Results
Plain radiography showed no abnormality in 42 joints, acetabular dysplasia in 19 joints, and decreased offset of head-neck junction in 2 joints. In the 42 joints without abnormality on plain radiographs, arthroscopy confirmed only labral tear in 28 joints, both labral tear and diffuse articular cartilage degeneration in 13 joints, and both labral tear and small chondral damage in 1 joint. 13 joints with both labral tear and diffuse articular cartilage degeneration were diagnosed as primary osteoarthritis. In the 19 joints with acetabular dysplasia on plain radiographs, CE angle ranged between 11 degrees and 18 degrees (mean;16). In 18 of 19 joints showing acetabular dysplasia, only labral tears were confirmed, and both labral tear and delamination of articular cartilage in 1 joint. In 2 joints with decreased offset of head-neck junction, labral tear and delamination of the articular cartilage were confirmed.

In all joints, acetabular labral tear confirmed either anterior or lateral part of the acetabular rim.

In 29 joints with no abnormality on radiographs and only labral tear or labral tear with chondral damage in arthroscopic findings, mHHS improved from mean score of 52.5 before surgery to mean score of 93.5 after surgery. In 19 joints showed acetabular dysplasia on radiographs, mHHS improved from mean score of 67.3 before surgery to mean score of 90.2 after surgery. In 13 joints diagnosed as primary osteoarthritis, mHHS improved from mean score of 63 before surgery to mean score of 86.2 after surgery. In 2 joints with decreased offset of head-neck junction, mHHS improved only for a few months.
Discussions
Acetabular retroversion and decreased offset of head-neck junction are thought to be major cause of acetabular labrum tear. However, in our cases no acetabular retroversion and only 2 joints with decreased head-neck junction were confirmed. The reason for this discrepancy is not clear. The fact that frequency of slipping upper femoral head in Japanese is reported to be less than that in western people might be one of the reasons. Early articles with small study groups from Japan reported that labral tears frequently occur posteriorly unlike recent reports with large series of cases from Europe and the U.S.A. in which most tears have observed laterally and anteriorly. The cause of this discrepancy may reflect unique aspects of population, may be aberrant due to small study groups, or different way of life among countries might contribute to them. However our study in 63 Japanese cases supported the reports from Europe and the U.S.A.
Long term clinical results of arthroscopic partial limbectomy are unknown. Our study revealed that in the normal shaped hip with or without chondral degeneration and mild dysplasia, arthroscopic partial limbectomy will assume good clinical results in intermediate term. However long term clinical outcomes was unknown.

Conclusions
Unlike the reports from western countries, normal shaped hip was the most frequent in Japanese patients with acetabular labrum tear. The reason for this discrepancy is not clear. Anterior and superior parts of acetabular rim are the most frequent portion where labrum tear occurs even in Japanese. In the normal shaped hip with or without chondral degeneration and mild dysplasia, arthroscopic partial limbectomy will assume good clinical results within 4 years after arthroscopic partial limbectomy.
Results of Hip Arthroscopy in Patients with Gluteus Medius Tendon Tears

When an MRI or MR arthrogram of the hip documents a labral tear and a gluteus medius tendon (GMT) tear in a patient with hip pain, a question that arises is what should be done about the GMT tear. Arthroscopic repair of GMT tears has been advocated as an adjunct to hip arthroscopy for the treatment of hip pain. To date, the indications for this procedure and the outcomes of patients who have had hip arthroscopy without repair of their GMT tears have not been delineated. This study compares the results of 30 patients with and 30 patients without GMT tears who at the time of their hip arthroscopy only had treatment of their intra-articular lesions.

Material and Methods: For this study, the preoperative magnetic resonance arthrograms (MRA’s) of 150 patients who had their imaging completed at our institution and their hip arthroscopy performed by the senior author, were reviewed by two musculoskeletal radiologists who were specifically looking for gluteus medius tendon (GMT) tears. From this review, 6 patients with partial-thickness and 24 patients with full-thickness GMT tears (0.5 to 3.7 cm in length) were identified. The results of hip arthroscopy in these patients were compared to those of 30 demographically-matched patients that were selected from the remaining 120 patients that did not have GMT tears. All 60 hips included in this study were examined by the senior author and assessed with Byrd's 100-point modified Harris hip scoring system prior to arthroscopy, and at 3, 6, and 12 months after surgery.

Results: The average age of the 30 patients with tendon tears (GMT patients) and the 30 patients without tears (GWT patients) was 44 and 42 years, and their preoperative scores averaged 41 and 46 points, respectively. Prior to surgery, all 60 patients had anterior hip pain with prolonged sitting and with twisting activities, and 20 patients (10 in each group) had pain and tenderness at the greater trochanter. By three months after surgery, the average hip scores for the GMT and GWT patients were 85 and 88 points, respectively. At six months, the scores averaged 88 and 89 points, and after 12 months, the scores averaged 90 and 91 points, respectively. At all of the follow-up intervals, there were no significant differences between the scores of the two groups (p>0.05).

Conclusions: Gluteus medius tendon tears that were evident on preoperative MRA’s did not affect the outcomes of patients who at the time of their hip arthroscopy only had treatment of their intra-articular lesions.
SUSHI: The Super Simple Hip Score for Younger Patients

Introduction
Hip pathology is increasingly recognized in younger persons, for example femoro-acetabular impingement. Outcome assessment is important to evaluate rapidly expanding treatment options. Established scoring systems such as the Harris Hip Score are time consuming and have ceiling effects because they are not aimed at the hip impairments of young and active persons. The patient-based Super Simple Hip (SUSHI) score is targeted at younger persons with hip problems and focuses on activities that are difficult for someone with a hip problem. It includes nine questions and an activity rating scale that measures the highest level of physical activity that was engaged in the past year. The aim of this study was to evaluate the validity, sensitivity to change and floor-ceiling effects of the SUSHI score.

Patients & Methods
68 Patients (age < 55yr) with hip problems filled out the SUSHI pre- and postoperatively, using a web-based application. The SUSHI was compared with the Dutch Hip disability and Osteoarthritis Outcome Score (HOOS). Patients reported which score they preferred. The validity of the SUSHI was tested with Spearman correlation coefficients. The sensitivity to change was tested by calculating the standardised response mean (SRM).

Results
The SUSHI has a good construct validity, as shown by high correlations with the HOOS, both pre- and post-operatively (r=.651, p< 0.01; r =.802, p< 0.01). Both the SUSHI and the HOOS had a high sensitivity to change (SRMHOOS = 2.21, SRMSUSHI = 2.51). The higher SRM of the SUSHI suggests it is more sensitive to change compared to the HOOS. No significant floor and ceiling effects were observed.

Discussion
Outcome assessment becomes more patient than doctor focussed. We have shown the SUSHI correlates well with the more extensive HOOS, yet is more sensitive to change and is preferred by the young and active patient. It provides additional information in the form of an activity rating. No physician assistance is required for the easy web-based data entry, favouring the SUSHI over the more complicated scores that are currently filled out in the clinic.

References
Autologous Osteochondral Grafts in the Treatment of Focal Chondral Defects of the Femoral Head: An Experimental Study in Rabbits

Purpose of study: To investigate and compare macroscopically and histologically the reconstructed articular surface of a focal defect of the right femoral head treated with subchondral drilling or autologous osteochondral transplantation in rabbits.

Material and method: A 2.5 mm diameter and 3 mm depth iatrogenic osteochondral defect in the anterolateral weight bearing area of the right femoral head was created in 12 rabbits. Autologous osteochondral transplantation was performed in a group of 6 rabbits. Donor site was the lateral condyle of the ipsilateral knee joint. The other group of 6 rabbits was treated with subchondral drilling. Both groups were sacrificed and evaluated histologically under the classification system of the ICRS after 6 weeks. For statistical analysis we used the Mann – Wittney test.

Results: According to the ICRS, score statistical significance favoring the osteochondral transplantation was found in all variables between the 2 groups: articular surface (p=0.049), matrix (p=0.003), cell distribution (p<0.0005), subchondral bone (p=0.010), cartilage mineralization (p=0.0) except cell population viability.

Discussion: In comparison to subchondral drilling, autologous osteochondral transplantation offered mature fully constructed tissue providing better results. Both methods provided viable cells. All grafts had successful incorporation of the osseous part. No necrosis of the femoral head was noticed.

Conclusion: Reconstruction of the articular surface of the femoral head through autologous osteochondral graft transplantation after focal osteochondral defect in rabbits gives superior macroscopical and histological results in comparison to subchondral drilling.

Key words: Hip joint-autologous osteochondral transplantation-osteochondral defect – subchondral drilling
Surgery for Rectus Femoris Muscle Tears

During 11 years (1997 - 2007) 23 patients with 24 rectus femoris muscle tears were treated surgically. There were 20 males and 3 females in the series. The mean age of the patients was 28 years (16-45 years). The right side was affected 15 times and the left side 9 times. In one patient both thighs were operated with the interval of two years. The sports events of the patients were: soccer 14, running events 3, orienteering 2, long jump 1 and judo 1. Two of the patients were not athletes. The site of injury was the distal third in 3 cases, medial third in 14 cases and proximal third 7 times. The trauma mechanism was in 10 cases sudden injury causing the tear, in 12 cases recurrent injuries lead to tear / scar / adhesions and in 2 cases relatively small trauma caused a "spontaneous" tear. In addition to clinical examination ultrasound echography was used 20 times and MRI 7 times. The indications for surgery were: loss of extension power, pain, cramps and weakness. In surgery there were total tear 16 times, subtotal tear with scarring 5 times and adhesions / scarring 3 times. The delay for surgery of the acute total tears was 3 months (1-10 months). It was possible to suture the muscle back in 7 cases and repair it with the help of the thickened fascias and scar tissue 9 times. Absorbable suture materials were used in most of the operations, nonabsorbable sutures only in 4 cases. In cases of recurrent tears the correction was done with plastic repair using the scarr tissue and compartement fascias on the sides, anteriorly and posteriorly in the rectus femoris muscle lodge. Sometimes Z-plasty of the central tendon was used or only excision of the adhesions and fasciectomy to maintain the normal muscle function. No postoperative plaster was ussed, cruthes were used from 3 to 7 days after surgery. Rehabilitation was started with isometric femoral settings and slowly increasing knee flexion angle, swimming, bicycling, gym training and jogging. The athletes were usually able to start running 2 months after surgery. More intensive sports performances were allowed 3-4 months after surgery. In 2 patients wound healing complications occurred. They healed well with antibiotics. In three patients a postoperative hematoma appeared. In delayed healing, but did not cause later problem. In 2 cases (a soccer player and a non-athlete) reoperation was done appr. 6 months after the primary surgery. The follow-up of the patients was 2.5 years (8 months to 7 years). The results were good or excellent in 19 cases and moderate in 6 cases. Only 3 of the athletes did not return to the previous level of sports.
Surgical Outcomes for Athletes with Osteitis Pubis, Adducter Tendonitis or Posterior Inguinal Wall Deficiency: A Retrospective Review of Three Surgical Procedures

The commonest cause of groin pain in athletes is a functional anterior pelvic instability. The three soft tissue stabilisers at risk of overuse injury in this group of sportsman are the symphysis pubis, the adducter longus origin and the posterior inguinal wall. Characteristically occurring in running, twizzling, kicking athletes, patients with instability can present with pain arising any one or a combination of the three stabilisers. The three surgical diagnosis are

1. Osteitis Pubis
2. Adductor tendonitis
3. Posterior inguinal wall deficiency

Since 1997 we have offered a combined surgical approach to athletes presenting with these diagnosis. Presented is a smaller retrospective review of the outcomes of patients who underwent surgery for an isolated diagnosis. The diagnosis, surgical indications and procedures are discussed.

Osteitis Pubis: 9 patients recieved an isolated debridement and drilling of the symphysis pubis. 88% had good/excellent relief of symptoms, 77% returned to full sport and 77% reported the surgery as worthwhile.

Adductor tendonitis: 17 patients recieved an isolated adductor tendon lengthening. 88% had good/excellent relief of symptoms, 82% returned to sport and 83% reported surgery as worthwhile.

Posterior inguinal wall deficiency: 38 patients recieved an isolated posterior inguinal wall mesh repair. 100% reported good/excellent relief of symptoms, 99% returned to sport and 84% reported the surgery worthwhile.

The surgical outcomes of athletes with an isolated clinical diagnosis as part of anterior pelvic instability pain are satisfactory. Many patients have combined diagnosis and may require a combined surgical approach.
The Prevention of Post-operative Arthrosis Following ACL Reconstruction Is Possible if Osseous Homeostasis is Restored and Maintained: Arthrosis Perspective

Background: Recent reports from the USA, Europe, and Asia have documented the disconcerting phenomenon of early knee arthrosis following even biomechanically well done ACL reconstructive surgery. In prior work, we have suggested that the achievement of a normal Tc 99-MDP bone scan - representing an objective marker of the restoration of osseous/joint homeostasis – following ACL reconstructive (and other) knee surgery is predictive of the absence of DJD out to 7 years. In this work, we report on 19 patients with 20 ACL reconstructed knees followed to between 10 to 15 years postoperatively both radiographically and scintigraphically.

Materials and methods: 19 patients (14 males and 5 females with a mean age of 28 - range 18 to 43 -at the time of single bundle BTB autograft reconstruction by SFD) with 20 reconstructed knees are included in this report. In addition to a history and physical examination, all patients had a Rosenberg X-ray and a standard 3 hr delayed static Tc 99MDP bone scan of the knees between 10 and 15 (mean 12.8) years post reconstruction.

Results: 18/20 knees demonstrated a normal or nearly normal Rosenberg X-ray and bone scan of the involved knee. Two of the 20 knees demonstrated a positive bone scan associated with radiographic signs of degenerative arthrosis (joint space narrowing and osteophyte formation). The degree of post-operative laxity did not correlate with the absence of degenerative changes.

Discussion: In prior work, we have shown that persistent loss of osseous homeostasis (manifested by positive bone scans) identifies knees “at risk” of developing early arthritis. In this work we have demonstrated in a population of ACL reconstructed knees using a single-bundle BTB autograft technique - the principle that if osseous/joint homeostasis can be restored and maintained (currently best documented by normal bone scans) such knees can remain free of degenerative changes out to a mean of 12.8 years post-operatively. For those who may wish to avoid irreversible degenerative arthrosis in ACL reconstructed knees, it is recommended that the achievement of osseous/joint homeostasis become a clinical priority.
Long-Term Durability of Functional Improvement After Treatment with Autologous Chondrocyte Implantation (ACI): a Multicenter, Observational Study in US Subjects

Introduction: Autologous Chondrocyte Implantation (ACI) for full-thickness lesions of the distal femur has demonstrated good short- to mid-term clinical improvement. However, long-term durability (> 5 years) of ACI has not been evaluated in US patients to date. The purpose of this study was to determine if patients who improve from baseline to earlier follow-up will sustain improvement at later follow-up.

Methods: In a multicenter, observational, within-patient control cohort study, study patients met predefined eligibility criteria before data analyses (full-thickness distal femur lesion(s); modified overall Cincinnati knee scores at baseline and 1-5 year follow-up; ACI before Dec. 31, 1996). Per a priori analysis plan, ACI durability was determined by comparing early (1-5 year) outcomes to long-term (6-10 year) outcomes.

Results: 72 patients met eligibility criteria. Patients and defect baseline characteristics were: mean age=37 years; 61% male; mean lesion size=4.3 cm²; low mean baseline overall condition score=3.4 points (poor). Within the 5-years prior to the cartilage biopsy harvest, 68% (49/72) of patients had at least one cartilage repair procedure. At 1-5 year follow-up (mean follow-up=4.6 years), 75% (54/72) improved. At 6-10 years follow-up (mean follow-up=9.2 years), 87% (47/54) of patients who improved at the earlier follow-up period sustained a significant mean improvement in overall condition score of 3.8 points from baseline. In addition, at a mean follow-up of 9.2 years, 69% (50/72) of patients significantly improved in overall condition score from baseline. In total, ACI failed in 12 patients; 75% (9/12) of treatment failures occurred at a mean follow-up of 2.5 years.

Conclusions: Treatment with ACI for large, symptomatic, full-thickness lesions of the distal femur in patients with a history of failed prior surgeries can result in early improvement that is sustained at longer follow-up (up to 10 years) in the majority of patients.
Cartilage Morphology after High Tibial Osteotomy for Varus Gonarthrosis

Introduction: Valgus-producing high tibial osteotomy (HTO) is an established and effective treatment for varus malalignment and medial gonarthrosis [1-7]. Good to very good results were achieved in long-term studies, especially with a slight overcorrection of the mechanical axis [1-7]. Long-term joint preservation is possible, especially in young, active patients [5,7]. In spite of this clinically favourable evidence, there are no findings available on the cartilage status of the joint operated on: can stabilisation of the cartilage of the affected medial compartment be achieved? Will the cartilage of the lateral compartment withstand the modified loading?

Method: A valgus-producing opening wedge HTO using a locking plate with spacer (Puddu Plate®, Arthrex, Karlsfeld, Germany) was performed on 12 patients (8 men, 4 women; 39.4 ± 10.4 years) with mild and moderate varus gonarthrosis [8] (Hip-Knee-Ankle angle (HKA) = 5.9 ± 2.2°). The mechanical axis was corrected operatively to 3 - 6° varus, dependent on the extent of the malalignment and the grade of arthrosis. Before surgery and two years later the affected knee joint was examined with MRI (1.5 T). The morphology (mean thickness and volume) of the femoral and tibial cartilage was determined by means of these images (gradient echo with fat suppression) using oblique coronal section orientation. The values were compared with a healthy collective (n = 40; 28 men, 12 women; 30.9 ± 10.9 years; HKA 1.3 ± 0.8°) using an unpaired T-Test. The changes in cartilage morphology were tested within the patient group with a paired T-Test for significant findings.

Results: Preoperatively, all patients showed a significant (p<0.05) reduction in mean tibial medial cartilage thickness. A significant reduction in cartilage volume was displayed only in patients with moderate varus gonarthrosis (medial compartment: tibial and femoral). No further medial cartilage loss occurred in any patients as a result of the HTO; on the contrary, all patients showed a significant increase in average cartilage thickness or cartilage volume. There was not any notable decrease in cartilage thickness or volume in the lateral compartment in any patient.

Discussion: The preoperative medial (tibial) cartilage loss may be assessed as an expression of the increased mechanical loading in varus malalignment. The valgus-producing opening wedge HTO halted cartilage loss in the medial compartment or achieved stabilisation of the cartilage morphology. The correction of the mechanical axis into the lateral compartment led to no cartilage loss there either. The cartilage in the lateral compartment appears to be able to withstand this increased mechanical load. The results presented in this paper support clinical long-term studies already mentioned above and lead to an improved understanding of the processes taking place in the knee joint following valgus-producing HTO. These results must be followed over time.

Literature:
Effect of High Tibial Osteotomy on Knee Function: A Gait Analysis Study

Introduction
The role of biomechanical factors such as dynamic and static alignment in the progression and development of osteoarthritis (OA) has been recognized in recent investigations (1). Understanding mechanical factors influencing the loading on the knee joint is crucial for a better insight into the disease process and development of new prevention and treatment strategies. High tibial osteotomy (HTO) alters knee alignment, usually from varus to valgus. By moving the mechanical axis laterally, knee joint forces and moments during daily activity should also be changed in order to reduce the loading on the medial compartment. The aim of this ongoing longitudinal study is to evaluate the effects of tibial osteotomy on gait characteristics.

Method
15 subjects undergoing high tibial osteotomy were enrolled in the study. Retro-reflective spherical markers were placed on prominent anatomical landmarks to indicate 12 body segments (forefoot, midfoot and rearfoot, shank, thigh, pelvis, thorax) and 6 lower body joint centres (ankles, knees and hips). The three dimensional position of each marker was calculated using fourteen cameras (Eagle 8 mm, Motion Analysis Corp., Santa Rosa, CA) recording at 100Hz and a motion analysis system (EvaRT4.6, Motion Analysis Corp.). Three-dimensional external moments and inter-segmental joint forces were calculated using inverse dynamics in the Kintrak™ software. Kinematic and kinetic data from this cohort will be analysed at baseline, 6 months, 1 year and 2 years post osteotomy to determine how a change in the alignment of the leg affects gait patterns in these patients. Subjective outcome scores will also be used to determine whether any relationships between patient satisfaction and mechanical changes exist.

Results
The mean age of patients was 48 ± 11 years at the time of surgery. Mean height, weight and BMI were 173 ± 8 cm, 88 ± 19 kg and 29 ± 5 respectively. Pre-operatively KOOS scores for symptoms, activities of daily living and quality of life were 45 ± 25, 60 ± 24 and 57 ± 34. Results at 6 month gait analysis demonstrated a decrease of in the external knee adduction moment.

Discussion
HTO is likely to become an increasingly popular procedure, as patients become higher demand and we move more towards joint preserving procedures. This study has shown that alteration of mechanical alignment can favourably affect joint mechanics, coinciding with improvements in clinical outcome also. The reslts will give improved guidance to the appropriate degree of alignment correction to optimise functional outcome of this increasingly used procedure.
The “Boomerang Osteotomy” for Severe Varus Gonarthrosis: A Novel Technique.

Introduction. The authors have developed a new technique of proximal tibial osteotomy, so-called “Boomerang osteotomy”, for the treatment of severe varus gonarthrosis, which generally would have been candidates for total knee replacement. The technique comprised infratubercle boomerang-shaped osteotomy stabilized with dual plates.

Purpose: To evaluate the results of the infratubercle boomerang-shaped osteotomy.

Methods: One hundred and thirty-one knees in 103 patients with varus gonarthrosis, who had been treated with the Boomerang osteotomy, were evaluated after a minimum follow-up of 24 months (average 47 months, range, 24-87 months). The average age was 64.1 years (range, 51-80 years). The average preoperative femorotibial angle was 14.7 degrees varus (range, 0-32 degrees varus). All of the knees were classified as Ahlback grade IV or V.

Results: Using the modified American Knee Society Clinical Rating System the average knee score has been improved significantly from 31.4 points preoperatively to 83.9 points at the last follow-up study. One hundred and fifteen knees (87.8 %) had good or excellent results. For the patients global assessment 127 out of 131 patients (96.9 %) were satisfied with the results. At the last follow-up study the average femorotibial angle of the group with good/excellent result had significantly more valgus than that of the group with fair/poor result (9.6 degrees valgus vs. 1.3 degrees varus, p<0.001). Likewise, the average femorotibial angle of the group with no/mild pain had more valgus than that of the group with moderate pain (9.2 degrees valgus vs. 0.2 degrees varus, p=0.027). No patient had severe pain (needed opioid analgesics). No serious complication was found.

Conclusion: In addition to its cost-effectiveness the modified infratubercle displacement osteotomy is a valuable and safer procedure for patients with severe osteoarthritic change of the knee. Achieving and maintaining adequate valgus alignment are the key to obtain good or excellent results.
High Tibial Osteotomy in Varus Gonarthrosis – Open Versus Closed Wedge Osteotomy

Purpose: High tibial osteotomy has been effective to treat medial compartmental arthritis by correcting varus mal-alignment. Over the past decades closed wedge osteotomy has become less popular, replaced by increasing trend of open wedge technique. The advantages and disadvantages of both techniques were compared in clinical and radiological viewpoints.

Methods and Materials: 115 closed wedge HTOs and 43 open wedge HTOs of 88 patients of 54.9 years of average age were followed-up for a mean of 62 months (closed) and 29 months (open). Radiological and clinical evaluations included assessment of indication, techniques, functional improvement, axis, survivorship and complications.

Results: Survivorship evaluation shows 91% in closed wedge and 97% in open wedge HTO, accepting that the follow-up of open HTO is shorter. The failure of closed HTO was attributed to recurrence of varus due to operative undercorrection and delayed union with inappropriate postoperative protection. Failed closed HTO showed decreased or reverse tibial slope and open HTO showed increased tibial slope respectively in sagittal views. In severe varus with anatomical axis of more than 15 degrees, complete medial corticotomy plus lateral translation of the distal tibia was required to prevent recurrence of varus and lateral cortical impingement in future total knee arthroplasty in closed wedge HTO.

Summary: The overall retrospective review of two techniques demonstrates the similar survivorship results. 90°-angled prebent plate has shown satisfactory result in closed HTO. There was no serious problem in conversion to total knee arthroplasty.
To identify causes of failure and rates of revision of the Oxford prosthesis (OXF) in New Zealand.

Method:
Review and compare the medial unicompartmental (UKA) and total knee arthroplasty (TKA) data from 2000 to 2007 as recorded in the New Zealand National Joint Registry.

Result:
Ninety nine orthopaedic surgeons performed 2620 OXF (61% of all UKA). UKA (4279) made up 11.8% of all knee arthroplasties (36,308). The number of OXF revisions (148) gave a revision rate (RR) of 5.6%. The equivalent RR for all UKA combined was 5.1% and for all TKA was 1.8% (difference OXF to TKA significant p=0.0001). The estimated RR for a hypothetical minimum 8 year follow-up for the OXF is 10.1% (Kaplan-Meier estimate).

The most common reason for revision of the OXF was unexplained pain (32%), followed by aseptic loosening (30%), bearing dislocation (11%), and deep sepsis (5%). The RR of TKA for unexplained pain(28%) was not significantly different from OXF (p=0.37) Deep sepsis as a cause for revision was 0.27% for OXF compared with 0.51% for TKA (p = 0.089).

The patient -generated Oxford scores at six months after operation were rated excellent or good (Kalairajah et al, 2005) in 79% of OXF compared with 72% TKA patients (p = <0.0001). The same ratings at 5-years after operation were 88% for OXF compared with 81% for TKA (p=0.001).

Six high-use OXF surgeons (10 or more/year) performed 27% of the operations with a RR of 2.5%.Thirty seven medium-use surgeons (2-9/ year) performed 60% of the operations with a RR of 6%. Fifty six low-use surgeons (2 or less/year) performed 12% of the operations with a RR of 10%. The difference in RR high:low users (p=0.001) and high: medium groups (p=0.017) were significant.

Conclusion:
The early RR for the OXF was 3.2 times greater than that for TKA. However, high-use OXF surgeons (ie those performing 10/year or more) had significantly fewer revisions than medium & low users and had a RR comparable to TKA (2.5% vs 1.8%). Deep infection rate was lower, and 6-month and 5-year function scores were significantly higher for OXF compared with TKA. Unexplained pain was the most common cause for OXF revision.
Complications in 223 Cases of the Oxford Phase 3 Unicondylar Arthroplasty (UCA) in a County Hospital

Objectives: Aim of this study was to analyse the complications during the first eight years of experience with the Oxford Phase 3 prosthesis for treatment of osteoarthritis by a minimally invasive technique.

Material and Methods: Between January 1999 and May 2007, 223 arthroplasties were implanted by a single surgeon in a non-teaching hospital. 191 cases had a minimal FU of one year (mean FU 35 months). Mean age was 69 years (range 49-91yrs).

Results:
Complications, cause and management:
I Dislocation of the meniscal insert in three patients (1.6%): two due to technical error (revised to TKA and Vanguard UCA respectively) and one traumatic (open reduction). II Three (1.6%) patients with persisting pain complaints due to failure of proper patient selection were revised to TKA. III Five (2.6%) patients with moderate pain complaints of which three had correct and two doubtful indications followed a wait and see policy. IV One intra-operative fracture of the proximal tibia due to surgical error was treated by CPM and casting. V Ten (5.2%) additional arthroscopic procedures were performed with good results.

Conclusion: The rate of revision surgery was 2.6%. Persisting pain complaints after one year of FU occurred in 4.2 %. Failure of using strict indication criteria e.g. three revisions to TKA due to pain and two patients with persisting moderate pain complaints, emphasizes once more the importance of strict patient selection. When strict indication criteria are considered the unicompartmental Oxford Phase 3 prosthesis is in our opinion the first choice of treatment of anteromedial osteoarthritis.
Tibial Cementing Technique for Unicompartmental Knee Arthroplasty

Introduction: The medial unicompartmental knee prosthesis is less invasive than a total knee arthroplasty and preserves undamaged structures of the joint, especially the crucial ligaments. According to that the range of movement is better and patients have a natural feeling of the joint. Postoperative pain reduction is at least as good as in total knee prosthesis, while recovery is faster in unicompartmental prosthesis. Tibial radiolucent lines are frequently observed at the interface between bone and cement after unicompartmental knee arthroplasty. Histological examinations of the interface showed the lucent zone to be composed of fibrocartilaginous connective tissue. According to the Swedish Knee Arthroplasty Register, unicompartmental arthroplastys have a higher revision rate than total knee prostheses (15% versus 10% after 10 years). One of the main reasons for revision is mechanical loosening. There is a paucity of information regarding cement fixation of unicompartmental knee prostheses. In our cadaver study, we compared pulsed lavage to conventional lavage with focus on cement pressures, interface temperatures and cement penetration.

Materials and Methods: Unicompartmental Knee Arthroplasty was performed in 10 paired whole human legs without any injury of bone and ligamental structures (Oxford Phase III, Biomet, Dordrecht, Netherlands).

Customized tibial implants and a pressure probe insert were used to measure the cement pressure anterior, posterior and near the implant fin during the implantation of the components and the polymerisation.

A drilling and fixation jig was used for standardized positioning of the three temperature probes. The polymerization heat was measured 5 mm below the bone surface at the medial and lateral plateau as well as under the fin.

The same cementing technique was performed for all knees using Refobacin® Bone Cement R. One side of the paired knees was cleaned using pulsed jet lavage, contra lateral cleaning was done with conventional lavage. A lavage volume of 1 liter was used for both methods.

Fluroscopically centered AP radiographs of the knees were taken and digitalized to quantify the cement penetration areas and depths, using a pixel-analysis-software.

Group comparisons were done with the Wilcoxon-Test using SPSS for Windows 15.0 (SPSS Inc., Chicago, Illinois).

Results: Average cement pressure under the tibial implant is statistically significant higher for the cementing technique with conventional lavage (avg cement pressure 25.69 ± 17.85 kPa, p= 0.005) than for the jet lavage (avg cement pressure 13.28 ± 12.82 kPa).

Mean temperature increase measured 5 mm below the bone surface medial and lateral, as well as under the implant fin, were statistically significant higher for the cementing technique with jet lavage (lateral 14.10 ± 5.72°C, p= 0.018 / medial 8.49 ± 4.20 °C, p= 0.176 / fin 5.95 ± 1.92 °C, p= 0.063) than for the conventional lavage (lateral 9.42 ± 5.17 °C / medial 6.42 ± 2.21 °C / fin 3.96 ± 2.03 °C).

On AP radiographs, cement penetration areas under the tibial implant were statistically significant higher for jet lavage (penetration area: 122.15 ± 33.94 sq mm, p= 0.046) than for the conventional lavage (penetration area: 89.82 ± 23.92 sq mm).

Discussion: The use of pulsed jet lavage showed clear advantages in our cadaver studies. Pulsed jet lavage resulted in higher cement penetration despite of lower cement pressures under the tibial implant. The higher cement penetration lead to higher interface temperatures but exposure to high temperatures over 50 °C with a risk for bone necrosis could not be measured. Clinical longterm studies will show, if a better stability and longevity for prostheses can be achieved with the use of pulsed lavage.
Periprosthetic Tibial Plateau Fractures in UKA: Associated with a Vertical Sawing Defect?

Background and purpose: Due to its good clinical and functional results unicompartmental knee arthroplasties (UKA) gain more importance in the endoprostatic treatment of anteromedial osteoarthritis (OA) of the knee joint. Periprosthetic medial tibial plateau fractures represent a severe but rare complication of UKAs. Since they usually appear perioperatively they can be associated with sawing defects during implantation. Aim of the study was to show that vertical sawing defects of the dorsal tibia, which occur during tibial preparation, weaken the corticalis and lead to periprosthetic medial tibial plateau fractures more often. Therefore a difference of the maximum axial load leading to plateau fractures between a group with a vertical sawing defect (group A) and a normal group without any defects (group B) should be detected. Additionally, individual data and bone quality was analyzed.

Material and Methods: In 6 matched paired fresh frozen tibiae (donor data: f/m = 2/4, median age 79.6 years, median weight 59.51kg) tibial implantation was performed with (group A) or without (group B) vertical sawing cuts of 10°. DEXA bone density measurement and X-Ray were performed before tibiae were fractured under load (maximum load of 10.000N) with defined conditions using a material testing machine. After load induction fracture patterns and maximum fracture loads were analyzed and correlated to BMD.

Results: All tibiae fractured under load. A vertical saw defect reduces the stability of the tibial plateau. A significant difference of fracture loads could be found between the two groups (p = 0.043; z = -2.023). The mean fracture load of tibiae with vertical sawing defects (group A) was Fmax = 2,754.0N (1,084.6 – 5,086.0N) and Fmax = 4,014.0N (2,346.2 – 8,500.0N) in the group without sawing defect. In general a vertical saw defect of 10° lead to a reduction of about 20% of the applied forces to induce a medial plateau fracture.

Discussion: Inexperienced surgeons tend to cut too deep vertically, which weakens the bone structure and can lead to medial tibial plateau fractures. In general, vertical sawing defects of 10° reduce maximum fracture loads about 20%, so that the risk of periprosthetic medial tibial plateau fractures rises. Special training should be performed to minimize the sawing defects or additional sawing jigs should be designed to avoid sawing too deep and to maintain mechanical stability of the tibial plateau.
Minimal Invasive Ankle Lateral Stabilization Using A Split Peroneus Brevis Graft

Introduction:
Injury to the lateral ligaments of the ankle is one of the most common sports-related injuries. Chronic lateral instability of the ankle may occur in up to 30% of this population. The best surgical treatment for chronic instability remains controversial. The most widely used procedures (Watson-Jones, Evans and Chrisman and Snook), have a high rate of success, but have been criticized because they do not place the graft in an anatomical position, and cause a sub-talar stiffness.

Objective:
Describe a minimal invasive technique for the chronic lateral instability of the ankle, ensuring a long lasting fixation of the graft and respecting the sub-talar joint.

Materials and Methods:
We describe a new minimal invasive technique for the lateral stabilization of the ankle. We performed this technique in 44 patients. We excluded patients with a history of a previous surgery of the ankle. Our patients were radiographically and clinically tested preoperatively and postoperatively following the Karlsson scale, and the telos measurement. All the procedures were performed by one surgeon. Our mean follow-up was 22.6 months ± 9.768 months. All the results were analyzed with the SPSS 11.0 program.

Results:
We had 11 females and 33 males, with an average age of 31 years ± 9.398 years. The average preoperative Karlsson scale was improved from 48.63 ± 10.97 preoperative mean, to a postoperative mean of 86.34 ± 16.827. From the radiographic point of view the telos has improved from a mean preoperative of 17.11 ± 5.453 to 7.68± 4.142 postoperative. We found minor complications in eleven patients, 25%. The patient satisfaction was self-evaluated as excellent in 24 cases (54.5%), very good 12 (27.3%), good 7 (15.9%), moderate 1 case (2.3%), bad 0 (0%).

Conclusion:
The minimal invasive techniques allow us to perform important procedures with great respect to the anatomical structures, thus decreasing soft tissue complications, limiting the wound derived complications and improving postoperative cosmetic, and return to every-day activities.
**Distal Tibiofibular Syndesmosis Injuries Cause Multi-directional Ankle Instability**

**INTRODUCTION:**
Compared with lateral ankle ligament injuries, isolated tibiofibular syndesmosis injuries have been thought to be less common. Currently, however, from 17% to 74% of ankle injuries among young athletes, especially football players, soccer players, skiers, and hockey players, are distal tibiofibular syndesmosis injuries. The rupture of the distal tibiofibular syndesmosis commonly occurs with extreme external rotation. Most studies of syndesmosis injuries have concentrated only on external rotation instability and have not examined other defects. The purpose of this study was to examine the details of ankle instability related to the severity of syndesmosis injuries. We hypothesized that syndesmosis injuries cause multi-directional ankle instability, and that the degree of instability depends on the severity of injuries.

**MATERIALS & METHODS:**
Seven normal fresh-frozen cadaveric legs (6 male, 1 female) were used. The mean age at the time of death was 78.9 (range 67 to 97) years. Each leg was cut at the distal third of the femur without disrupting soft tissue and was mounted on a wooden fixture with the foot fixed at the calcaneus and the metatarsal bones using two 5 mm diameter Steinmann pins. Three electromagnetic sensors were attached to the tibia, fibula, and talus to monitor their three-dimensional movement using a magnetic tracking system (3 Space Fastrack, Polhemus, Colchester, VT, USA). Each sensor was attached via an acrylic rod using a minimum skin incision to avoid soft tissue disruption around the ankle joint. At first, the specimens were tested intact while anterior, posterior, medial, and lateral traction forces of 19.6 Newtons were applied to the proximal tibia 30 cm from the distal fixation level. These traction forces produced dorsiflexion, plantar flexion, inversion, and eversion forces at the ankle joint, respectively. Then a 2.0 Newton-meters internal and external rotation torque was applied to the femoral diaphysis. The diastasis and angular motion of each bone (tibia, fibula, and talus) were calculated by anatomical points using the magnetic tracking system while each load was applied. The syndesmoses were sequentially cut in the following order: the anterior tibiofibular ligament (ATiFL); the distal interosseous membrane (IO, distally 2 cm, 4 cm, 6 cm, and 8 cm from the ATiFL); and the posterior tibiofibular ligament (PTiFL). The same measurement protocol was used for each cutting condition. One-way repeated measures analysis of variance was used to evaluate the relationship between the angles or the diastasis and the ligament-cutting increments. Differences among the parameters were checked for significance using the Dunnett test. A p-value of 0.05 was chosen as the level of significance.
RESULTS:
Anterior traction force (Dorsiflexion force): Sequential cutting of the syndesmosis increased the diastasis when a force of 19.6 N was applied. The ATiFL and IO 4-cm cut significantly increased the diastasis from 0.4 ± 0.4 (mean ± SD) mm to 0.8 ± 0.6 mm (p=0.011). With complete cutting (ATiFL, IO, and PTiFL), the diastasis increased to 1.3± 0.5 mm.
Medial traction force (Inversion force): The ATiFL cut significantly increased the diastasis (from 1.1 ± 0.6mm to 2.0 ± 0.6mm; p=0.001) and the talar tilt angle (9.6 ± 8.9° to 15.2 ± 11.1°; p<0.001) when a force of 19.6 N was applied.

Sequential cutting of the IO increased the diastasis and the talar tilt angles; with complete cutting, the diastasis increased to 3.3 ± 0.7mm, and the talar tilt angles increased to 17.4 ± 8.9°. When a posterior or lateral traction force was applied after the syndesmosis was completely cut, neither the diastasis nor the talar tilt angle increased significantly.
External rotation torque: Sequential cutting of the syndesmosis gradually increased the diastasis; the complete cut significantly increased the diastasis from 0.5 ± 0.5 mm to 1.8 ± 2.1 mm (p=0.009). The ATiFL cut significantly increased the rotational angles from 7.1 ± 3.8° to 9.4 ± 4.0° (p=0.05). Subsequent sequential cutting of the IO maintained the increase of the rotational angles. Finally, the complete cut increased the rotational angles to 12.1 ± 5.4°. When internal rotation torque was applied after the syndesmosis was completely cut, neither diastasis nor the rotational angles increased significantly.

DISCUSSION:
We found that syndesmosis injuries cause external rotation and inversion instability of the ankle joint. In particular, the increase in talar tilt angles was significant when the ATiFL was cut. The talus presses on the lateral malleolus when an inversion force is applied. Usually, the lateral malleolus is firmly connected with the tibia by the syndesmosis, and therefore, talar tilt angles are unalterable. However, once the ATiFL is cut, the tibia and lateral malleolus can move separately. As a result, the talar tilt angles increase, even though both the anterior talofibular ligament and the calcaneofibular ligament are intact; the ATiFL is the important stabilizer of the syndesmosis. Clinically, athletes who have sustained syndesmosis injuries are at risk of developing severe ankle sprains, cartilage lesions, and osteoarthritis. Both physicians and athletes should be aware of multi-directional ankle instability caused by tibiofibular syndesmosis injuries.
Microfracture in the Treatment of Articular Cartilage Defects of the Talus: Mid-term Clinical and MRI Results

Introduction:
The microfracture technique is an established method for treating articular cartilage lesions of the talus. Promising results were evaluated for microfracture in the treatment of articular cartilage defects in the short term. Symptomatic chondral or osteochondral lesions of grade II or higher with softening or fraying of the chondral surface or an unstable rim are indications for débridement of the lesion and use of the microfracture technique. Controversy exists whether results will deteriorate over time. No published data exists about a longer follow-up by MRI. In advanced degenerative lesions, the indication must be determined critically.

Material & Method:
In a prospective study, results of 30 ankles (17 men and 13 women; average age at surgery: 43 years, range: 20-74 years) are presented. Treatment for the defects was arthroscopic microfracture technique. 20 patients had osteochondral defects (OCD) and 10 had degenerative chondral defects (DCD). Patients were evaluated with the Hannover Scoring System, a Visual Analog Score (0=very poor, 10=excellent) and MRI scan preoperatively as well as 3 months to 8 years postoperatively. Cartilage repair tissue assessment by MRI was done according to the following variables: Degree of defect repair and filling of the defect, integration to boarder zone, surface of the repair tissue, structure of the repair tissue and subchondral bone alterations. A Wilcoxon sign rank sum test and a Mann Whitney U-Test were used for statistical analysis. Level of significance was p<0.05.

Results:
At a mean follow-up of 5.2 years (range, 3.8-6.6 years), 23 ankles (15 OCD and 8 DCD) were available for follow-up. Three patients were lost for further operative treatment of the affected ankle within the first two years after surgery, three patients were not available. The results of the 23 ankles according to the Hannover Scoring System were 57% excellent, 29% good and 14% satisfactory. Results for patients with osteochondral defects were significantly better than for patients with degenerative chondral defects (p<0.05). Visual Analog Score revealed an average of 8 ± 2 for pain (preop 3 ± 2; p=0.001), 8 ± 2 for function (preop 3 ± 2; p=0.001) and 8 ± 2 for satisfaction (preop 2 ± 2; p=0.001). No deterioration of results was found for patients with osteochondral defects. Results for patients with degenerative chondral defects tended to worsen. However, this was not significant. Regarding the MRI follow-up examinations (15 patients), hypertrophy defect repair was found in 8 patients, complete filling in 3 patients and incomplete (>50% of adjacent cartilage) in 4 patients. Integration to the boarder zone was complete in 10 cases; a demarcation boarder (split like) was seen in 5 cases. In all cases a damaged surface (fibrillations, fissures or ulcerations) and an inhomogeneous structure of the repair tissue was found. The subchondral bone was regarded intact in 4 patients, whereas in 9 cases subchondral edema-like signal alterations were seen. Two patients showed subchondral cyst formation or granulation tissue.

Conclusion:
The microfracture technique appears to be a reliable method for treating chondral and osteochondral lesions of the talus, with good outcomes in a mid-term follow-up according reduction of pain and functional maintenance.
Mechanical Damage and Chemical Contaminants on Reprocessed Arthroscopic Shaver Blades

Background: In response to socio-economical pressure to cut budget in medicine, single-use surgical instruments are often reprocessed and reused in the hospital in spite of potential biological hazard of its reuse.

Objectives: The purpose of this study was to evaluate the quality of reprocessed shaver blades and to analyze contaminants on the blades.

Hypothesis: The reprocessed shaver blades cannot be used.

Study design: Controlled laboratory study.

Methods: Seven shaver blades (Full Radius Blade; smith & nephew) and three abraders (Abrader; smith & nephew) were reprocessed once or three times and then were assessed. In the first parts of the study, structural damage on the shaver blades after three times reprocessing was compared to the one after the first processing using the optical microscopy. In the second part of the study, surface damage was observed by the optical microscopy and the scanning electron microscopy (SEM), and the elemental and chemical analyses of contaminants found by the microscopy were then performed using SEM/energy dispersive X-ray spectroscopy (SEM/EDX), scanning Auger microscopy (SAM), and Fourier transform infrared spectroscopy (FT-IR).

Results: The optical microscopic examination revealed abrasion on the surface of inner blade and cracks on the inner tube even after first processing. These changes were more evident after processing for three times. The SEM-EDX and the SAM of the inner cutter of the blade showed contaminants containing calcium, carbon, and oxygen, and FT-IR demonstrated biological protein consisting mainly of collagen. The SEM-EDX and the SAM of the inner cutter of the abrader revealed contaminants containing carbon, calcium, phosphate and oxygen, and the FT-IR showed H2O, hydroxyapatite and some types of hydroxyl proteins.

Conclusions: This is the first report to analyze the elements and chemicals of contaminants on the reprocessed shaver blades. A previous study has shown that 48% of the reprocessed blades has detectable levels of protein and 63% has detectable levels of nucleic acid. In this study, it was confirmed that residual contaminants contains collagen and hydroxyapatite even after first processing.

Clinical relevance: Usage of the reprocessed shaver blades should be avoided.
Prospective Early Results of Resurfacing of Osteochondral Talus Defects by Synthetic Resorbable Scaffolds

Background and aim of the study: The purpose of the present study is to evaluate the efficacy of poly(D,L-lactide-co-glycolide) synthetic resorbable scaffolds transplantation of the talar dome with MRI and clinical short-term follow-up. We therefore present surgical technique steps and early results at one year obtained with preformed in shape and size bone graft substitutes in repair of III and IV degree full thickness osteochondral defects of the talus.

Methods: The utilized implant is a cylinder composed of poly(D,L-lactide-co-glycolide) to which calcium sulphate and surfactant are added to enhance bone in-growth and make implant’s surface more hydrophilic. The three-dimensional porous cylindrical implant with interconnected pores is press fit into the site for close apposition and encourage migration of repair tissue as blood and marrow into the scaffold. The two layer construct of the implant mimics the mechanics of the surrounding tissues, bone and cartilage, in order to facilitate from the beginning the nature of the repair tissue that will be formed. The plugs are available in different sizes (5,7,9 mm) preformed in order to match the talus dome surfaces. The first 15 patients were included in the study (7 women, 8 men). Every patient has undergone arthroscopic ankle assessment to evaluate size, location and degree of defects and has undergone implantation of TrufitTM cylindrical resorbable scaffold. Majority of synthetic bone substitutes implanted were 7 mm in diameter.

Results: All surgical procedures have been completed uneventfully. Patient have been controlled clinically and by serial ankle MRI’s and showed statistically significant improvement of AOFAS scores associated to healing of defect and integration of bone plugs in absence of adverse reactions.

Conclusions: Today several methods are available for surgical treatment of hyaline cartilage defects frequently incidentally encountered during arthroscopies, especially in the knee, as reported by various authors. At our institution, among other treatments, we recently have decided to use TrufitTM synthetic implants, retaining interesting to use a scaffold that enables bone and hyaline like cartilage in-growth before of it’s resorption. Preliminary results enable us to conclude that porous, resorbable scaffolds can be used in treatment of cartilage defects offering a secure support to secondary bone in-growth with the advantage of being applied in one single step procedure, enabling patients to quickly move back to previous daily and sport activities.
Arthroscopic Treatment of Anterolateral Soft Tissue Impingement of the Ankle: Is This an Effective Treatment in Patients Under 15 Years Old?

INTRODUCTION: Inversion injuries of the ankle are common in children and adolescents. Although the vast majority of these injuries are resolved uneventfully, some young patients develop chronic pain, swelling and giving-way aggravated by activity. The aim of this retrospective study was to evaluate the results of patients less than 15 years old treated with arthroscopic debridement of soft tissue impingement of the ankle.

MATERIAL AND METHODS: Between November 2003 and December 2007. Thirty three patients with residual complaints after an ankle sprain were diagnosed as having anterolateral impingement of the ankle. The mean age of patients was 11 + 3 (+ SD) years old. Diagnoses was established using the clinical criteria enounced by Liu et al. In all cases, the index traumatism was treated with casting for 3 weeks. Initial and preoperative X-ray analyses were normal and eliminated talo-crural laxity. Local anesthetic injection of the impingement for diagnosis was done in each case and all of them experienced pain relief. Time between initial traumatism and arthroscopy was 9 months (range, 5 to 17 months). All procedures were performed by a single surgeon. Arthroscopic treatment used standard anteromedial and anterolateral portals. Postoperatively, patients were immobilized in a long leg cast for three weeks. The mean follow-up was 26 months (range, 12 to 44 months). Clinical assessment at follow up used the French foot and ankle surgery society score and the Meislin’s Criterias.

RESULTS: The ankle joint arthroscopic evaluation found in all cases an anterolateral impingement (hypertrophy of the synovium, synovitis or fibrous adhesion). Associated cartilage damage of the anterolateral aspect of the dome of the talus was never diagnosed. No complications occurred. At final follow-up, all patients so treated were satisfied. The mean French foot and ankle surgery society score was 94 points (range, 82 to 100). According to Meislin’s criteria, 29 patients had an “excellent” result and 4 patients had a “good” result. All patients returned to their pre-injury activity level and no further complaints were observed.

CONCLUSION: This is the first study that we are aware of to investigate the effectiveness of arthroscopic treatment of anterolateral soft tissue impingement of the ankle in patients under fifteen years old. The results of this study emphasize the safety and the efficacy of this treatment in this population.
Arthroscopic Treatment of Anterior Ankle Impingement:
Results of a 70 Patient Multicenter Prospective Study

Purpose: The purpose of the present study is to assess the clinical results of the arthroscopic treatment of anterior ankle impingement and find predictive factors for poor results.

Materials and Methods: Seventy cases (in 70 patients with an average 36 year old) of anterior ankle impingement with arthroscopic treatment were included in this prospective, continuous, multicenter study. Preoperative assessment included sport level, previous trauma (type of injury, type of treatment, delay before surgery), functional impairment (with the functional ankle score of Kitaoka, clinical symptoms of antero-lateral ankle impingement (Liu criteria) and duration of the symptoms before surgery. Intra-operative data with type of impingement (bone, soft tissue or mixed), cartilaginous lesions or synovitis were also assessed. All the patients were reviewed after a mean 17 months follow-up (minimal one year follow-up) with a postoperative clinical assessment including sport level, clinical symptoms, functional ankle score of Kitaoka and satisfaction. Statistical analysis was performed with Wilcoxon test and Mann-Whitney test for continuous variables and an univariate and multivariate analysis was also performed for the assessment of predictive factors of poor results.

Results: Most of the patients (86%) had had previous ankle trauma before developing anterior ankle impingement symptoms. The mean delay between first ankle trauma and surgery was 22 months. A tibio-talar synovitis was found in 87% of the cases. Only 64% of the patients had no cartilaginous lesion. Functional results were good or very good in 86% of the patients and the Kitaoka score was significatively improved from a mean 70.5 preoperative to a mean 87.2 at final follow-up. All the patients returned to sport activities, with the same level for 75%. Bad results were significantly associated with older patients, longer delay between trauma and arthroscopy, ankle laxity and osteoarthritis.

Discussion: Anterior ankle impingement is a clinical syndrom with precise different physical signs and criteria. Arthroscopic treatment is simple and reliable with a 86% rate of good and very good results. In case of anterior ankle impingement longer than 2 years, with ankle laxity and joint space narrowing, the result after arthroscopic treatment is more uncertain.
Static and Dynamic Analysis of Foot Structure in Athletes Sustaining Proximal Fifth Metatarsal Stress Fracture

Introduction: Proximal fifth metatarsal stress fracture is a well recognized entity. Non union and re-injury are not infrequent following non operative management. Biomachanical foot characteristics as lateral overloading in rigid cavus foot have been suggested as contributing factors. However, scientific evidence supporting a unique foot structure in professional athletes sustaining this injury is lacking. The purpose of our study was to examine whether static and dynamic variables of foot structure in athletes which sustained this injury are unique and support a biomechanical rationale for the development of this fracture.

Methods: This study compared three groups: 10 injured feet of 10 soccer players which regained professional activity following unilateral proximal fifth metatarsal stress fracture, 10 contralateral non injured feet of these same athletes, and 20 control feet of 10 healthy non injured athletes. Static variables of arch height and flexibility were measured, followed by dynamic evaluation of foot loading which was performed using EMED-AT pressure measurement platform.

Results: Static measurements of arch height and flexibility did not reveal significant differences among the three groups. Dynamic variables as contact time, contact area and arch index, evaluated with the EMED system, did not reveal as well significant differences among the groups. However, peak pressures and pressure integral under the fourth and fifth metatarsals of injured athletes were decreased compared with non injured athletes, while pressures under the first metatarsal were increased in the injured population compared with control.

Conclusions: In the specific population of professional soccer athletes, arch height and flexibility may not play an independent role in the development of proximal fifth metatarsal stress fracture. Reduced pressures under the fifth metatarsal and increased pressures under the first metatarsal in this population may either play a role in the development of this fracture, or merely reflect a resultant pressure distribution pattern following this injury.
IKDC or KOOS? Which One Measures Symptoms and Disabilities Most Important to Postoperative Articular Cartilage Repair Patients?

Background: The relevance of knee-specific subjective measures of outcome to patients has not been evaluated for cartilage repair procedures. The aim of this study was to identify which instrument out of the Knee Injury Osteoarthritis Outcome Score (KOOS) and the International Knee Documentation Committee Subjective Knee Form (IKDC) measured symptoms and disabilities most important to postoperative articular cartilage repair patients.

Hypothesis: The KOOS will provide a better measure of symptoms and disabilities that are most important to postoperative articular cartilage repair patients.

Study Design: Cross-sectional study

Methods: Data was collected from 58 participants of a knee internet forum via a self-reported online questionnaire consisting of demographic and surgical data, the Tegner Activity Scale and 49 consolidated items from the KOOS and the IKDC. Item importance, frequency and frequency-importance product (FIP) were calculated.

Results: The study cohort comprised of 31 females and 27 males with a mean age at the time of surgery of 35.5 years (SD 7.7; range 23-49 years). Male gender was significantly associated with a higher Tegner Activity Scale score (p<0.05). Female respondents reported significantly higher item importance ratings relative to their male counterparts for the KOOS items (p<0.05) but did not report significantly higher ratings for the IKDC items. There were no statistically significant associations between individual patient ranking (IPR) and postoperative time (KOOS p=.942; IKDC p=.889) or age at surgery (KOOS p=.487; IKDC p=.304). The IPR for the KOOS and the IKDC were significantly correlated (rho = .944; p<.01). Overall the IKDC was the highest scoring instrument in all categories. However, two of the KOOS subscales (function in sport and recreation and knee-related quality of life) scored higher on mean importance and FIP than the overall IKDC score. Items associated with pain or difficulty with bending or straightening the knee scored low (mean FIP range=0.38-1.21) compared with functional activities such as items associated with going up or down stairs (mean FIP range= 2.15-2.31).

Conclusions: The IKDC provided the best overall measure of symptoms and disabilities that are most important to this population of postoperative articular cartilage repair patients. Issues related to sports and functional activities appear to be highly valued and very pertinent to evaluation of outcomes for this patient group.
Focal Inlay Resurfacing in Localized Defects of the Femoral Condyle in Middle-Aged Patients: Prospective, Multicenter, One and Two Year Results

Background:
Treatment of focal full thickness cartilage lesions remains challenging after biologic treatment options have failed in middle-aged patients with otherwise healthy articular surfaces. A novel resurfacing system allows for intraoperative mapping of the patient’s joint geometry and placement of a matched, contoured articular inlay prosthesis (HemiCAP®) as part of a tissue preserving, interim management prior to conventional arthroplasty.

Material and Methods:
34 patients (23 male, 11 female), mean age 47 years (31-67), were included in this multicenter prospective study. Inclusion, exclusion criteria restricted participation to patients with no additional cartilage defects (> grade 2), no malalignment > 7 degrees, and BMI < 30kg/m2. WOMAC, SF-36, and IKDC scores were collected preoperatively, at 3, 6, 12, and 24 months postoperatively. Radiographic evaluation was conducted by a single independent radiologist.

Results:
32 patients were treated on the medial femoral condyle, 2 on the lateral. Adequate defect coverage was achieved with 20mm (N=23) and 15mm (N=11) articular components. Five patients had no prior surgery (mean age 55yrs), 29 failed prior biologic interventions (mean age 46yrs). Mean current follow-up was 20.5 months (range: 12-24). The mean post-implantation Global WOMAC score improvement ranged from 73.4% at one year to 74.6% at two years; mean SF-36 subscores improved from one to two years and ranged from 62.8%-238.9%; IKDC scores were normal or nearly normal 12-24 months postoperatively. Radiographic evaluation did not reveal any signs of device disassembly, migration, progressive periprosthetic radiolucency, or joint space narrowing.

Conclusion:
HemiCAP® implantation resulted in reproducible subjective and objective outcomes improvement as a revision procedure for failed biologic interventions in middle-aged and elderly patients. Healthy articular surfaces and joint biomechanics were preserved through minimal removal of bone and congruent, anatomic surface reconstruction.
Purpose: Arthroscopic drilling is often performed for stable juvenile osteochondritis dissecans by either the transarticular or retroarticular method. Although several studies have clarified the efficacy of transarticular drilling, few reports have evaluated the clinical outcomes of retroarticular drilling. The purpose of this study was to evaluate the functional and radiographic outcome of retroarticular drilling for patients with juvenile osteochondritis dissecans after 6 months of unsuccessful non-operative treatments.

Methods: Retroarticular drilling was indicated for patients with osteochondritis dissecans whose articular cartilage of the lesion was intact or demonstrated cartilage softening, as confirmed by arthroscopic visualization and probing of the lesion. A total of 20 osteochondritis dissecans lesions in 12 skeletally immature patients were treated with retroarticular drilling. There were 10 boys and 2 girls with an average age of 12.0 years (range: 9 - 15). The functional outcomes were evaluated using the Lysholm score at an average follow-up of 2.6 years after drilling and healing of the lesions were confirmed using plain radiographs and MRI.

Results: The average Lysholm score significantly improved postoperatively (from 72.4 to 95.8). All lesions except one healed after the retroarticular healing. Healing was achieved at an average of 4.4 months on plain radiographs and 7.6 months on MRI. According to Hughston’s criteria, 16 knees were graded as excellent and 2 knees were graded as good. Seven of 9 patients who had been involved in sports activities returned to their previous activities without reduction of their activity levels within 6 months after the operation.

Conclusions: This study clearly demonstrated that retroarticular drilling was an effective treatment option for patients with stable juvenile osteochondritis dissecans, as proved by their functional and radiographic improvement. This minimally invasive procedure can be performed in an arthroscopic and fluoroscopic-assisted manner, thus avoiding unnecessary cartilage damage of the lesion and accidental damage of the distal femur’s open physis. We advocate retroarticular drilling for patients with stable juvenile osteochondritis dissecans of the knee whose initial non-operative treatment has failed.
Tibial Slope and Patellar Height After Opening Wedge High Tibia Osteotomy Using Autologous Tricortical Iliac Bone Graft

Our aim was to evaluate the alteration in angle of posterior slope of the tibia and the degree of patellar height following medial opening wedge high tibia osteotomy (HTO) using autologous tricortical iliac bone graft in 32 consecutive patients. Twenty three females and nine males underwent medial opening wedge high tibia osteotomy (HTO) using autologous tricortical iliac bone graft in 34 knees (33 primary medial compartment osteoarthritis and 1 idiopathic osteonecrosis of medial tibial condyle). Anterior to posterior tricortical graft width ratio was 0.68. The posterior slope of tibia was determined by the proximal tibial anatomical axis. Patellar height was measured by the Insall-Salvati and the Blackburne-Peel ratios. Preoperative and postoperative (last followup) values of these three parameters were compared. The intra- and interobserver variability of these methods was determined before and after operation. At the end of mean follow up of 3 years this procedure produced no significant change in posterior slope. Pre and postoperative posterior slope were 8.7°±3.6° and 8.2°±2.8° respectively (P=0.412). Pre and postoperative Insall-Salvati ratios were 0.93±0.10 and 1.05±0.11 respectively (P<0.001). The Insall-Salvati ratio increased in 94% of patients and patellar ligament length was significantly increased.

The distance between the patellar and tibiofemoral joint line decreased in 82% of patients. The mean Blackburne-Peel ratio declined from 0.71±0.12 to 0.61±0.13 (P<0.001). Twenty six percent of postoperative Blackburne-Peel values satisfied the radiographic criterion for patellar infera (Blackburne-Peel ratio < 0.54).

There was no difference in the intra-and interobserver variability of measurements either before or after HTO. Opening wedge HTO using autologous tricortical iliac bone graft with internal fixation and early mobilisation prevented change in posterior slope of tibia, lengthened the patellar ligament and elevated the tibiofemoral joint line when the mean ratio of anterior and posterior gap at the osteotomy site was around two thirds.
Meniscal Repair in the Elite Athlete: Results of 45 Repairs with a Minimum 5 Year Follow-up

Introduction and Aims:
We have an aggressive approach to meniscal repair, including repairing tears other than those classically suited to repair. Elite athletes represent the subgroup of patients who place the most demand on the menisci and as a result, place maximum stress on any meniscal repair. Here we present the medium to long-term outcome of meniscal repair (inside-out) in the elite athlete.

Methods:
42 elite athletes underwent 45 meniscal repairs between January 1990 and July 1997 were identified from a prospective database. All repairs were performed using an arthroscopically assisted inside-out technique. All patients returned a completed questionnaire (Lysholm and IKDC) to determine their current function and any symptoms or interventions that we were unaware of. The mean age was 23.2 (range 15 to 38). 67% medial and 33% lateral menisci were repaired (3 patients had both medial and lateral menisci repaired) with an average of 3.7 sutures (range 1 to 12). 83.3% of these repairs were associated with simultaneous ACL reconstruction. The average time from injury to surgery was 11 months (range 0-45 months). Follow-up time was a mean of 8.5 years (range 5.4 to 12.6 years).

Results:
In general, function was good with an average Lysholm and subjective IKDC scores of 89.6 and 85.4 respectively. 81% of patients returned to their main sport and most to a similar level at a mean time of 10.4 months post-repair, reflecting the high level of ACL reconstruction in this group.
We identified 11 definite failures, 10 medial and 1 lateral meniscus that ultimately required arthroscopic excision, this represents a 24% failure rate. We identified one further patient who had possible failed repairs, giving a worse case failure rate of 26.7% at a mean of 42 months post surgery. However, 7 of these failures were associated with a further injury, and 2 of the 7 failures ruptured their ACL reconstruction. Therefore the repairs had healed and were torn with reinjury. Age, size and location of tears were not associated with a higher failure rate. ACL reconstruction did not affect the failure rate although no tears were repaired as isolated procedures in ACL deficient knees. In this series medial meniscal repairs were significantly more likely to fail than lateral meniscal repairs, with a failure rate of 36.4% and 5.6% respectively (p<0.05).

Conclusions:
This series reflects an aggressive approach to meniscal repair with repair of tears in a high demand elite group of patients. Despite this, on a worst case analysis 73% were intact at a mean of 8.5 years post repair. We conclude that meniscal repair and healing is possible and that most patients can return to preinjury level of activity.
Specific Factors That May Influence Repeat Meniscus Surgery in Patients After Suture Repair of the Meniscus

Purpose: Meniscus repairs with sutures have become more common as the importance of preserving the meniscus has been proven. Studies have shown a high rate of repeat surgery after meniscus repair, but it is unclear what factors contribute to failure. The purpose of this study was to determine what factors might lead to repeat surgery following suture meniscus repair.

Methods: Two hundred eighty-three (283) meniscus suture repairs were performed by a single surgeon. The average patient age was 31 years (range, 18 to 71). There were 177 males and 106 females. Average time from injury to surgery was 12 months (range, 0 days to 15 years). All repairs were completed with an inside-out suture technique. Ninety-three (93) patients had concurrent ACL reconstruction and 44 had a 2-stage ACL reconstruction. One hundred eighty-one (181) medial menisci and 102 lateral menisci were repaired. Of the medial repairs, 80% were in the posterior third of the meniscus, 11% in the middle third, 1% in the anterior third, and 8% extended to all areas of the meniscus. Of the lateral meniscus repairs, 49% were in the posterior third, 26% in the middle third, 22% in the anterior third, and 3% extended to all areas.

Results: Thirty-seven (37) patients (13%) required repeat surgery on the repaired meniscus. There was no difference in time from injury to surgery between patients who required repeat surgery and those who did not. Nine (9) patients underwent suture re-repair at subsequent surgery and 28 had partial excision/debridement of the meniscus. The subsequent surgeries which involved re-repair occurred sooner than the excisions (17 mos vs. 33 mos; p=0.05), and patients were younger than in the excision group (23 vs. 31 yrs; p=0.01). Fifteen percent (15%) of the medial repairs and 10% of lateral repairs required repeat surgery. Of the reoperated menisci, 29% of the medial and 11% of the lateral repairs required subsequent suture re-repair. There were no differences based on gender or location of meniscus tear. The average time to repeat meniscus surgery was 2.5 years (range, 75 days to 13 years). Thirty-eight percent (38%) of repeat surgeries were within one year, 32% between one and two years, 16% between 3 and 5 years, and 14% greater than 5 years. Medial meniscus repairs required repeat surgery significantly earlier (1.8 yrs) compared to lateral meniscus repairs (4.5 yrs) (p=0.01). Patients with associated ACL reconstructions who required subsequent surgery were younger (24 vs. 30 yrs; p=0.03) and more likely to undergo a repeat suture repair (p=0.03; odds ratio 5.7 [95CI 1.2 to 27]) than patients without associated ACL treatment. Staged ACL reconstructions had fewer second meniscus surgeries (2%) compared to concurrent ACL reconstructions (16%) (p=0.03). Patients who underwent concurrent ACL reconstructions were 7.6 times more likely to undergo repeat meniscus surgery compared to staged reconstructions (CI: 1.3 to 44.9).

Conclusion: Patients who undergo meniscus suture repair and subsequently require repeat meniscus surgery usually undergo debridement, but suture re-repair may be an option. Subsequent re-repair occurred more in younger patients, those with associated ACL treatment, and those which involved medial meniscus repair. In our patient population, medial meniscus suture repairs, age, and repairs with concurrent ACL reconstructions (not staged) were factors that resulted in higher rates of repeat meniscus surgery.
The Effect of Pullout Suture For the Radial tear of Posterior Horn of Medial Meniscus in Porcine Knee

Purpose:
The radial tear of the meniscus results in the loss of hoop tension which may lead to the premature degenerative changes of knee joint. The effect of current pullout suture techniques on radial tear of posterior horn of medial meniscus (PHMM) is unknown. The aim of this study is to measure the contact pressures of medial compartment of the knee joint after pullout suture in radial tear of PHMM.

Methods and Materials:
Eleven pig knees (body weight = 100.1 ± 5.4kg, n=11) were tested with the intact, radial tear (resected) and after pullout suture for radial tear of MMPR respectively. K-scan sensor (Tekscan Inc., Boston, USA) was inserted into medial compartment between the undersurface of posterior medial meniscus and posteromedial tibial condyle. Contact pressures of medial compartment were measured at 0°, 15°, 30°, 60°, 90° of flexion under 1500N using mechanical testing system and recorded by the K-scan sensor. The Student-Newman-Keuls method was used to analyze the effect of intact, resected and repaired medial meniscus on contact pressures. Differences were considered statistically significant where P <0.05.

Results:
The contact pressure in the knees with radial tear of PHMM was significantly high at 0°, 15°, 30°, 60°, 90° flexion(p<0.05). The contact pressure following pullout suture technique was significantly high at 0° and 15° flexion(p<0.05), when compared to that of intact knee specimens. The difference was not significant at 30°, 60° and 90° flexion.

Conclusion:
Pullout suture technique for the radial tear of PHMM might not contribute to restore the hoop tension of medial meniscus. Because pullout suture technique is non-anatomic method, it disturbs the anterior meniscal excursion, especially at 0°, 15° flexion.

Clinical relevance:
During the stance phase of gait (ave. 15°-20° flexion), PHMM moves anteriorly, but pullout suture technique disturbs the meniscal excursion which may lead to increase the contact pressure of medial compartment or retear of pullout suture site. Future repair technique should aim at restoring medial meniscus under physiologic loads.
Clinical Results Following Matrix-assisted ACT Change for Better After 1, 2 and 3 Years of Follow-up

Introduction:
Autologous chondrocyte transplantation (ACT) is an increasingly used procedure for the surgical repair of full-thickness articular cartilage defects in the knee. For larger defects it is now recommended as a first-line treatment by the respective German professional societies. For even matrix-based implants remain just cell-grafts, the early-stage cartilage repair tissue is rather squishy and lacks of any primary stability. Based on a primary soft and vulnerable transplant, the graft increases in strength and load capacity within the following months and years. Based on the clinical results of 118 patients that have been examined and evaluated preoperatively and between 3 and 48 months postoperatively, we investigated whether there are differences in the clinical outcome (IKDC-score) related to the follow-up interval.

Material and Methods:
From 11/03 to 12/06 a total of 118 patients (80m, 38f) have been treated with matrix assisted autologous chondrocyte transplantation (MACT, NOVOCART™3D, B.Braun - Aesculap, Germany). All patients have pre- and postoperatively been examined and evaluated according to the IKDC subjective knee score. The total sample of n=118 patients has an average follow-up of 24,6 months (3-48 months) and was divided in two subgroups of a follow-up between 3 and 24 months (n= 63, avg. follow-up: 14,7 months) and a follow-up between 25 and 48 months (n=55, avg. follow-up: 36,1 months).

Results:
The subgroup I with an average follow-up of 14,7 months shows an increasing IKDC score of 13,7 pts (31,7%). Within the total sample (avg. follow-up: 24,6 months) the IKDC increased at 19 pts (47,5%). Subgroup II with an average follow-up of 36,1 months shows an increase of 25,4 pts (68,3%) compared to the preoperative status.

Discussion:
Our data suggest, that clinical results following matrix-ACT change for better depending on the follow-up period. For even matrix-ACT remains just a cell transplantation, the primary graft is soft and vulnerable and gains in strengths and durability within the years after transplantation. This process seems to continue over at least 3 years. Our clinical observation goes along with some histological data, showing an improvement of tissue quality between 1 and 3 years after ACT [Roberts S et al. Arthritis Res Ther. 2003;5(1):R60-73].
Weekly Intraarticular Injections of Bone Morphogenetic Protein-7 Inhibit Osteoarthritis Progression

(Introduction) Osteoarthritis is mainly caused by the breakdown of joint cartilage, and nonsurgical treatment for retarding its progression is highly desired. BMPs have some effects on the improvement of chondrocyte metabolism. We examined the therapeutic effects of weekly intraarticular injections of bone morphogenetic protein-7 (BMP-7) in an osteoarthritis model in rabbits.

(Methods) Experimental osteoarthritis was induced in the knee joints of rabbits by bilateral anterior cruciate ligament transection. Rabbits were treated with weekly intraarticular injections of BMP-7. First, knee joints were randomly divided into four groups: 50, 500, 5000 ng BMP-7, and control groups. Following that, to compare results more strictly, matched pair analysis was performed (n=5). The knee joints were evaluated at 1, 2, and 3 months. Immunohistochemical and ELISA study were performed to see BMP-7 expression in chondrocyte by BMP-7 administration. Possible adverse effects of BMP-7 were also examined.

(Results) Histological scores in the 500 and 5000 ng BMP-7 groups were significantly better than those in the others at 3 months. Matched pair analysis showed that both macroscopic and microscopic scores in the 500 ng BMP-7 group were significantly better than those in the control group. Immunohistochemistry demonstrated that chondrocytes in the BMP-7 treated knees expressed higher than those in the control knees. ELISA analysis revealed that BMP-7 concentration in cartilage tissue rapidly decreased one day after intraarticular injection but that BMP-7 concentration in cartilage in the BMP-7 treated knees was still higher than that in the control knees 7 days after injection. Histology and quantitative micro CT analysis demonstrated that weekly injections of 500 ng BMP-7 did not promote synovial fibrosis or ectopic bone and osteophyte formation.

(Conclusions) Weekly intraarticular injections of BMP-7 inhibited osteoarthritis progression in rabbits with anterior cruciate ligament transection. BMP-7 was detected in cartilage 7 days after injection. No adverse effects resulting from repeated intraarticular BMP-7 injections were observed.
The Effects of OP-1 on the Prevention and Treatment of Osteoarthritis in Articular Cartilage

Introduction
Osteoarthritis, a degenerative disorder resulting from the breakdown of articular cartilage, has many possible treatments, but none are disease modifying. Previous studies have shown that OP-1 (also known as BMP-7) is vital to cartilage matrix integrity and repair, stimulates synthesis of cartilage matrix components, proteoglycans and collagen, and has a protective effect against catabolic mediators like MMPs and IL-1. In this study, OP-1 was tested as a novel tissue engineering solution to protect articular cartilage from degeneration during the development of OA as a preventive measure and after four weeks of arthritis progression following an ACL transection as a therapeutic agent for the treatment of OA.

Materials and Methods
The rabbit ACLT model was used in which the ACL was transected leading to a predictable progression of OA. OP-1 was delivered to the joint surgically by implantation of an Alzet osmotic pump into the medial thigh with a catheter threaded from the pump into the knee joint. In the preventive group, 40 rabbits (20 control, 20 experimental) had the ACLT surgery and implantation of the pump performed simultaneously. They were sacrificed 9 weeks after for analysis. In the therapeutic group, 30 rabbits (15 control, and 15 experimental) had the ACLT surgery performed 4 weeks prior to implantation of the osmotic pump. Sacrifice was also performed 9 weeks post-ACLT. The OA was graded using the Outerbridge classification with India Ink staining. Histological staining with H&E and Safranin O was performed to analyze OA progression using histomorphometry and Semi-quantitative PCR for anabolic and catabolic genes.

Results
The preventive experimental group had an average Outerbridge score of 1.81 versus 2.49 for the controls (p<0.05). Histomorphometry showed 10.9% surface deterioration or an average depression of 0.05mm versus 22.3% and 0.1mm for the controls (p<0.05). Semi-quantitative PCR showed a significantly greater expression of aggrecan and collagen type II in the OP-1 treated cartilage when compared to controls and less expression of aggrecanase, a catabolic mediator. The treatment experimental group had an average Outerbridge score of 1.90 versus 2.60 for the controls (p=0.140). Histomorphometry demonstrated 23.5% average cartilage deterioration for OP-1 treated cartilage with an average depression of 0.103mm versus 30.8% and 0.141mm for the controls (p>0.05). Semiquantitative PCR showed a significantly greater expression of aggrecan in the OP-1 treated cartilage when compared to controls and less expression of MMP-3 and MMP-13, catabolic mediators.

Conclusions
OP-1 may have a potential benefit in protecting articular cartilage during the development of OA and has shown a trend towards treatment of degenerative effects once OA has been established.
Strength and Anatomical Measures in ACL-injured and Non-injured Elite Team Handball Players

Background:
Non-contact ACL injuries represent a major problem in team sports, especially for females and little is known about risk factors. Therefore, a five-year prospective cohort study has been initiated in the elite division of Norwegian female team handball to identify risk factors for ACL injuries.

Objectives:
To compare previously ACL-injured and non-injured elite female team handball players, and describe side-to-side differences in ACL-injured players.

Design: Case-control study

Participants:
184 elite team handball players, 14 with unilateral reconstructed ACL injury.
Methods: Isokinetic quadriceps and hamstrings strength, isometric hip abduction strength, hamstrings mobility, knee laxity (KT1000), navicular drop and generalised joint laxity (Beighton index) were examined.

Results:
No differences were found between groups in generalised joint laxity, leg press strength, navicular drop, hip anteversion or knee laxity. Injured players had greater hamstrings mobility than non-injured players (154° [149°-159°] vs. 144° [143°-146°], p=0.002) and greater hip abductor strength when the non-injured side was compared with non-injured players (13.7 [12.4-15.0] kg vs. 10.9 [10.6-11.3] kg, p<0.001). When comparing the injured and non-injured leg, injured players had lower isokinetic quadriceps (163 [146-179] vs. 181 [167-195] Nm, p=0.048) and hamstrings strength (99 [86-111] vs. 107 [97-118] Nm, p=0.042) in their injured leg and, and there was a trend towards lower hip abductor strength (12.4 [11.2-13.6] vs. 13.7 [12.4-15.0] kg, p=0.069). No difference was found in the ratio between hamstrings and quadriceps strength (0.61 [0.54-0.68] vs. 0.59 [0.55-0.64], p=0.66). Among previously injured players, there were no significant differences between legs in hamstrings mobility, knee laxity, navicular drop or isometric hip abductor strength.

Conclusions:
Generally, ACL-injured players were at least as strong as the non-injured group, but have returned to elite level pivoting sport with strength differences between the injured and the non-injured leg. Such side differences may leave the players prone to new injuries.
Muscle Strength and Functional Performance in Patients with ACL Injury Treated with Training and Surgical Reconstruction or Training Only: A 2 to 5-Year Follow-up

Objective:
To study muscle strength and functional performance in patients with anterior cruciate ligament (ACL) injury with or without surgical reconstruction 2 to 5 years after injury. Good muscle function is important in preventing early-onset osteoarthritis (OA), but the role of reconstructive surgery in restoring muscle function is unclear.

Methods:
54 patients (mean age at follow up 30 years, range 20-39, 28% women), out of 121 patients with ACL injury included in a randomized controlled trial on training and surgical reconstruction vs. training only (the KANON study, ISRCTN84752559), were assessed 3 years (SD 0.9) after injury with reliable, valid and responsive test batteries for strength (knee extension, knee flexion, leg press) and hop performance (vertical jump, one-leg hop, side hop). The Limb Symmetry Index (LSI, injured leg divided by uninjured and multiplied by 100) value, and absolute values were used for comparisons between groups (analysis of variance). An LSI =90% was considered normal.

Results:
There were no differences between the surgical and the non-surgical treatment groups in muscle strength or functional performance. Between 44% and 89% of the subjects had normal muscle function in the single tests, and between 44% and 56% had normal function in the test batteries.

Conclusions:
The lack of differences between patients treated with training and surgical reconstruction or training only, indicates that reconstructive surgery is not a prerequisite for restoring muscle function. Abnormal muscle function, found in about one third or more of the patients, may be a predictor of future knee OA.
Quadriceps Muscle Function 8 Years After Anterior Cruciate Ligament Reconstruction

Purpose of the study: Long term results have shown that anterior cruciate ligament (ACL) reconstruction does not prevent osteoarthritis. Previous studies have shown that patient do not regain full muscle strength and voluntary muscle activation two years after ACL reconstruction. The purpose of the study was to find out how the quadriceps muscle performs eight years after ACL reconstruction.

Methods: Ten patients were evaluated prospectively at a mean time of eight years after ACL reconstruction using semitendinosus and gracilis tendon grafts. Isometric knee extension torque and maximal voluntary activation was performed using a twitch interpolation technique in order to measure the quadriceps function at both the operated and non operated site. The extend of the voluntary activation was calculated as a percentage of the relation between the twitch amplitude at MVC and the estimated twitch amplitude of the muscle stimulated at rest in order to get the true muscle force. International Knee Documentation Committee Evaluation Form and the Lysholm-Score was used for clinical evaluation. Data is given as mean. T-Test and ANOVA was used for statistical analysis.

Results: The maximal voluntary contraction (MVC) was 135,29Nm at the operated side and 164,15Nm at the non operated side (p=0,006) prior surgery and 127,06 Nm and 137,95 Nm respectively (p=0,201) at the time of follow up. The MVC of the non operated side decreased significantly (p=0,012) but did not change at the operated side. The voluntary activation (VA) prior reconstruction of the operated and non operated side was 83,93% and 87,64% respectively and at the time of follow up 82,07% and 80,46% respectively. Again, the VA decreased only at the non operated side (p=0,048).

Discussion: The study has shown, that the quadriceps function does not return to normal after ACL reconstruction based on the MVC and VA. The voluntary activation at the non operated side deteriorates to a level of the operated side. Thus the muscle function on both the operated and non operated side does not recover after ACL reconstruction considering a MVC of over 200 Nm and a VA of over 90% in normal subjects.

Conclusion: The mid term success of ACL reconstruction does not only depends on the restoration of the biomechanical stability. Other factors such as the neuromuscular function seems to play an important role. Further studies are required to investigate whether the quadriceps muscle deficits correlate with the development of early osteoarthritis.
Comparison of the Effects of Different Postoperative Rehabilitation Programs on 100 Intra-articular Anterior Cruciate Ligament Reconstructions Using Doubled Semitendinosus and Gracilis Tendons (DGST) Grafts in Athletic Population

Purpose: The purpose of this study was to assess knee function after ACL reconstruction using DGST grafts in different postoperative rehabilitation programs (PORP).

Materials & Methods: A prospective study was conducted. We had three groups; Group I: Thirty patients underwent traditional PORP. In Group II: Thirty patients underwent special sports PORP. In Group III: Thirty patients were without any rehabilitation programmes. At the follow-up examination 6 (range 6-22) months after the operation, we evaluated three factors: Lysholm score; Tegner activity level and range of motion (ROM) over 135 degrees.

Results: In Group I – The Lysholm mean scoring was 90 and standard deviation (SD) as 1.012; the tegner activity level scoring was 5 and (SD) as 1.14; and the ROM achieved by 24 subjects. In Group II – The Lysholm score was 96 and SD as 1.16; the tegner activity level was 7 and SD as 1.22; and the ROM were achieved by all subjects. In Group III – The Lysholm score was 91 and SD as 1.014; the tegner activity level was 5 and SD as 1.26; and the ROM achieved by 27 subjects. All three groups were compared and the results were significant (p<0.05).

Conclusions: Our study proves that different post operative rehabilitation programme after a successfully reconstructed ACL and knee function are dependent to each other. A special sports post operative rehabilitation programmes has significantly shown better results when compared with patients who had other types of post operative rehabilitation programmes especially in athletic population.

Key words: Anterior cruciate ligament (ACL), doubled semitendinosus and gracilis tendons (DGST), Lysholm score, tegner activity level, range of motion (ROM).
Conservative Treatment of Ruptured ACL: A Prospective Study of Controlled ACL Healing with Fully Restored Anatomy and Function in Patients Pre-selected by Diffusion-weighted MRI: Initial Experience

Purpose:
To assess the healing potential of a conservative treatment with fully restored anatomy and function in patients with anterior cruciate ligament (ACL) rupture with no displacement of ligament fibers.

Materials and methods:
After an initial clinical examination to establish ACL rupture (objective IKDC) new diffusion-weighted MRI sequences were used to select 24 cases of fully-ruptured ACL with no displacement of ligament fibers (11 females, 13 males; ages ranging from 15 to 67, mean 31; mean time between trauma and diagnosis: 10 days). The diffusion-weighted MRI sequences were applied to the knee to locate precisely the ruptured ACL fibers within the post-traumatic edematous infiltrate of the intercondylar notch. The edema usually hampers the visualisation of the fibers on conventional MRI sequences. The patients’ knees were placed in a (load-bearing) splint for 6 weeks, with an ROM of 30° to 60° flexion. Another clinical examination and MRI check at 6 weeks were performed to verify ligament continuity. Progressive rehabilitation of the knee was then started. Eight months after the initial trauma a clinical examination (objective IKDC), stress radiography with TELOS device (side-to-side differences between the injured and the intact knees) and an MRI were performed to assess the functional status and anatomical aspect of the ligaments. At one year a subjective functional assessment of the ACL (subjective IKDC) was performed after interviewing the patient.

Results:
20 patients (i.e. 83%) showed full healing of the ACL: normal clinical examination (objective IKDC: 17 patients stage A, 3 patients stage B), fully-restored ACL anatomy on distance MRIs, normal functional assessment (subjective IKDC ranging from 90 to 100, mean 97; TELOS side-to-side differences ranging from 0 to 3mm, mean 2mm). The four failures include an ACL replaced by heterogenous scarring tissue (objective IKDC stage B), a case of non healing and 2 early rupture recurrences (one at 3 months and the other at 6 months: objective IKDC stage C); the last three cases were revised with ACL reconstruction.

Conclusion:
In cases of full ACL rupture with no displacement of ligament fibers a splint-based conservative treatment enabled anatomical and functional restoration. Such patients can now be pre-selected using diffusion-weighted MRI sequences applied to the knee.
Range of Motion and Quadriceps Muscle Power After the Early Surgical Treatment of Acute Combined ACL and Grade III MCL Injuries: A Prospective Randomized Study of 47 Patients

Background: Early operative treatment of combined ACL and MCL injuries have led to frequent motion complications and slow quadriceps muscle power gains. The purpose of this study is to evaluate the effect of early operative or nonoperative treatments of the concomitant MCL injury on knee range of motion and quadriceps muscle strength in combined ACL/MCL injuries. We also wanted to determine the ability of the rehabilitation program to restore normal knee motion after early operative intervention.

Methods: Forty-seven consecutive patients with combined ACL and grade III MCL injuries were randomized into two groups. MCL was treated operatively in group I (N 23) and non-operatively in group II (N 24). In both groups ACL was treated with early reconstruction. Sequential range of motion, one leg hop test, and isokinetic muscle power measurements were performed.

Results: All patients achieved full knee extension. The amount of flexion deficit was higher in the operatively- treated group at any time interval, but the difference was statistically significant only at 6 wk (100? versus 112?, P= 0.009), 12 wk (119? versus 128?, P= 0.043), and at 36 wk (130? versus 136?, P= 0.011) after the operation. At 52 wk (132? versus 137?) and 104 wk (134? versus 137?) follow-up there was no statistical difference. Quadriceps muscle power deficit at 52 wk was 30.7% in the operative group and 20.5% in the non-operative group (P=0.015), and at 104 wk 14.4% and 9.7% (P= 0.2, ns).

Conclusions: Early operative treatment of combined ACL-MCL injuries is possible without increased long-term mobilization complications. The rehabilitation period is long and aggressive physiotherapy is recommended. However, nonoperative treatment of MCL allows faster restoration of flexion and quadriceps muscle power. At 52 wk follow-up the muscle power was better in the non-operative group. At 104 wk follow-up, there was no statistical difference in the muscle power or in the range of motion of the knee. These results favor non-operative treatment of MCL in combined ACL and MCL injuries.

Level of evidence: Therapeutic Level I

Key words: Rehabilitation; Anterior cruciate ligament (ACL); Medial collateral ligament (MCL); Randomized Controlled Trial, Multiligament injury.
Semitendinosus Tendon Regeneration after ACL Reconstruction: A Morphological and Functional Study

[INTRODUCTION]
The semitendinosus (ST) tendon is commonly used as an autogenous graft for anterior cruciate ligament (ACL) reconstruction. Several post-operative studies reported that the ST tendon regenerates with a similar histological structure. However, shortening and atrophy of the ST was confirmed more than one year after surgery. Moreover, athletes who perform in deep knee flexion, such as dance, judo, and gymnastics complained of decreased performance ability due to ST muscle atrophy. However, the mechanism of muscle atrophy and decreased knee flexion torque has not been reported and the process of ST tendon regeneration after operation is unclear. Thus, the purpose of our study is to examine the regeneration process of the ST tendon longitudinally as well as evaluate the ST muscle function after surgery.

[METHODS]
Twenty-nine patients (13 males, 16 females, mean age ± SD: 22.3 ± 3.8 years) who had obtained isolated unilateral ACL rupture participated voluntarily in the present study. All patients were either recreational or competitive athletes belonging to a high school, college or recreational league team. Arthroscopically assisted reconstruction with an autogenous quadrupled ipsilateral ST tendon was performed by the same orthopaedic surgeon. The same rehabilitation program was used for each patient. At the time of evaluation (Average: 22.4 months post-operation, Range: 12 to 43 months), all patients had returned to their previous sport activities without any pain or restriction.

Isometric knee flexion torque was measured using a dynamometer (Biodex System III, Biodex Medical Systems, NY, USA). Patients were seated in a prone position with 0 degrees of hip flexion and the lower body tightly secured to the seat. Two trials of isometric knee flexion with maximum voluntary effort were performed for three seconds at 45, 90 and 105 degrees representing shallow and deep angles of knee flexion, respectively. For each of the ACL reconstructed and the contralateral knee, the mean torque value of the two trials was calculated and expressed as a percentage relative to the patient’s body weight (%BW).

Magnetic resonance imaging (MRI) scans were used to calculate the muscle volume of the ST, cross-sectional area (CSA) of the ST tendon, length of the ST tendon, and to confirm the presence of the regenerated ST tendon after harvesting for ACL reconstruction. The patients were in a supine position with the knee in full extension. MRI scans were obtained with a 0.5-T scanner (FLEXART, TOSHIBA Medical Systems, Tokyo, Japan). T1-weighted spin-echo, transaxial sequences were performed over the thigh perpendicular to the femoral shaft. The images were taken from the ischial tuberosity to 50 mm below the knee joint space. To obtain the muscle volume of the ST, the anatomical CSA of the ST from each image was calculated using Scion Image (Scion Corporation, MD, USA). Muscle volume was determined by summing the anatomical CSA of each image times 12 mm which is the slice thickness plus the interslice gap. The CSA of the ST tendon was also measured using Scion Image (Scion, USA). Tendon length of the ST was defined as the length from the joint line of the knee to the distal musculotendinous junction of the ST.

As an index of recovery, each value of knee flexion torque, muscle volume, tendon length and tendon CSA in the ACL reconstructed limb was expressed as a percentage relative to that in the contralateral limb (% contralateral). A paired t-test was used to test for side-to-side differences. Pearson product-moment correlation coefficient was used to examine the relationship between the values for every measured. One-way ANOVA and Fisher’s LSD post-hoc test was used to test for difference between degrees of the tendon regeneration to assess the knee flexion torque and muscle volume. The threshold for statistical significance was set at p<0.05 for all tests.
[RESULTS]
In 27 of the 29 patients, the regeneration of the ST tendon-like structure was confirmed. In the remaining two patients, a tendon-like structure was not identified. There was no significant correlation between time since surgery and % contralateral value of each of knee flexion torque at 45, 90, 105 degrees, muscle volume, tendon length and CSA of ST tendon.

The isometric knee flexion torque of the ACL reconstructed limb was significantly lower at each of 45 (133.3 ± 28.8 vs. 120.2 ± 26.9 Nm), 90 (82.1 ± 20.9 vs. 57.5 ± 21.0 Nm) and 105 (65.9 ± 21.2 vs. 44.3 ± 16.8 Nm) degrees as compared to that of the contralateral limb. The percentage of the isometric knee flexion torque of the ACL reconstructed limb to that of the contralateral was apparently lower at 90 and 105 degrees (71.5 ± 25.0%, 69.4 ± 29.1%) than at 45 degrees (91.4 ± 17.2%).

The volume of the ST in the ACL reconstructed limb (120.1 ± 55.6 cm3) was significantly smaller as compared to the contralateral limb (164.7 ± 65.3 cm3). Thus, atrophy of the ST in the reconstructed limb was confirmed. The tendon length of the ST in the reconstructed limb (28.8 ± 3.1 cm) was significantly longer than that in the contralateral limb (24.8 ± 3.1 cm). Thus, longer tendon length of the ST was due to a proximal shift of the distal musculotendinous junction in the ACL reconstructed limb. Furthermore, there was significant correlation between % contralateral value of muscle volume and that of tendon length (r=-0.70, r2=-0.48).

The CSA of the ST tendon in the reconstructed limb (0.18 ± 0.12 cm2) was significantly greater than that in the contralateral limb (0.081 ± 0.049 cm2). In 20 of the 29 patients, the CSA of the ST tendons was greater or equal to that of the contralateral limb (Group 1). In the 7 patients, the CSA of the ST tendons was smaller than that of the contralateral limb (Group 2). In the remaining two patients, tendon-like structure was not identified (Group 3). Knee flexion torque at 45 degrees was tended to be lower Group 2 than Group 1 (p=0.06), and significantly lower Group 3 than Group 1 and Group 2. Group 3 had significantly lower muscle volume than Group 2 with lower volume than Group 1.

[DISCUSSION]
The findings obtained in this study indicate that changes in knee flexion torque are associated with the degree of morphological changes in the ST muscle-tendon complex after harvesting its tendon for ACL reconstruction. By analyzing the torque measurements together with the morphological results, we propose that the regenerated tendon-like structure is considered to have the similar function to the native ST tendon when contributing to knee flexion. As our results of this study, CSA of ST tendon in the reconstructed limb is better to be bigger than in the contralateral limb to avoid the decrease of the knee flexion torque and the muscle volume.

From our previous study, we are concerned that the important point for the ST tendon regeneration is to control the excessive tension of ST tendon and at the same time avoiding the muscle atrophy during the early months after operation. To prevent deficits in knee flexion torque after ACL reconstructive surgery, therefore, further studies are needed to investigate the operative technique and rehabilitation program enable to regenerate the ST tendon-like structure while maintaining the morphology of the ST.
Functional Regeneration of the Semitendinosus Tendon in ACL Reconstruction with Hamstring Autograft: A New Technique of Inducer Grafting

[Objective] After ACL reconstruction using the tendons of the semitendinosus (ST) and/or gracilis (G), there have been reports that harvested ST tendon has the potential to regenerate and usually the regenerated ST insert to the popliteal fascia. Furthermore there have been reports that the postoperative hamstring muscle performance such as standing active flexion angle and flexion torque at the deep flexion decrease. Therefore, it’s seemed that one of the reasons for the ST muscle weakness is not anatomical attachment of the regenerated ST tendon. The purpose of this study is to report that a new technique for functional regeneration of the ST tendon using Inducer grafting.

[Patients and methods] Fourteen patients underwent ACL reconstruction using autologous hamstring tendons. They were 7 males and 7 females with a mean age of 22.7 at the time of surgery. The average follow up periods after surgery were 7.7 months. MRI was taken at 1, 2, 4, 6, 12 months after ACL reconstruction. At second look arthroscopy we evaluated attachment of the regenerated ST tendon.

[Surgical technique] After harvesting the ST tendon Passing-pin was inserted along tendon stripper. Passing-pin went through thigh medial skin and retained a loop thread. Inducer graft inserted in the run of the native ST tendon the way of pulling out loop thread in knee extension after the ACL graft fixation. As Inducer graft, the ST tendon branch to gastrocnemius fascia was divided to the ST tendon. The postoperative rehabilitation was same for ACL reconstruction without Inducer grafting.

[Results] In MRI axial view the regenerated ST tendon could be identified from superior pole of patella level to pes anserinus in all cases. At second look arthroscopy the regenerated ST tendon could be divided to surround soft tissue at the attachment all in three cases. And the regenerated ST tendon was same in the run of the native ST tendon.

[Discussion and conclusion] Various attachment of the regenerated ST tendon must have an influence on the moment arm of ST muscle at the flexion. The role of Inducer grafting is seemed that tendon canal after harvesting the native ST tendon connect to pes anserinus and effect like drainage for hematoma. This study was suggested the possibility that Inducer grafting could guide to pes anserinus for the regenerated ST tendon and improve the regeneration rate of the ST tendon.
Microarchitecture of Patella

Objectives
The aim of this study is to quantify bone micro-architecture within the patella. High-resolution micro-computed tomography ([mu]CT) imaging have been instrumental in providing true quantitative and qualitative three-dimensional data on baseline bone morphology. This technique is interesting for its excellent precision for both density and structure measurements.

Materials and Methods
20 fresh-frozen human cadaveric patella were analysed. The right side and the left side were both analysed on the same patient. The mean age of the specimens was 70 years. All patellae were inspected for normal anatomic landmarks. The total trabecular of the whole inner area of the patella was determined by use of peripheral quantitative computed tomography (pQCT) (Xtrem Ct; Scanco, Zurich, Ch). Each patella was fixed horizontally in a custom-made jig, and axial pQCT scans (pixel size, 1536/1536; slice thickness 80 microns), perpendicular to the articular surface, were obtained at the level of the inner area area. A cylinder was marked off as cartilaginous and sub-chondral areas were eliminated. From the resulting binarized three-dimensional reconstruction, Scanco software was used to calculate the bone volume per tissue volume, mean trabecular separation and mean trabecular number. Trabecular architecture and appearance were revealed.

Results
The total mean BV/TV or bone density of the patella was quite homogenous: 0.3934. The mean trabecular volume was 617.15 mm³ as the trabecular thickness was 0.3320. The average number of trabecular structures was 1.34 per mm. Trabecula are built in all directions. Size and shape of trabecula has been observed and then bone strength was evaluated. That’s means that the patella has a significantly poor density.

Conclusions and Clinical relevance
Although the specimen age was quite high in our material, we believe aging does not affect our study as knee prosthesis are generally performed on old patients. The very cancellous nature of bone and the poor density of the patella may explain some “button” loosening. In the future, a better knowledge of the bony architecture of the may improve bone implantation.
Regulation of Joint Contact Area is an Essential Mechanism for Maintaining Physiological Patellofemoral Joint Mechanics

Introduction: Elevated pressure, reduced contact area and increased patellar tilt are thought to play a role in the onset of patellofemoral pain and their quantification in an experimental as well as clinical setting is of increasing importance. Nevertheless, these parameters have only been examined under simplified loading conditions, and under considerably lower forces than those occurring during activities of daily living. The purpose of this study was to investigate the healthy patellofemoral joint over the complete range of loading from unloaded up to physiological levels during walking and stair climbing. We hypothesized that the muscle loads significantly influence these biomechanical parameters.

Materials and Methods: Six intact cadaveric knees with physiological trochleas were loaded with muscle forces simulating critical instances of walking (5 load cases) and stair climbing (4 load cases) with knee flexion ranging from 12° to 57°. The set up allowed for individual muscle load control of three quadriceps components from a passive joint state up to physiological load levels (max. 3509 N). Optical markers were attached to the femur, patella and tibia for kinematic measurements, and a pressure sensitive film was inserted into the joint for pressure and contact area measurements.

Results: The application of physiological force magnitudes resulted in a maximal patellofemoral pressure of 5.7 ± 0.8 MPa (mean ± SD). Load magnitudes below physiological levels resulted in a significant underestimation of contact area of up to 2.0 cm². The patellar tilt was also underestimated (up to 2.0° underestimation), although only at initial knee flexion angles. Whilst pressure was linearly dependent upon the applied muscle loads, contact area and tilt increased non-linearly. Specifically, contact area increased logarithmically with load, reaching a plateau at 700 N.

Conclusion: For the first time, physiological-like muscle loading (force magnitudes and directions) has been successfully applied to the knee in a multi-planar loading manner, simulating both walking and stair climbing. This study has demonstrated that physiological loading conditions are essential for a clinically relevant assessment of patellofemoral biomechanics. Since the knees were evaluated under physiological loads, this study provides an understanding of the in vivo mechanics and therefore provides the basis for assessing pathologies and surgical outcome.

Contact area and patellar tilt significantly increased with muscle loading, following non-linear patterns. This increase in contact area has been previously described as a possible mechanism that regulates the attenuation of increasing loads in an animal model. The existence of this mechanism in humans has been confirmed in the current study. Furthermore, the data from this study suggest that this regulating capacity is exhausted under high load bearing conditions, often associated with patellofemoral pain. Consequently, surgical, as well as conservative procedures (such as bracing and taping), to treat patellofemoral pain syndrome or malalignment should aim to restore this key regulating mechanism.
Second Generation ACI in Patellofemoral Full-Thickness Chondral Defects: 
A Clinical, Arthroscopic, and Histologic Review at 5 Years Follow up

Background: Patellofemoral lesions represent a very troublesome condition to treat for orthopaedic surgeons; however, second generation Autologous Chondrocyte Implantation (ACI) seems to offer an interesting treatment option with satisfactory results at short term follow-up.

Hypothesis: Hyaluronan-based scaffold seeded with autologous chondrocytes is a viable treatment for damaged articular surface of the patellofemoral joint.

Study Design: Prospective cohort study.

Methods: Amongst a group of 38 patients treated for full thickness patellofemoral chondral lesions with second generation ACI, we investigated 34 who were available for final follow up at 5 years. These 34 had chondral lesions with a mean size of 4.45 cm². 21 lesions were located on the patella, 9 on the trochlea, while 4 patients presented multiple lesions: 3 patellar and trochlear lesions and 1 with patellar and lateral femoral condyle lesions. 26 lesions (76.47%) were classified as ICRS grade IV A or B , 5 lesions (14.70%) were grade IIIC, and 3 (8.82%) were lesions secondary to osteochondritis dissecans (OCD). Results were evaluated using the IKDC 2000 subjective and objective scores, EuroQol VAS and Tegner scores at 2 and 5 years. 8 patients had second-look arthroscopy and biopsies.

Results: All the scores used demonstrated a statistically significant improvement (P < 0.0005) at 2 and 5 years of follow up. Objective preoperative data improved from 8/34 (23.52%) normal or nearly normal knees to 32/34 (94.12%) at 2 years and 31/34 (91.17%) at 5 years after transplantation. Mean subjective scores improved from 46.09 points preoperatively to 77.06 points 2 years after implantation and 70.39 at 5 years. Tegner score improved from 2.56 to 4.94 and 4.68, and EQ VAS from 56.76 to 81.47 and 78.23 at 2 and 5 years follow up, respectively. Significant decline of IKDC subjective and Tegner scores was found in multiple and patellar lesions from 2 to 5 years follow up. Second-look arthroscopies in 8 cases revealed the repaired surface to be nearly normal with biopsy samples characterized as hyaline-like in appearance.

Conclusion: Hyaluronan-based scaffold seeded with autologous chondrocytes can be a viable treatment for patellofemoral chondral lesions.

Keywords: autologous chondrocyte implantation (ACI); chondral lesions; patellofemoral; chondrocytes; scaffold
Arthroscopic Patellar Denervation for Patellofemoral Pain and Normal Patellar Alignment: Arthroscopic Technique and Preliminary Results

Introduction
Patellofemoral pain depends on many pathophysiological factors and can be difficult to treat. Nociceptive receptors are richly distributed in the peripatellar soft tissue. During a knee arthroscopy, a lesion in this region with an electrocoagulator would lead to theoretical desensitization of the patella, in what we term "arthroscopic patellar denervation".

Purpose
This study presents this new arthroscopic technique and, our experience and the preliminary results of arthroscopic patellar denervation in patients with intractable patellofemoral pain and normal alignment.

Material and Methods
After six months of unsuccessful conservative treatment, ten patients with patellofemoral pain and normal patellar alignment (8 women, 2 men; mean age 33 years, range 22-49), were treated by arthroscopic patellar denervation, involving thermal lesion to the peripatellar soft tissue.

Results
Functional improvement was obtained in all cases. At six months after the procedure, all patients had resumed their normal daily activity and the younger patients were able to practice sports without difficulty. No clinical changes were observed at the two-year follow-up in any patient.

Discussion
Very few surgical techniques have been described to treat patellofemoral pain in patients with no apparent cause justifying the condition. Lavage, cartilaginous debridement or lateral patellar release are arthroscopic procedures has show temporary remission of symptoms in these patients. Arthroscopic patellar denervation decreases pain sensitivity in the anterior region of the knee and is effective in this patient population.

Conclusions
Arthroscopic patellar denervation is simple to perform and as with other arthroscopic procedures, morbidity is low and easily resolved. Our results suggest that arthroscopic patellar denervation can be effective in cases of intractable patellofemoral pain and normal alignment or chondromalacia patellae, with a minimal morbidity.
Biomechanical Properties of an Arthroscopic Anterior Capsular Shift and an Arthroscopic Suture Anchor Repair in Anterior Shoulder Instability

Background: In this biomechanical study, the primary stability of two frequently used arthroscopic shoulder stabilization techniques are compared, the anterior capsular shift, and the bankart repair using suture anchors.

Hypothesis: Both techniques supply sufficient anterior shoulder stabilization with no decrease of external motion.

Study Design: Experimental biomechanical human cadaver study.

Methods: We tested 10 fresh human cadaver shoulders in a robot-assisted shoulder simulator (Kuka Roboter GmbH, Augsburg). External rotation, and anterior- and antero-inferior and inferior translation were measured under applied moment and loading of 2 Nm and 20 N respectively, and at 0° and 80° of glenohumeral abduction. All measurements were performed under four conditions: on the non-operated shoulder (physiologic); following the setting of 3 arthroscopic portals (vented); following an arthroscopic anterior capsular shift (shift) using 4 sutures (Fiberwire, Arthrex, Naples); and following a simulated defined bankart lesion (lesion); and finally following an arthroscopic bankart repair (repair) using 3 suture anchors (Fastak Fiberwire®, Arthrex, Naples).

Results: The application of three arthroscopic portals resulted in a significant increase of the anterior- (0°: 3,3mm to 7,8mm; p=0.01 / 80°: 4,8mm to 8,9mm; p=0.004) and antero-inferior translation (0°: 3,8mm to 9,7mm; p=0.03 / 80°: 5,4mm to 7,8mm; p=0.02) at 0° and 80° abduction, as well as an increase in external rotation at 80° abduction (95,1° to 98,8°; p=0.03). Capsular shift reduced external rotation (p=0.03), but did not significantly decrease translation. Under simulating anterior shoulder instability (lesion) glenohumeral translation significantly increased at 0°and 80° of abduction, ranging from 50% to 279% of physiological translation. Arthroscopic shoulder stabilization resulted in a decrease of translation in all tested directions to approximately physiologic levels. External rotation in 0° abduction was thus decreased significantly (p=0,003) an average of 19° to the physiologic rotation. No decreased external rotation in 80° abduction was found.

Conclusions: An arthroscopic anterior capsular shift decreases external rotation without a significant influence on glenohumeral translation. In treating anterior shoulder instability, arthroscopic shoulder stabilization with suture anchors sufficiently restores increased glenohumeral translation but also decreases external rotation in neutral abduction.
The Latarjet Technique for Failed Bankart Repair

PURPOSE
The clinical outcome of revision surgery for the failed Bankart repairs is not well known. We retrospectively reviewed a series of patients with recurrent anterior shoulder dislocations after open/arthroscopic Bankart repair who underwent repeat stabilisation by the Latarjet procedure.

METHODS
Thirty patients were reviewed at a mean follow-up of 25 months (range 12-54 months). There were 29 men and 1 woman with a mean age of 23 yrs (range, 15 - 48yrs) 24 patients practiced sport with 18 involved in contact type activities. Ten patients previously underwent open Bankart repairs while twenty patients had arthroscopic procedures. Clinical outcomes were determined using the Walch-Duplay and Constant scores and standard x-rays (four views) were obtained to assess radiographic results. Arthroscopy demonstrated significant bony defects in 27 patients (90%). The shoulder was approached through an L-shaped incision with transection of the upper two thirds of the subscapularis muscle in 13 patients and through a subscapularis muscle split in 17 patients.

RESULTS
The mean Walch-Duplay score was 77 (range 25 - 90) with 56% of the patients rated as excellent or good, 40% fair and 6% poor. The Walch-Duplay scores were not significantly different between the patients who had vertical transection of the subscapularis vs those who had a suscapularis split (81 vs 84) The mean Constant score was 85 (range 77-96). 11 patients returned to their pre-injury level of sport and 13 patients dropped a level or did not return to sporting activities Complications included recurrent dislocation in one patient, wound sepsis in one patient and axillary nerve palsy in one patient. There were no complications related to screw fixation of the coracoid fragment. During this follow-up period, no increase in arthritic changes were detected on radiographic assessment

CONCLUSION
The Latarjet procedure can provide a suitable outcome for revision of the failed Bankart repair.
What is the Stabilizing Mechanism of the Latarjet Procedure?

Introduction: The Latarjet procedure is one of common ones for patients with anterior instability of the shoulder and its excellent clinical results have been reported. It has also been used as a bone-grafting procedure in patients with a large glenoid defect. “Sling effect of the subscapularis muscle” or “bone block effect of the coracoid process” has been believed as a main stabilizing mechanism of this procedure. However, the true mechanism is still unknown and there have been no biomechanical studies in the literature. The purpose of this study was to clarify the stabilizing mechanism of the Latarjet procedure for patients with anterior instability and ones with a large glenoid defect.

Materials and Methods: Seven fresh-frozen cadaveric shoulders (mean age, 76 years) were investigated. The skin, subcutaneous tissue, and deltoid were removed preserving the rotator cuff muscles. Two arm positions (60° of abduction and maximum external rotation and neutral rotation) were chosen to simulate the terminal and mid-range conditions. With use of a custom multi-axis electromechanical testing machine with a six-degrees-of-freedom load-cell, the humeral head was translated 10 mm in the anterior direction. With a 50-N axial force constantly applied to the humerus in order to keep the humeral head centered in the glenoid fossa, the peak translational force was determined under eight sequential conditions: in the terminal range, 1) with the capsule intact, 2) after the creation of a simulated Bankart lesion, 3) after the Latarjet procedure, 4) after sectioning the conjoint tendon, 5) after sectioning the subscapularis tendon; in the mid-range, 6) after the creation of a large anterior glenoid defect (6mm width), 7) after the Latarjet procedure with and without applied load, 8) after Bankart repair. A 10-N and 2.5-N load was applied to the subscapularis and conjoint tendons, respectively. We followed G Walch’s surgical technique.

Results: In the terminal range, the peak translational force with intact capsule was 157 ± 17, which significantly decreased down to 53 ± 26 after creating a Bankart lesion (p = 0.0004) and significantly increased to 131 ± 25 after the Latarjet procedure (p = 0.0010). After sectioning the conjoint and subscapularis tendons, the force was 112 ± 24, 107 ± 22 (19% decrease compared to that after the Latarjet procedure) (p < 0.0001), respectively. In the mid-range, the force with intact capsule was 67 ± 8, which significantly decreased to 17 ± 4 after creating a large glenoid defect (p < 0.0001) and did not return (33 ± 4) to the intact condition even after Bankart repair. However, it was significantly increased to 63 ± 6 (p < 0.0001) and 73 ± 4 (p < 0.0001), respectively, after the Latarjet procedure with and without load. Percentage contribution to the increase of the stability was 82% after the Latarjet procedure without load, 18% that with load, respectively.

Discussions: From our results, the stabilizing mechanism of the Latarjet procedure both in the terminal and mid-range motion was demonstrated. In the terminal range, 81% of the stability was contributed by the shortening of the anterior capsule including the anteroinferior glenohumeral ligament (re-tension effect), and the contribution of sling effect which many have believed was only 19%. On the other hand, in the mid-range, 82% of the stability was contributed by reconstruction of the glenoid concavity (glenoid plasty effect) and 18% by sling effect. Thus, it was demonstrated that the Latarjet procedure had a reasonable stabilizing mechanism as a re-stabilizing procedure for shoulders not only with anterior instability but also with a large glenoid defect.
Normalization of Glenohumeral Articular Contact Pressures after either Latarjet or Iliac Crest Bone Grafting Procedure: Impact of Graft Type and Position

Purpose: The articular contact pressures after both Latarjet and Iliac Crest Bone Graft (ICBG) for glenoid bone deficiency remains poorly defined. We investigated glenohumeral articular contact pressures in a clinically relevant glenoid bone loss model to: 1) determine if articular contact pressure could be restored after either a Latarjet or ICBG procedure, and 2) to determine the increase in pressure with proud, flush, and recessed Latarjet or ICBG procedures.

Methods: A total of 12 fresh-frozen cadaveric shoulders stripped of all tissues except labrum and contact pressures in 4 equal quadrants of the glenoid were determined with a Tekscan flexible tactile force sensor. In serial static glenohumeral positions of scapular abduction (30o, 60o, and 60o with 90o external rotation) with a compressive load of 440N, the glenohumeral contact area, contact pressure, peak pressure, and peak force were determined for several conditions: 1) intact glenoid, 2) glenoid with clinically relevant 15% and 30% defect from 2:00 to 6:00, 3) 30% glenoid defect with Latarjet bone block placed 2mm proud, flush, and 2mm recessed to the glenoid, 4) 30% glenoid defect with iliac crest bone graft placed 2mm proud, flush, and 2mm recessed to the glenoid.

Results: With a clinically relevant anterior glenoid bone defect of 30%, contact area decreased 35% (p<0.05) and mean contact pressure increased nearly 100% (p<0.01), with mean contact pressure in this quadrant increasing 400% (p<0.01). An ICBG placed in a flush position restored mean contact pressure to 85% (p<0.05) of the intact specimen. The Latarjet placed in a flush position restored mean contact pressure and force to 65% (p<0.02) of intact specimen, and demonstrated statistically higher pressure than the ICBG at nearly all positions (p<0.02). With 30% bone loss and bone grafts placed in a proud position, mean contact pressure increased 100% (p<0.01) in the posterior glenoid indicating a shift of pressure to the posterior glenoids; an additional 50% increase in pressure (p<0.01) was noted in the anteroinferior quadrant over the flush condition. Mean contact pressures and forces of bone grafts placed in a recessed position were not significantly different from those of 30% glenoid defect, however, edge-loading was significantly increased.

Conclusions: Due to the inherent congruity of the ICBG versus the Latarjet, contact pressures and forces were lower in the glenoids bone loss model reconstructed with ICBG. Grafts placed in a proud position increased the peak pressure not only at the graft location, but also posteroinferiorly suggesting a shift in the articular contact forces posteriorly. These findings may favor the potential clinical utility of ICBG versus Latarjet in an optimally placed position in glenoid defects based upon normalization of articular contact pressure.
Radial Nerve Anatomy at the Elbow Joint: Guidelines for Arthroscopic Safety

PURPOSE:
To study the anatomy of the radial nerve at the elbow joint.

MATERIALS:
Seventy fresh frozen cadaveric elbows were studied for the anatomy of the radial nerve, with respect to the adjacent and arthroscopically relevant bony landmarks. Measurements were taken with digital callipers, with the forearm in neutral, pronation, and supination.

RESULTS:
The average transverse dimensions of the radial fossa and capitellum were 8.0mm (range 7.5 to 8.4), 17.0mm (range 16.6 to 17.5) respectively. The radial head dimensions in supination, neutral and pronation were 24.8 mm (range 23.0 to 25.4), 25.20 mm (range 23.0 to 25.9), and 24.75 mm (range 23.0 to 25.3) respectively. The radial nerve translates medially upon the capitellum and radial head during pronation, with an average excursion of 1.8mm at the capitellum and 10.5mm at the radial head. During its course the radial nerve lies lateral to the medial edge of the radial fossa and the anterior margin of the proximal radioulnar joint, and on the medial half of the capitellum. A medial free space of 1.1 mm at the radial fossa, 3.4mm at the capitellum and 16.9mm at the radial head exists in supination. The medial free space in neutral rotation at the capitellum is 5.5mm. The medial free space in neutral rotation and pronation at the radial head is 13.1mm and 6.5mm respectively.

CONCLUSION:
When performing any arthroscopic anterolateral elbow compartment procedure, the radial nerve can be endangered if the anterior capsule is breached lateral to the medial radial fossa margin, or lateral to the proximal radio-ulnar joint. The radial nerve was not found to breach these anatomical landmarks in 70 consecutive cadaveric elbows. These simple intra-articularly accessible anatomical landmarks are safe guides for avoiding radial nerve injury.
Clinical Evaluation of Surgical Treatments for Lateral Type Osteochondritis Dissecans of the Humeral Capitellum

[Objective]
Osteochondritis dissecans (OCD) of the humeral capitellum most frequently occurs in adolescent baseball players. The treatment for advanced OCD is controversial, especially, the prognosis of the extended lateral type OCD lesion which destroys the lateral wall of the humeral capitellum is poor. We performed two surgical procedures for these cases; first, osteochondral fragment fixation using autologous osteochondral plug for cases of preservationable osteochondral fragment with sufficient cancellous bone and acceptable congruity with reduction, and, second, replacement of the osteochondral fragment with osteochondral autograft for cases without preserved fragments. The objective of this study was to compare the clinical results between the fixation group and the replacement group.

[Methods]
Nine patients were treated with fixation procedure (average age: 12.3 years, average follow-up period: 21.3 months) and 7 patients were treated with replacement procedure (average age: 14.4 years, average follow-up period: 21.2 months). First, arthroscopic evaluation was performed, followed by direct visualization of the OCD lesion by the posterolateral approach. In the fixation procedure, the osteochondral fragment was fixed with one or two osteochondral plugs of 5-6mm diameter obtained from the ipsilateral knee joint, and the elbow joint was immobilized in a long arm cast for 2 weeks after surgery. In the replacement procedure, the osteochondral fragment was resected, and replaced with an osteochondral plug of 9-10mm diameter obtained from the ipsilateral knee joint. All patients were evaluated with range of motion (ROM) of elbow joint, Timmerman’s scoring system, and the return to activity level. Postoperative radiographs and magnetic resonance imaging (MRI) were obtained for all patients, radiocapitellar congruity with 45 degree flexion view in radiographs and high signal intensity in the subchondral bone area in T2-weighted MRI were evaluated.

[Results]
No significant difference between pre and post operative ROM was detected in either group. In the scoring system, the postoperative average of 185±18 points was statistically significantly higher than the preoperative average of 156±24 points in fixation group, and the postoperative average of 185±12 points was statistically significantly higher than the preoperative average of 149±35 points in the replacement group. All patients returned to full activity level except for one in the fixation group. No significant difference between the groups was detected in the period to return to full activity level. In the radiocapitellar congruity, the postoperative average of 80±15 % was statistically significantly higher than the preoperative average of 39±7 % in the fixation group, and the postoperative average of 70±17 % was statistically significantly higher than the preoperative average of 33±10 % in the replacement group. In the postoperative MRI evaluation, the high signal intensity in the subchondral bone area that was detected in the preoperative T2-weighted MRI was not detected in 5 cases in the fixation group and 7 cases in the replacement group.

[Discussion]
This study indicated that both methods were effective for lateral type elbow OCD. It is important to make a choice between the methods based on the condition of the OCD lesion.
Surgical Management of Unstable Elbow Dislocation without Intra-articular Fracture: Surgical Findings and the Results of Early Stabilization and Mobilization in 20 Patients

Background: The evaluation and management of unstable elbow dislocation with persistent subluxation after closed reduction remains variable and controversial. The purpose of this study was to describe soft tissue injury patterns and report the clinical results of primary ligament repair with use of protected early mobilization in unstable elbow dislocations with pure capsuloligamentous injuries.

Materials and Methods: Twenty consecutive patients presented with traumatic unstable elbow dislocation without associated intra-articular fracture were reviewed. Clinical information, radiographs and intraoperative findings were collected. Anatomic repair was performed using metal anchor screws and bone tunnel method. All patients returned for radiographs and functional evaluation with use of Mayo Elbow Performance Score at a minimum of 24 months after the operation.

Results: Ligament avulsion is noted in 55 % for MCL, 80% for LCL, 60% for flexor tendon, 80 % for extensor tendon. Some injury patterns had a high association of brachialis and anterior capsular injury. Overall mean functional Mayo Elbow Performance Score was 93.2. Concentric stability as measured clinically and radiographically was achieved in the elbows of all patients. Brachial artery injuries occurred in two elbows. Heterotopic calcification of the joint capsule and collateral ligaments was noted in 14 patients (70%) and there was one severe traumatic arthrosis.

Conclusion: This study showed a high incidence of reattachable avulsion injuries to ligaments, tendon/muscle and capsule in unstable elbow dislocations. Primary ligament repair coupled with an early rehabilitation in acute unstable elbow dislocation provided satisfactory outcomes at two to four year postoperatively.
Key words: Unstable Elbow, Ligament, Repair
Surgical Treatment of Distal Biceps Tendon Ruptures: A Randomized Prospective Study Comparing Single Incision Endobutton Versus Double Incision Suture Anchor Repair

Introduction
Distal biceps tendon ruptures commonly occur in the dominant arm of male between 40 and 60 years of age. The degenerative tendon avulses from the radial tuberosity. Conservative treatment results in decreased flexion and supination strength. Surgical reattachment is the treatment of choice and several surgical approaches and fixation devices have been proposed.
The purpose of this study was to compare the results of two different techniques, anterior approach Endo Button-assisted versus double approach suture anchor repair of distal biceps tendon ruptures.

Material and Methods
Between September 2004 and February 2007, twenty-two consecutive patients with distal biceps tendon ruptures were randomly assigned to one of two treatment groups.
In group A, 11 patients underwent distal biceps repair using an Endobutton® (Acufex Smith & Nephew, Andover MA) through a single transverse anterior approach.
In group B, 11 patients had their biceps tendon reattached with two biodegradable Panaloc® anchors (Mitek, Norwood, MA) through a double anterior and posterior approach.
All patients were male. Average age was 42 (range 35-56) in group A and 40 (33-57) in group B. The rupture was located in the dominant arm in 8 patients in group A and 7 patients in group B.
The interval between injury and surgery was similar in both groups, less than a week in 8 patients in group A and 9 patients in group B.
Postoperative protocol and rehabilitation was the same in both groups. Full range of motion as tolerated was allowed one week after surgery.
Active range of motion, Mayo Elbow Performance Score (MEPS), pain, strength, patient satisfaction, and elbow radiographs were evaluated at 12 months postoperatively.
The minimum follow-up in was 12 months.

Results.
Average operative time was 44 minutes in group A and 65 minutes in group B.
There were no complications in group A. Two patients in group B had a transient posterior interosseous nerve neurapraxia with spontaneous full recovery after 3 months, and other 2 developed asymptomatic heterotopic bone formation.
There was no statistical significant difference in MEPS score, range of motion, time to return to work or strength assessed by Cybex isokinetic testing between both groups.
All patients in both groups were satisfied with their final result and eventually returned to their pre-injury activity level.
Time to return to work was 3.5 months in group A and 3.8 months in group B.

Conclusion
Although the functional results were similar in both groups, the Endobutton single approach assisted technique should be considered the gold standard procedure for distal biceps tendon repair due to its shorter operative time and lower morbidity.
In Vivo Hyperflexion Kinematics After PS TKA in Asian Patients

Introduction
Achieving high flexion after total knee arthroplasty (TKA) is important for kneeling in commonly encountered activities of daily living such as prayer, meditation and gardening. However, little is known about the tibiofemoral articular contact and function of the cam-post mechanism of the posterior stabilizing (PS) TKA during kneeling. Therefore, the objective of this study was to investigate the biomechanics of the knee after PS TKA with a novel dual fluoroscopic imaging technique to help elucidate whether patients should pursue kneeling activities after reconstruction [1].

Materials and Methods
Sixteen South Korean female patients (22 knees) after PS TKA (LPS-Flex, Zimmer Inc) were randomly recruited from the practice of the same surgeon (SEP). Using the Knee Society scoring system, the patients had clinically successful results. The average International Knee Score was 99 ± 2, and the average Functional Knee Score was 96 ± 6. The patients kneeled under weight-bearing conditions from initial to maximum flexion while being imaged simultaneously by two fluoroscopes (BV Pulsera, Philips Medical) placed orthogonally to each other. The acquired images and 3D CAD models were then used to create a virtual fluoroscopic system. The in-vivo pose of the components was determined by manipulating the TKA models until the component projections matched the component outlines on the fluoroscopic images. Contact was determined by locating the intersection between the surfaces of the femoral component and polyethylene tibial insert. A Wilcoxon Rank test was performed to detect changes in kinematics and articular contact.

Results and Discussion
Patients flexed, on average, from 107.3° to 128.0° during the kneeling activity. Changes in kinematics from initial to maximum kneeling included 1.0 mm of proximal, 0.9 mm of medial and 7.6 mm of posterior translation and 1.7° of varus rotation (p < 0.04). A change in internal tibial rotation was not observed.
Articular contact moved posteriorly by 5.9 mm and 6.4 mm in the medial and lateral compartments, respectively. Contact also moved medially by 3.2 mm and 5.8 mm in the medial and lateral compartments. A decrease in articular contact was observed in both condyles, and lateral lift-off was observed to increase with flexion (p = 0.0001). Over 80% of the patients demonstrated cam/post engagement, which always occurred in the distal portion of the post. During the kneeling activity, patients were observed to have kinematics similar to that reported in the literature. Normal articular contact was also observed in this patient cohort. Furthermore, the knee joint was constrained during the weight-bearing activity such that femoral subluxation and dislocation did not occur.
As the patients flexed, a high incidence of posterior cam/post engagement occurred, and all instances were detected in the distal portion of the polyethylene post. Excessive stress and loading have been previously noted as possible etiologies of tibial post fracture. From a mechanical point of view, distal tibial post contact found in this study occurred in a favorable location relative to bending stress, thereby not increasing the risk of tibial fracture and revision surgery.

Conclusion
Given clinically successful results, patients who were able to comfortably kneel without pain did not demonstrate detrimental biomechanics during the activity. The articular contact observed in the tibiofemoral and cam/post compartments further suggest that kneeling may be performed by patients after PS TKA who feel comfortable doing so and are free of pain.
Is High Flexion Important in Post Operative Total Knee Arthroplasty?

Introduction
One of the main shifts in attitude by surgeons is towards obtaining high flexion in knee arthroplasty. Surgical techniques, prosthesis design and post operative rehabilitation all contribute to increased knee flexion. This study aims to compare functional outcome scores and patient satisfaction rating against post operative knee flexion.

Method
This is a prospective study of a cohort of 233 patients. Follow up was 4.5 years with 3.2% lost to follow up. The patients' primary diagnosis was osteoarthrosis.

The patients were interviewed for the study at 6 weeks, 3 months, 6 months, 1 year and then every 2 years.
Pre-operative scores taken included the KSS, OXFORD, WOMAC, SF12 and VAS Pain Score.
Post operatively the same scores were taken along with the patient satisfaction questionnaire and compared with knee flexion.
Orthowave Statistics software was used to generate results.

Results
57% of the study group were female with an average of 70 years
The preoperative data obtained are as follows:
Flexion 117° +/- 13°; KS knee Score 41/100 ;VAS 7/10 ; SF 12 Mental- 7 ; SF 12 Physical – 28.6 ; Womac 27 ; Oxford 38.7
The Post operative data obtained included
Flexion 128° +/- 10°; KS knee Score 95/100 ; VAS 1/10 ; SF 12 Mental- 88 ; SF 12 Physical – 93 ; Womac 1.07 ; Oxford 13.17
There were no correlations between knee flexion and post operative knee functional scores.
However the patient satisfaction questionnaire generated statistical correlations with increased flexion. These include:
Regular activities, Heavy work, Expectation met (all P<0.05)

Discussion
As noted in the results, high flexion (>120) knees do not have a statistically significant difference in validated knee functional scores. However patient satisfaction is statistically higher in the high flexion group.
This may indicate that validated functional scores are not designed to give better scores for higher flexion. Perhaps modern patients have different functional expectations to patients at the time of inception of these functional scores.

Conclusion
Our cohort study demonstrates that high flexion does play a role in patient satisfaction and that it does not necessarily correlate with better functional scores. More importantly the high flexion knees have better post operative pain scores, return to regular and heavy activities.
Why 180° is Not Always the Good Target for TKA in Varus Knee

INTRODUCTION: Varus deformity can be due to (1) wear of the medial tibial plateau, (2) extra articular bone deformity of the tibia and (3) extra articular bone deformity of the femur. In (3) any orthogonal cut of the distal femur creates a lateral laxity (resection laxity). Balancing in extension requires then a medial release which creates also a medial laxity in flexion. Balancing the knee in flexion can be challenging particularly if the Trans Epicondylar axis (TEA) is externally rotated in respect with posterior condylar line (PCL).

AIM OF THE STUDY: To analyse the morphology of the distal femur in the varus knees and deduce specific difficulties due to different situations.

MATERIAL AND METHOD: Among 208 TKA done in 2005-2006, 158 were implanted for medial OA with varus deformity (mechanical femorotibial angle FTA = 179°). The preop planning included: frontal and lateral monopodal weight bearing X-ray of the knee, a long bipodal weight bearing X-ray of both lower limbs, a skyline view of both patellae and a computed tomography (CT) scans of the lower limb, which is part of the standard preoperative planning for TKA at our centre since 2003. TEA was measured between lateral epicondyle and sulcus of the medial epicondyle. Posterior Condylar Angle (PCA), measured between TEA and PCL was 1.9°±2.15 (-7° to 7), FTA was 171.3°±4.2 (161° to 179°), mechanical Femoral Angle a was 90.8°±2 (82° to 97°).

RESULTS: No significant relationship was observed between a and PCA (r=0.094). In 35 knees angle a was <0° and in 27 a=0°. 12 femurs had a PCA<0°: in 4 a was <90°, in 3 a =90° and in 5 a was > 90°. Four groups were then defined according to angle a and PCA, with different technical consequences:
- Group I: a=90° and ACP>0° (23 knees): PCA=2.6°±1, a= 87.6°±1.8, FTA= 169.4°±5. It is impossible here to both cut the distal femur at 90°/a, and align femoral component with TEA in flexion. This option would increase medial laxity.
- Group II: a=90° and ACP>0° (96 knees): PCA=2.9°±1.6, a=91.8°±1.5 and FTA=172.6°±4.2. It is possible to cut the femur at 90°/a and align femoral component with TEA in flexion. Even in case of tibial bone deformity, external rotation of femoral component is favorable.
- Group III: a=90° and ACP=0° (25 knees): PCA=-0.92°±1.7, a=91.7±1.6 and FTA=172.4°±4.8. external rotation of femoral component is here defavorable. Correction of a tibia varus requires a MCL release.
- Group IV: a<90° and ACP =0° (14 patients): PCA=-0.35°±0.6, a= 88.2±1.1 and FTA=170.0±4. Aligning femoral component with TEA requires sometimes internal rotation (5 cases). Orthogonal cut of femur is then possible if this is accepted.

CONCLUSION: The two goals: distal cut at 90° and femoral rotation aligned with TEA are easily compatible in only 61% of the cases in this serie (group II). In group I (14.5%) and group IV (8.8%) a compromise is necessary and one can consider accepting residual varus deformity in the femur. A pre-op CT Scan is usefull in daily practice to analyse different situations and establish a correct strategy.
Comparative Study of Soft Tissue Balancing Using Tension Device With or Without Reduction of the Patella During Total Knee Arthroplasty (TKA)

Introduction: It is important to obtain adequate ligament balance for stable and good long-term clinical results in total knee arthroplasty. Several assessments for the ligament tension during surgery have been reported. However, there have been few studies evaluating the method of assessing ligament tension in patella reduction. The purpose of this study is to compare soft tissue balancing using a tension device with or without reduction of the patella during TKA.

Subjects and methods: We evaluated soft tissue balancing during total knee arthroplasty (TKA) using two kinds of tension devices in the varus deformity of osteoarthritis of the knee, in 35 joints of 33 patients, 25 females and 8 males with an average age of 71.6 years. We used two kinds of tension devices in all patients, reflection and reduction of the patella, in a position of extension and flexion of the knee at 90°, to assess and compare the joint gap length (mm) and lateral balance angle (°) between the two methods.

Results: The joint gap using the reduction method averaged 1.5 mm larger than the reflection method. However, the data varied between the reflection and reduction methods for a single patient. There was no significant difference in the lateral balance angle between the two groups.

Discussion: Our tension device measurement method of the reduction of the patella proved less time consuming, and is applicable for minimum invasive surgery dealing with narrowed space vision. However, there was no difference in the lateral balance angle between them. Future studies should evaluate more TKA patients with this method and improve upon the measurement method of joint tension to enable stable and proper ligament adjustment.
Resurfacing Versus Non-resurfacing the Patella in Total Knee Arthroplasty: An Appraisal of Available Evidences

Introduction.
The decision whether to resurface or not the patella in total knee arthroplasty (TKA) is highly controversial and surgeons show a wide variety of attitudes in Europe and in the USA. Surgeons favouring patellar resurfacing advocate that post-operative knee pain following TKA is significantly diminished, which would improve patient-based outcome. On the other hand, patellar replacement carries a number of potential complications which may outweigh the benefit of reduced anterior knee pain. A systematic search of available evidences comparing the outcome of unresurfaced versus resurfaced patellae in TKA was therefore conducted. The purpose of the present paper is providing orthopaedic surgeons with an updated appraisal of relevant evidences that may assist them in their decision-making process.

Material and Method.
A bibliographic search was conducted through the most representative databases. We searched for meta-analyses (MA), systematic reviews (SR) and randomized controlled trials (RCT) comparing outcome between resurfaced and unresurfaced patellae in TKA. The following databases were used: Cochrane Musculoskeletal Injuries Group Specialized Register, the Cochrane Register of Controlled Trials, Health Technology Assessment (HTA), PEDro, Medline, EMBASE, CINAHL, AMED, DARE, TRIP, The National Research Register (UK). The search was ended on February 2008. The search term selected from The National Library of Medicine’s medical subject heading (MESH) database were: patella; resurfacing; total knee arthroplasty; TKA; total knee replacement; TKR. Additionally, the rate of reduced post-operative anterior knee pain in patients undergoing patellar resurfacing was compared with the current rate of complications associated with patellar replacement.

Results.
Five MAs, 1 SR and 6 RCTs not included in the published evidence syntheses were retrieved. All evidence syntheses would warrant patellar resurfacing in order to reduce anterior knee pain and the related risk of re-operation. Conversely, 4 RCTs failed to detect significant differences using accepted clinical scores at mid- and long-term follow-up while 2 RCTs did not report significant variations of the biomechanical performance in vivo between replaced and un-replaced patellae.

Conclusion.
Current evidences would support the decision to resurface the patella when anterior knee pain and the related risk of re-operation are used as end-points of outcome at mid-term follow-up. However, no clinical differences would be detectable between resurfaced and unresurfaced patellae at long-term follow-up. In addition, both patella-replaced and patella-unreplaced TKA exhibit similar biomechanical behaviour in vivo. The rate of anterior knee pain improvement in patients undergoing patellar replacement should be contrasted with the rate of potential complications related to patellar resurfacing.
Sub-vastus Approach Versus the Medial Parapatellar Approach in Primary Total Knee: A Controlled Trial

Background:
Orthopaedic surgeons vary in their surgical approaches to total knee arthroplasty. The aim of this investigation was to compare outcomes after two different surgical approaches.

Methods:
The study was a prospective single-centre longitudinal randomized controlled trial. A sub-vastus approach was compared with a medial para-patellar approach. Participating surgeons elected to randomize their patients to one of the two types of approach. Outcomes included the Knee Society (KS) Clinical Rating System, WOMAC Osteoarthritis Index, SF-36, and EuroQol (measured at 1, 6, 12 and 52 weeks post-operatively compared to baseline) complications, surgeon rated ease of exposure, and proportion of patients who had a lateral release.

Results:
Two hundred and thirty one patients were randomized to the two approaches. One hundred and sixteen patients were randomized to the sub-vastus approach. At one week compared to baseline, range of motion, KS global, KS knee, and KS pain scores were significantly better in the sub-vastus group. At six weeks, the medial para-patellar group tended to have better outcomes, but not statistically significantly. At fifty-two weeks compared to baseline, the WOMAC global and pain scores, the SF36 physical function and role-physical scores, and the EuroQol utility and pain score were significantly better in the sub-vastus group. Surgeons reported the ease of exposure in the sub-vastus group was significantly worse on average.

Conclusions:
This trial is the largest of its kind to date, and the first, so far as we are aware, to compare clinical outcomes of different surgical approaches at one year post-operatively. The sub-vastus approach to total knee arthroplasty was more effective than a medial para-patellar approach at both one week and fifty-two weeks post-operatively in patients whose surgeons considered either approach would be suitable. However, surgeons reported worse ease of exposure in the sub-vastus group.
Cemented Versus Uncemented Femoral Component in Total Knee Arthroplasty: Early Radiological Findings-- A Prospective Randomized Study

INTRODUCTION
Several authors have indicated that radiolucent lines (RLL) in TKA almost all appear within 12 months postoperatively. The aim of this study is to analyze the influence of femoral cement on early appearance of RLL.

MATERIAL AND METHODS
This study was prospective randomized. In 2004 and 2005, 130 consecutive TKA were performed on 125 patients. The diagnosis was either osteoarthritis (126 knees) or chondrocalcinosis (4 knees). The total knee replacement system was the HLS Noetos. The femoral component was either cemented or uncemented with hydroxyapatite. All patients were preoperatively randomly assigned to treatment in either the cement group (group 1, n=66) or the cementless group (group 2, n=64). A medial approach was used in 107 cases and a lateral approach in 23 cases. The radiographic assessment was performed preoperatively and 2, 6 and 12 months postoperatively. Anteroposterior, lateral, skyline view of the patella and long leg film X-rays were assessed for RLL and measurements of the implant axes. We evaluated RLL in terms of width, situation and progression as recommended by the Knee Society.

RESULTS
125 patients were reviewed at an average 13 month follow-up. There were no significant differences concerning axes between the two groups. After one year, RLL were observed in 21% of group 1 and 6% of group 2 (p=0.02). RLL were mainly in zones 1 (68%) and 4 (26%). Progressive RLL was found in two patients in group 1 and none in group 2. In group 1, one patient presented an aseptic loosening after 17 months. We observed a difference in bone transparencies between groups we attribute to stress shielding (group 1, 13%; group 2, 46%; p<0.001).

DISCUSSION
Only the method of fixation was varied while all other variables in this study were controlled. It is suggested that the RLL seen in cemented components are due to a deficiency in cement but that in non-cemented components it may be due to imperfect integration of bone with the implant. Further investigation of bone transparencies and the progression of RLL with longer follow-up is necessary to confirm this.
Continuous Infusion of a Local Anesthetic for Pain Relief Following Total Knee Arthroplasty Surgery

Background
The pain resulting from total knee arthroplasty surgery is often excruciating for patients. Adequate pain control improves satisfaction, alleviates anxiety, and hastens rehabilitation and discharge from the hospital. Locally administered pain medications may reduce the need for systemic narcotics that sedate the patient, depressing respiratory and cardiac function, which may complicate rehabilitation. Though continuous infusion of a local anesthetic—bupivacaine (marcaine)—with a pain control infusion pump (PCIP) has been successfully used for pain relief after numerous surgical procedures, it has not been studied after total knee arthroplasty. The purpose of this study is to determine if this treatment method is effective in reducing post-operative pain following total knee arthroplasty.

Experimental Design and Methods
This is an ongoing randomized, prospective, double-blind study comparing the effects of intraarticular marcaine versus placebo (saline) on post-operative pain management. The study is approved by the Institutional Review Board of the authors’ institution. Three pain-assessment variables are analyzed for the 48-hour period after surgery: a pain visual analog scale (VAS), taken at 0, 12, 24, 36, and 48 hours; the amount of morphine administered by the patient controlled analgesia (PCA) pump, measured at 12, 24, 36, and 48 hours; and the number of attempts at morphine administration, measured at 12, 24, 36, and 48 hours.

Eligible patients are at least 18 years old, are not taking pre-operative narcotic pain medication, and are undergoing unilateral primary total knee arthroplasty. All patients are enrolled following thorough discussion of the study and after signing an informed consent.

Patients are recruited from the surgical schedule of the primary investigator at the University of Texas Medical Branch (UTMB). The prosthesis is posterior cruciate substituting, and all components are cemented. A midline incision with a median parapatellar approach is used. Navigation is not employed. At the end of surgery, with the patient still under general anesthesia, two plastic catheters are inserted percutaneously into the knee joint for continuous infusion of a local anesthetic (0.5% marcaine) or saline. The catheters are attached to the PCIP unit. The patient’s pain is assessed using a pain visual analog scale at the 0 time point. After this, the PCIP is started with a bolus of 10cc and then reset to infuse continuously at 4cc per hour for 48 hours. A patient-controlled analgesia (PCA) pump is initiated at this time as well; this device, the standard of care for all total-knee-arthroplasty patients, records the amount of morphine administered per hour and the number of administration attempts per hour. Both indices are collected for 48 hours. The PCIP is removed and the study concluded after collection of the data from the 48-hour time point.

We hypothesize that patients in the experimental group will require less systemic pain medication administered through the PCA pump to achieve similar pain relief.
Results
The collected data in the study indicate the following: Twenty-eight patients were female (68.2%), and 13 were male (31.7%). Twenty-four patients were Caucasian (58.5%), nine were Hispanic (21.9%), and eight (19.5%) were African American. Patient ages ranged from 46 to 85 years with a median age of 66; average age was 65.8 years. The average age of patients receiving marcaine was 63.3 years, and the average for patients receiving placebo was 68.3 years. A total of 21 patients received marcaine (51.2%), and 20 received the placebo (48.7%). VAS scores for pain reveal that, for both groups, measurements peak at hour 0 and then decline considerably (by at least two points) by hour 12; however, between hours 24, 36, and 48, for both groups, scores decrease slightly or remain steady, but do not exhibit the larger decrease seen between hours 0 and 12.

The number of attempts for morphine delivery between the groups showed its strongest difference at hour 12 (mean 43.9 attempts for the marcaine group and 61.1 for placebo group); however, after hour 12 there was little difference between the groups.

The amount of actual morphine delivered between the two groups was similar at all measuring points (range: 18.3-26.0 for marcaine and 19.7-29.7 for placebo).

Conclusion
These results suggest little difference between the use of the PCIP containing marcaine and the use of morphine only for the management of pain following total knee arthroplasty.
Use of Tranaxemic Acid vs Post Op Cell Salvage in Reducing Blood Loss After Total Knee Replacement Surgery

Background: Total knee replacement is associated with significant blood loss, which can necessitate blood transfusion thereby increasing the risk to the patient and also adding to the cost of health service.

Aim: to study the effect of local tranaxemic acid in reducing blood loss in total knee replacement surgery.

Method:
This study was performed from September 2007 to February 2008 in Diana princess of Wales Hospital, Grimsby, UK. It is a prospective non-randomised controlled study, comparing the use a tranaxemic acid given locally into tissue intra-operatively against the control.
A group of 67 patients were included with a mean age of 69.6 years. There were 38 females and 39 males non-randomly distributed.
27 patients received 100 gm Tranaxemic acid diluted with 100 ml saline (Group A) intra-operatively. Sixty ml of fluid was injected in the soft tissues around knee and 40 ml was injected in the knee joint after closing deep tissues. 40 patients included in control group (Group B) who did not receive any Tranaxemic acid. Post Op cell salvage was used in this group.
The pre-operative haemoglobin was recorded. Post-operative drain volume, haemoglobin and heamocrit were measured at 48 hours. Patients who were given post-operative autogenic and/or allogenic blood transfusion were noted. All patients were given clexane 40mg daily post operatively. A prospective log of complications was maintained throughout the study for complications like DVT were recorded.

Results:
Mean pre-operative haemoglobin in Group A was 13.74 and Group B was 13.65.
Average blood loss in drain was 462 ml and 640 ml in Group A and B respectively.
Average fall in Hb were 2.56 and 3.3 in Group A and B respectively at 48hours.
Average fall in Hct were 0.086 and 0.093 in Group A and B respectively.
None of the patients in Group-A received either autogenic or allogenic transfusion. However in Group B 31/40 received autogenic transfusion and 7/40 required allogenic blood transfusion.
There were no clinically evident DVT cases in either group.

Conclusion:
This study demonstrates intra-operative local use of tranaxemic acid in Total knee replacement surgery is useful in reducing blood loss significantly. It appears to be more effective and less costly then use of cell salvage with no significant increase in complications.
Post-operative Bleeding after Total Knee Arthroplasty  
-A Comparison of the Intravenous Use of Tranexamic Acid and Drain Clamping-

[Purpose] The purpose of this study is to compare the outcome of the patients who underwent conventional TKA with or without intravenous use of tranexamic acid and drain clamping.

[Patients and Methods]  
We divided 106 patients, who underwent TKA between Apr. 2005 and Feb. 2008, into three groups. In group ID (n=20), 1000mg of Tranexamic Acids (TXA) was injected 15 min. before deflation of the pneumatic tourniquet (TXA-IV), and after the closure of the wound, retrograde infusion of additional 1000mg of TXA and 40ml of saline was made through the drainage tube. The drainage tube was clumped for 2 hours (Drain Clamping). In group D (n=66), only Drain Clamping was performed without TXA-IV. In group C (n=20), no TXA treatment was performed. We evaluated the following data; 1) Autologous blood transfusion, 2) Volume of drainage at 24 hours and total, 3) Values of CPK, CRP, D-Dimner 7 days after surgery, 4) Hospital stay, 5) ROM recovery at 4 weeks.

[Results]  
No blood transfusion was necessary in group ID and D. In group C, more than 400ml of autologous blood was transfused in all the cases. Volumes of drainage were less in group ID and D than those in group C both at 24 hours and total volume. The CPK and CRP value at 7th post-operative day were less in group ID than those in group D and C but not statistically significant. The difference of D-dimner value at 7th post-operative day, the days of hospital stay and the difference of ROM% at 4 wks post-operative day were not statistically significant in all groups.

[Discussion]  
The use of TXA, iv and/or drain clamping, was effective to reduce bleeding after TKA. Although the use of TXA did not increase the risks of thromboembolic complications, drain clamping only was essential and intravenous infusion of TXA was not necessary to reduce bleeding after TKA.
Reliability of Bony Landmarks for Restoration of the Joint Line in Revision Knee Arthroplasty

Introduction
The aim of this study was to determine the reliability of bone landmarks for restoring the joint line in revision knee arthroplasty.

Materials and methods
The relationship of the femoral epicondyles, the tibial tubercle (TT) and the fibular head to the joint line was measured on 200 MRI (100 females, 100 males), including assessment on intraobserver and interobserver reliability. MRI scans demonstrating chondral lesions and osteoarthritis were excluded, as were patients with immature skeletons or a history of previous knee surgery. Sequences in sagittal, coronal and axial planes were used as well as cross referencing with the same computer software. In order to account for size differences between patients, each bony landmark measurement was converted to a ratio relative to the femoral or/and tibial width.

Results
We found a transepicondylar axis equal to 3.11° (±1.9). The average distance from the epicondyles to the joint line was respectively 23 mm on the lateral side and 28 mm on the medial side. However there was a variation of distance from the epicondyles of the joint line up to 11mm and a significative difference was found between male and female. The distance from the tip of the fibular head to the joint line averaged 14 mm (3.04; 4.1-22.13) with no gender difference. The tibial tubercle was located at 22 mm (3.09; 10.61-32.09). The epicondylar ratio (distance from the lateral epicondyle to the joint line related to the femoral width) averaged 28% with no gender difference (p = 0.09). The TT ratio (distance joint line- TT) was equal to 27% of the femoral width. (p= 0.4).

Discussion
There is a large variation of bony landmarks depending on the size of the individual. Previous studies have measured the absolute values from various landmarks to the joint line. This study provides a significant advantage, in that the level of the joint line can be determined for each individual by using a ratio to account for gender and size differences.
A Simple Radiographic View with a Landmark of an Anterior Femoral Condyle for Determining Rotational Alignment of the Femoral Component in Total Knee Arthroplasty

Introduction:
The precise rotational setting of the femoral component is important for adequate patella tracking and good ligament balance in total knee arthroplasty (TKA). The posterior condylar line (PC line) that connects the posterior condyle of the femur is widely used as a landmark for the cutting of the posterior condyle. An alternative landmark of the angle between the TEA and anterior trochlear line of the lateral and medial femoral condyles (trochlear line angle) for determining the rotational positioning of the femoral component should be considered.
We here report a simple radiographic view with a landmark of the anterior femoral condyle for determining the rotational alignment of the femoral component in TKA. Using this view, we measured the internal rotation angle between the clinical transepicondylar angle (clinical TEA) and the anterior trochlear line. We also examined the reproducibility between our view and the reconstruction image from a 3-dimensional helical CT system.

Subjects and methods:
Our new radiograph presented an axial view of distal femur of a patient. The patient lay in the supine position and flexed the knee about 120 to 130 degrees. An x-ray beam was applied to the knee at the angle of 20 degrees to the ground surface. We pointed out the location of the anterior surface of the condyles, medial epicondyle and lateral epicondyle. Then, we defined the trochlear line and clinical TEA and measured the rotation angle between them (trochlear line angle).
This study involved 122 knees in 82 patients, comprising 22 males and 60 females with osteoarthritis of the knee. They ranged in age from 37 to 89 years, with an average age of 67.3 years. Thirty-five 3D-CT images and our view with plain radiography was performed in 28 patients, and compared with the measurement of the angle.

Results:
The internal rotation angle of the trochlear line and clinical TEA (trochlear line angle) was 4.9°±2.1°. The tibio-femoral angle was positively correlated with the trochlear line angle. The trochlear line angle from 3D-CT was 5.7°±2.3°. The average of the difference between our view and the 3D-CT was 0.46°±1.60°, P<0.001 with a Spearman’s rank test.

Discussion and conclusions:
The posterior condyle of the deformed side makes for an inaccurate angle of the TEA and PC line because the thickness of the cartilage and bone are different between the medial and lateral condyle. We improved the simple radiographic view in order to evaluate the TEA and PC line, and also the anterior trochlear line, for assessing the rotational alignment of the distal femur in TKA. A minimally invasive operative method in TKA is reported to be effective and recommended in primary OA. However, the reference guide of the angle between PCA and TEA is sometimes difficult to set properly with the full contact of both condyles in the limited view of the non-open side, especially MIS TKA. In contrast, it is easy to set the guide or template properly for the trochlear line angle because the anterior trochlear is completely visible. Therefore, we are able to measure and evaluate both angles, and reduce the measurement error by double-checking the conventional angle and trochlear line angle.
The trochlear line angle with a landmark of the anterior femoral condyle by our radiographic view was reliable. Our method may be a possible one for determining the rotational alignment of the femoral component in total knee arthroplasty.
Changes in Patellar Alignment After Total Knee Arthroplasty

[ Introduction ] Although the results of total knee arthroplasty continue to improve, problems related to the patellofemoral joint remain significant. This study examined the factors affecting patellar alignment after total knee arthroplasty and subsequent changes during a postoperative period of 5.3 years.

[ Patients and Methods ] Fifty-five knees in 39 patients were retrospectively evaluated by radiography for postoperative patellar alignment. This study included four men and 35 women with a mean follow-up time of 5.3 years (range: 2.5 to 8.4). All procedures utilized identical surgical technique; through a midline skin incision and medial parapatellar arthrotomy, the patella was fully everted. We adjusted the rotation of the femoral component until it was parallel to the surgical epicondylar axis. Using the posterior femoral condyles as references, we inserted the femoral components with 3° to 5° of external rotation to the posterior condylar axis according to preoperative CT scans. Tibial components were set using the medial third of the tibial tuberosity as a reference. All patellae were resurfaced with three-peg offset-dome all-polyethylene patellar component. Patellar alignment was assessed by measuring the lateral tilt and lateral displacement in skyline views taken with the knees at approximately 60° of flexion. Patellar alignment was evaluated one month after surgery, and at final follow-up. Changes in patellar lateral tilt angle and lateral displacement in the postoperative period were calculated using data obtained one month after surgery and at final follow-up.

[ Results ] We did not observe severe malalignment of the femorotibial joint, patellar bone fracture, prosthesis failure, or any other clinical complications after TKA in any cases. The mean patellar lateral tilt angle was -0.7° (range: -13.7 to 7.0°) one month after surgery and -0.4° (range: -11.4 to 11.6°) at final follow-up. The mean patellar lateral displacement was 1.1mm (-2.7 to 6.6mm) one month after surgery and 0.9mm (-3.7 to 5.8mm) at final follow-up. We observed a negative correlation between the patellar resection angle and lateral tilt one month after surgery (p<0.0001) and between the patellar resection angle and patellar lateral displacement one month after surgery (p=0.0003). Lateral retinacular release was required for thirteen knees. In these cases, the resection angle was significantly smaller than that seen in knees without lateral retinacular release (p=0.0012). These results demonstrate that a smaller resection angle correlated with an increased frequency of lateral retinacular release. The change in patellar lateral tilt angle after 5.3 years was 0.3° (range: -7.2 to 7.0°), while the change in patellar lateral displacement was -0.3 mm (range: -5.2 to 3.7 mm). These changes did not significantly correlate with patellar alignment at any time point, resection angle, resection thickness, lateral retinacular release, or clinical results. The postoperative femorotibial alignment, however, exhibited a statistically significant correlation with the changes in lateral tilt angle (p=0.020). A more varus postoperative alignment correlated with increased lateral tilt of the patella in the postoperative period.

[ Discussion ] We observed a satisfactory patellar alignment after a postoperative period of 5.3 years. The patellar resection angle had a significant effect on postoperative patellar alignment. Our findings suggest that leaving a thicker patellar remnant on the medial side can decrease postoperative lateral tilt and the resulting need for lateral retinacular release. Postoperative changes in patellar alignment were very small; none of the knees demonstrated complications of the patellofemoral joints. In this study, we observed the tendency that a postoperative varus alignment leads to patellar lateral tilt. Surgeons should pay scrupulous attention to femorotibial alignment during total knee arthroplasty to decrease patellofemoral complications and femorotibial problems.
Relationship Between Knee Anthropometry and Surgical Time in Total Knee Arthroplasty in Severely and Morbidly Obese Patients: A New Prognostic Index of Surgical Difficulty

Introduction: Total knee replacement (TKR) in severely obese patients is one of the current challenges in knee surgery. In our hospital, 12% of the patients undergoing TKR had a body mass index (BMI) > 35kg/m2. Recent reports have highlighted the technical difficulties that may occur during surgery. The BMI can identify patients in whom surgery may be longer and who may have more postoperative complications. However, we have observed that many patients with a high BMI do not have more surgical difficulties than other patients. Problems are more frequently caused by the somatotype of the patient and the distribution of body fat which, in some patients, accumulates in the trunk while in others there is a uniform distribution affecting the lower limbs. To determine which anthropometric parameters were useful in predicting surgical difficulties we carried out a prospective study in patients with a BMI > 35kg/m2, with the aim of determining the correlation between the BMI, the suprapatellar, infrapatellar and supra/infrapatellar indexes and the length of the intervention.

Material and methods: One hundred patients with a BMI >35kg/m2 undergoing TKR during 2006. Before surgery, the suprapatellar diameter 4cm from the superior pole of the patella, the infrapatellar diameter at the level of the TTA and the length of the limb (measured from the iliac crest to the centre of the ankle) were measured. The quotients between the perimeters and the length of the limb and between the supra- and infrapatellar perimeters were calculated to obtain three morphological indexes of the knee: suprapatellar index, infrapatellar index and supra/infrapatellar index. The surgical intervention was carried out by specialised knee surgeons using an identical protocol and the same cemented prosthesis (Profix, Smith and Nephew). The surgical time and the time of ischemia (tourniquet time) were determined. Pearson’s correlation coefficient was used to determine the correlation between the parameters.

Results: A total of 100 patients (87 males, 13 males) were included. The mean age was 70.43 ± 7.73 years and the mean BMI was 39.81 ± 3.75. The tourniquet time was 41.67 ± 9.26 minutes. The suprapatellar index was 1.63 ± 0.17, the infrapatellar index 1.99 ± 0.21, and the supra/infrapatellar index was 1.22 ± 0.08.
No correlation was found between BMI and tourniquet time. When the BMI was separated into two groups (above or below 40) there were non-significant differences between the two groups which did not correlate with tourniquet time. (< 39.99 kg/m2 /tourniquet time 40.34 ± 8.77 min; > 40 kg/m2/ tourniquet time 43.27 ± 9.78 min).
There was a statistically significant correlation between time and the suprapatellar index (p<0.038), with the tourniquet time increasing as the suprapatellar index decreased.
A suprapatellar index below 1.6 was associated with more tourniquet and surgical time.

Conclusion: The BMI is not the only parameter that should be used to identify severely obese patients who may potentially present difficulties during TKR, due to the different morphology of the knee that these patients can present. Preoperative determination of the suprapatellar index may help to classify severely obese patients according to the morphology of the knee and may predict surgical difficulty if its level is less
Prospective Comparative Study Between Static Cement Spacer and Mobile Cement Spacer in Infected Total Knee Arthroplasties

Purpose: Infection in total knee arthroplasty (TKA) is a devastating complication. The two-stage exchange procedure has evolved as an effective treatment option. The use of antibiotic-impregnated cement spacers may be considered at the first-stage surgery. Spacers may be static or mobile type. This prospective study was undertaken to compare the clinical results achieved using static cement spacer and mobile cement spacer in infected TKA.

Materials and Methods: From July 1998 to February 2006, 25 infected TKA were treated with two-stage reimplantation. Static spacers were used in 12 knees, and mobile spacers were used in 13 knees. We evaluated Hospital for Special Surgery Knee Score (HSS) at just prior to second stage re-implantation and at the minimum 2 year follow up of second stage re-implantation.

Result: In the static group, 2 knees were fused because of recurrence of infection and 10 (83%) knees were revised to TKA successfully. In the mobile group, 2 knees were fused, and 11 (85%) knees were revised. After first-stage surgery, in the static group, 1 knee could bear weight, in the mobile group 6 knees could. Prior to revision, in the static group, the average of ROM was 10.0 degrees (0 to 50) and average of HSS score was 48.2 (31 to 52), in the mobile group, the average of ROM was 75.5 (30 to 120) and average of HSS score was 67.2 (56 to 81). At the last follow up after second stage re-implantation, in the static group, the average of ROM was 80.0 degrees (35 to 115) and the average of HSS was 75.8 (52 to 88), in the mobile group, the average of ROM was 115.0 (85 to 140) and the average of HSS was 86.8 (80 to 95).

Conclusion: Patients receiving mobile spacer had better range of motion and knee score than those with static spacer not only after cement spacer insertion but also at the final follow up after second stage re-implantation.
Stiffness Complicating Total Knee Arthroplasty: Computerized Tomography Evaluation of Component Rotational Position and Outcomes of Complete Revision for Restoration of Adequate Rotational Alignment

Introduction
Stiffness following TKA is devastating and poorly understood. This study was conducted to determine if rotational positioning of tibial and/or femoral components was related to the development of stiffness following TKA. In addition, post-revision rotational alignment was studied to determine if it contributed to improvement.

Methods
Patients who presented with stiffness and either a fixed flexion contracture >15 and/or flexion <105 degrees were included in the study. 34 revisions were investigated preoperatively by computerized tomography (CT) for rotational evaluation of the components. Clinical and radiographic data were also recorded.

Results
All 34 revisions had some degree of combined internal rotation on the preoperative CT-scan. The net combined angle averaged 14.8 degrees of pathologic internal rotation (in excess of the normal 18 degrees)[1]. The most significant source of internal rotation was the tibial component, with 33 of the 34 patients having internal rotation with a mean pathological (in excess of the normal 18 degrees) angle of 13.3 degrees (1-35 degrees) Postoperatively, the combined rotation angle was restored to an average of 5.1 degrees of external rotation for the 18 patients with available CT-scans (p < 0.0001). The 34 revised knees were clinically followed for an average of 22.0 months. The mean preoperative Knee Society knee and function scores were respectively 41.6 and 47.9. The mean preoperative range of motion was 61.4 degrees. Postoperatively, the knee and function scores increased respectively to 77.3 and to 65.7 (p < 0.0045). The mean postoperative range of motion averaged 98.1 degrees (p < 0.0001).

Discussion & Conclusion
Rotational positioning of the components should be investigated with CT-scan in stiff knees following TKA. Revision surgery of all the components with restoration of an adequate rotational alignment has been shown to improve range of motion, function and pain.

One Stage Revision for Infected Total Knee Replacement

Introduction: Infection in total knee replacement is a devastating complication. Current literature supports two-stage revision as the gold standard. The alternative single stage procedure has been reported to have favourable results. We assessed the early clinical results of single stage revision for infected total knee replacement.

Methods: Between February 2005 and August 2007, 12 patients had revision total knee replacement for infection by the senior authors at two centres. In the majority of the patients, the infective organism was isolated by either arthroscopic synovial biopsy prior to revision. Standard single stage procedure included the explantation, debridement and re-implantation of the prosthesis. All the patients received intravenous antibiotics for a minimum period of six weeks and oral antibiotics were continued for further 6 weeks. All the patients had the inflammatory markers monitored during their follow-up at 6 weeks, 3, 6, 12 and 24 months.

Results: Significant improvement was noted in the SF-12 PCS, WOMAC pain and stiffness scores at the latest follow-up. None of these patients required re-revision. Radiological evaluation was done using the Knee Society system. None of the knees showed evidence of progressive loosening. Radio-opaque lines were found around the stems and were present on immediate post-operative radiographs; this did not indicate loosening or infection at a mean follow-up of two years.

Conclusions: Early clinical and radiological results of the single stage revision for infected total knee replacement appear to be promising. One operation, one anaesthetic and quicker recovery are the advantages for the patient and with the reduced hospital stay it is cost-effective. The problems of stiffness in the knee and muscle wasting with cement spacer are avoided.
Patellar Cut Obliquity in the Sagittal Plane May Be Predictive of Peri-prosthetic Patella Fracture in Cemented Total Knee Arthroplasty

Background:
Patellar cut geometry has been proposed to influence patellar fracture after total knee arthroplasty (TKA). To our knowledge, there are no large studies in current literature directly examining the association of patella fractures to the integrity of the patellar cut. This paper examines the thickness and obliquity of the bony patellar resection in 74 patella fractures occurring in cemented all-polyethylene patellar components.

Methods:
We retrospectively reviewed 5,073 TKAs performed between 10/4/88 to 8/31/2004 by a single surgeon. Within this period, 74 peri-prosthetic patella fractures in 68 patients were identified and compared to a matched control group. Post-operative radiographic assessments of all patellae included merchant and lateral views of the patellae. Thickness of the remaining patellar bone was measured using both merchant and lateral radiographs. Patellar cut tilt was evaluated on lateral and merchant views using 10mm thickness measurements from the midpoint on each view. Geometric and statistical analysis was conducted.

Results:
With greater sagittal obliquity angles, patellae were 1.196 times more likely to experience a fracture than our controls.

Conclusions:
Patella fracture after TKA may be due to trauma or a stress fracture around the construct. Bone removal for the fixation lugs can weaken the patella, causing fracture through the stress risers. This effect may be magnified with a more generous or oblique cut. Improvement in surgical technique to retain a more level cut could theoretically help prevent the problem.
Comparative Anatomy of the Knee and the ACL

Introduction
The function of knee is determined by its complex anatomy. Anterior cruciate ligament (ACL) is an important structure of knee and controls the stability of knee, whereas the sizes and shapes of condyles determine the anterior-posterior and rotational motion of the knee. A comparison of the basic anatomy of modern human knee to ancestral human knees, and to those of other animals (mostly primates) can provide novel insights into the natural history of human knee structure and function. This study will help surgeons to better understand the correlation between anatomy and function.

Purpose
1 - Review ACL anatomy and osseous landmarks in human and different animals, and correlate the anatomy of the ACL with knee function.
2 - Measure and compare the sizes and shapes of the medial and lateral femoral condyles.

Hypothesis
1 - Animals in greater need of rotation of the knee will present with a larger ACL, more specifically of the PL bundle.
2 - The size of the overall medial femoral condyle contact area will be bigger than the size of lateral femoral condyle contact area. Animals with greater rotation will have a larger ratio between condyle sizes.
3 - The size of the distal femoral contact area of both condyles (contact area in extension) will be different than the posterior femoral contact area of condyles (contact area in flexion)

Methods
Animal anatomy was studied on freshly frozen specimens. The ACL anatomy was studied by MR imaging, followed by dissection. Bones from different species were studied by using three-dimensional laser photography and 3D CT scans and measurements were done on specific software.

Results
We have found a large variety of ACL anatomy in the Animal Kingdom. The Nubian goat (Capra hircus), the springbok (Antidorcas marsupialis), the pig (Sus scrofa domestica) and the Rhesus monkey (Macaca mulatta) have three ACL bundles (AM, IM, PL). Human (Homo sapiens) has 2 bundles. The ostrich (Struthio camelus) and the chicken (Gallus gallus) have only one bundle.

Discussion / Conclusion
By studying the complexities of functional morphologic features of the knee in different animal species we can help surgeons better understand knee kinematics and the role of each ACL bundle in human being and this knowledge will help surgeons reconstruct anatomy more accurately and therefore perform a more precise knee surgery.
Anatomical Description and Quantitative Analysis of the Anterior Cruciate Ligament of the Goat Knee

Purpose:
The goat knee has been widely used for anterior cruciate ligament (ACL) reconstruction models, including biomechanical and biological studies. The purpose of this study was to perform a detailed qualitatively and quantitatively assessment of the ACL, its bundles and its insertion site in the goat knee.

Materials and Methods:
Ten fresh-frozen non-paired adult goat knees were used in this study. We measured the insertion site area of each bundle, the distances between the center of these areas and the anatomy landmarks. Moreover, we analyzed the ratio between the femoral and tibial insertion site areas and the midsubstance cross-sectional area of the ACL. A digitizing systems, Microscribe 3D and 3D-laser camera, were used to record the data. Statistical analysis was performed using a t test with \( p < 0.05 \) being considered statistically significant.

Results:
Three bundles could be clearly identified in each ACL: anteromedial (AM), intermediate (IM) and posterolateral (PL) bundle. Interestingly, the anterior horn attachment of the lateral meniscus divides the anterior portion of the tibial ACL insertion into AM and IM/PL bundles. On the tibial side, the insertion of the IM and PL bundles could not be identified separately. On the femoral side, each insertion were clearly identified separately.

On the femur, the area of insertion site, represented as a percentage of the entire footprint, was \( 54.3 \pm 7.8\% \) for AM, \( 9.9 \pm 3.8\% \) for IM and \( 35.8 \pm 4.4\% \) for PL bundle. The area of tibial insertion was \( 68.6 \pm 4.7\% \) for AM and \( 31.4 \pm 4.7\% \) for IM/PL bundle. The differences between the entire femoral (51.9 ± 4.6 mm²) and tibial (81.1 ± 11.9 mm²) footprint areas and between each bundle were statistical significant (\( p < 0.05 \)).

All insertions had significantly larger areas than the ligament midsubstance cross-sectional area (21.76 ± 7.26 mm²) (\( p < 0.05 \)).

Conclusion:
The precise knowledge of the ACL anatomy in the goat knee is necessary when a goat model is planned. Our study provides valuable information about the ACL, its bundles and its femoral and tibial insertion sites. Although it shares some similarities with the human ACL, the goat has some specific features that must be considered. Further investigation should be conducted in order to determine the biomechanical role of each bundle in the goat knee.
Size Variability of the Human Anterior Cruciate Ligament Insertion Sites: A Prospective Study

Background:
Current trends in anterior cruciate ligament reconstruction (ACL-R) have been towards a more anatomic reconstruction that restores the normal size and location of the ACL insertions. This has resulted in a more individualized approach to ACL-R. Several studies have shown that the size of the ACL insertion sites is variable, however these studies are limited by relatively small sample sizes. The purpose of this prospective study is to evaluate the size of the ACL insertion sites at the time of arthroscopic ACL-R.

Methods:
60 patients with an average age of 22.9 years (SD 9.8, range 13.6 to 55.3) undergoing anatomic ACL-R with identifiable insertion sites from November of 2007 to February 2008 were included in this study. Time from injury to surgery averaged 60.9 days (SD 74, range 15 to 369). Demographic data from each patient was recorded prior to surgery. Under arthroscopic visualization the tibial and femoral ACL insertion sites, as well as the two bundle anatomy, were identified using the ACL injury pattern, the soft tissue remnants, and bony landmarks. After marking the insertion sites with electrocautery, the total length and width of the femoral and tibial insertion sites and the two ACL bundles were measured using an arthroscopic ruler. The distance between the centers of the two bundles was also recorded. The reliability of insertion site measurements was blindly tested by a second surgeon.

Results:
The tibial insertion sites had a mean length of 16.8 mm (SD 2, range 12-20 mm). The tibial AM bundle had a mean length of 8.7 mm (SD 1.1, range 7-11 mm) and a mean width of 9.2 mm (SD 1.1, range 10, 7-11 mm). The tibial PL bundle had a mean length of 7.4 mm (SD 1.1, range 5-9 mm) and a mean width of 6.6 mm (SD 1, range 4-8 mm). The distance between the centers of the tibial AM and PL bundles averaged 8.7 mm (SD 1.5, range 7-10 mm). The femoral insertion sites had a mean length of 16.7 mm (SD 2.2, range 12-20 mm). The femoral AM bundle had a mean length of 9.7 mm (SD 1.2, range 7-12 mm) and a mean width of 8.6 mm (SD 0.9, range 7-10 mm). The femoral PL bundle had a mean length of 7.1 mm (SD 1.1, range 4-9 mm) and a mean width of 6.6 mm (SD 1.1, range 4-9 mm). Statistical evaluation of patient demographics revealed a positive correlation in regard to patient height and weight (p<0.05) for femoral and tibial ACL length, tibial PL bundle length, femoral AM bundle length, and tibial AM and PL bundle areas.

Conclusions:
This study is the only arthroscopic in vivo study of ACL insertion site anatomy and has the largest sample size reported in the literature. The results of this study clearly support a large variation in ACL insertion site sizes, but are the first to show a positive correlation with patient weight and height. With current trends in ACL-R supporting a more anatomic approach, knowledge of the insertion site sizes and locations are keys to the restoration of native ACL anatomy.
Anatomical and Histological Study of the Anterior Cruciate Ligament: Is There an Intermediate Bundle?

Introduction: The anatomy of the anterior cruciate ligament (ACL) is divided in two functional bundles, anteromedial (AM) and posterolateral (PL) bundles. However, there is a controversy about the number of anatomic bundles that constitute the ACL. This subject is controversy in the literature. We can find studies where the ACL is made by only one bundle, or by two bundles, and even three bundles. The third bundle described is the intermediate bundle (IM). Another important subject that needs to be clarified is the microscopic features of the ACL, mainly regarding to the mechanoreceptors and vascularity of the ACL. In this study we performed an anatomical and histological evaluation of the ACL in order to determine: 1) the gross anatomy of the ACL regarding the number of bundles and its tibial and femoral insertion; 2) the histology of the ACL regarding the number of bundles in the tibial insertion part of the ACL, in the midsubstance and in the femoral insertion part; 3) the presence of mechanoreceptors and vascularity in the ACL regarding the anatomical position of the ACL.

Methods: Twenty eight knees were used in this study. The knees were dissected and the gross anatomy was observed regarding the numbers of bundles and its tibial and femoral insertion. Eight ACLs with three distinct bundles were removed, divided in three bundles in order to measure the length and diameter of each bundle. Twenty ACLs were removed, divided in three transverse part (1/3 tibial part, 1/3 midsubstance, and 1/3 femoral part) and subjected to histological process. Coronal and transverse sections were stained with haematoxilin & eosin in order to identify different bundles of the ACL. Immunohistochemistry with S100 antiprotein was performed to identify the presence of mechanoreceptors regarding the type of the mechanoreceptors and its location in the ACL.

Results- Gross anatomy: The ACL usually contains three distinct bundles, AM, IM and PL. The bundles were identified by invagination of the synovial membrane into the ligament. We found 24 out of 28 ACLs composed of three bundles. The distinction between bundles varies from each ACL, with some ACL having well distinct three bundles. In 4 ACLs we could not observe the presence of three bundles, but two bundles were observed (AM and PL). The length and the larger diameter was respectively 36.4±2.8 and 8.2±1.2 mm for the AM bundle, 30.7±2.7 and 6.3±1.1 mm for IM bundle, and 25.1±2.2 and 4.5±1 mm for PL bundle. The tibial insertion has a triangular shape and the femoral insertion has a semicircular shape. Histology: The histological sections demonstrated that the ACL changes its configuration through the entire length of the ACL. In the tibial part the ACL is composed of three bundles in 16 out of 20 ACLs. In the midsubstance as well as in the femoral part, the ACL was composed of three bundles in 12 out of 20 ACLs. There were septum across the ACL and it was a connective tissue rich in vascularity that divide the bundles of the ACL. In the tibial part there were thick septum dividing the bundles of the ACL in three bundles (n=16/20). The septum decreases its thickness as it goes to the midsubstance and femoral part, being thinner and in some ACLs the septum does not go through the entire cross section of the ACL, only partially. The mechanoreceptors were found mostly in the septum tissue and there were very few mechanoreceptors within the bundles tissue. The most common type was the Type II also called Pacini corpuscles, followed by type IV or free nerve endings, type I or Ruffini endings, and type III or Golgi. As the mechanoreceptors are found most often in the septum, the tibial part has the prevalence of the mechanoreceptors.
Conclusion: The anatomy of the ACL is complex. The ACL has three bundles (AM, IM, and PL bundles) in most of the knees. The bundles are divided by an important septum. It is made by a connective vascularized tissue, it is rich not only in vessels but also in mechanoreceptors.

Clinical Relevance: The understanding of the anatomy of the ACL is important for surgeons reconstruct the ACL in a more anatomic fashion. The knowledge of the ACL histology is important to aim an ideal graft for ACL reconstruction.
Measuring the Position of the ACL Footprint with a Navigation System. Comparison with X-Ray, CT-Scan and Anatomic Measurements

INTRODUCTION
Anterior cruciate ligament (ACL) reconstruction allows overall good results, but there is still a relevant rate of failure. It is well accepted that the main reason for ACL reconstruction failure is a misplacement of tibial or femoral tunnels. Conventional techniques rely mainly on surgical skill for intra-operative tunnel placement. It has been demonstrated that, even by experienced surgeons, there was a significant variation in the accuracy of tunnel placement with conventional techniques. Navigation systems might enhance the accuracy of ACL replacement.

MATERIAL - METHODS
10 cadaver knees with intact soft-tissue and without any intra-articular abnormalities were studied. We used a non image based navigation system (OrthoPilot®, Aesculap, Tuttingen, FRG). Localizers were fixed on bicortical screws on the distal femur and on the proximal tibia. Both cinematic and anatomic registration of the knee joint were performed by moving the knee joint in flexion-extension and palpating relevant intra- and extra-articular landmarks with a navigated stylus. The most anterior, posterior, medial and lateral point of both tibial and femoral attachment of the ACL were marked with metallic pins. The navigated stylus was positioned on these points, and the system recorded its position in comparison to the bone contours. Subsequently, we performed conventional plain AP and lateral X-rays and a CT-scan, and measured the position of the pins in comparison to the bone contours. Finally, all measurements were made again with a caliper after disarticulating the knee joint. We calculated the center of the footprint as the mid-point between the four pins of both tibial and femoral attachment for each measurement technique. All measurements were expressed as percentages of the bone size to compensate for the different sizes. The results were analyzed with a Friedman test with post-hoc comparison, considering the anatomical measurements as the reference.

RESULTS
The mean medio-lateral position of the tibial tunnel was (origin at the lateral tibial border):
- 52% (SD 2%) for anatomical measurement;
- 50% (SD 2%) for navigated measurement;
- 49% (SD 2%) for CT measurement;
- 51% (SD 2%) for X-ray measurement.
The differences were globally significant (p<0.001); there was a significant difference between the reference and navigated and CT measurement techniques.
The mean antero-posterior position of the tibial tunnel was (origin at the anterior tibial border):
- 53% (SD 7%) for anatomical measurement;
- 50% (SD 7%) for navigated measurement;
- 50% (SD 7%) for CT measurement;
- 50% (SD 7%) for X-ray measurement.
The differences were globally significant (p=0.03); there was a significant difference between the reference and the radiological measurement technique.
The mean proximo-distal position of the femoral tunnel was (origin at the distal femoral border):
- 75% (SD 12%) for anatomical measurement;
- 78% (SD 15%) for navigated measurement;
- 80% (SD 11%) for CT measurement;
- 74% (SD 12%) for X-ray measurement.
The differences were globally significant (p=0.05); there was no significant difference between the reference and any measurement technique.

The mean antero-posterior position of the femoral tunnel was (origin at the anterior femoral border):
- 79% (SD 13%) for anatomical measurement;
- 83% (SD 19%) for navigated measurement;
-85% (SD 14%) for CT measurement;
- 77% (SD 15%) for X-ray measurement.
The differences were globally significant (p<0.01); there was no significant difference between the reference and any measurement technique.

DISCUSSION
Anatomical measurement of the location of the ACL footprint is the gold standard in an experimental situation. CT-scan measurement of the positioning of the ACL replacement tunnels is the gold standard in a clinical situation. X-ray measurement of the positioning of the ACL replacement tunnels is the most used technique in a clinical situation. Navigation might help improving the accuracy and the reproducibility of ACL replacement. However, the precision of each system has to be evaluated. The measurements by the OrthoPilot system were significantly different from the anatomical reference, but the difference appeared to be clinically not relevant. We concluded that this system allowed locating in a precise and accurate way the position of the ACL footprint on both tibial and femoral sides when compared to the reference techniques. This navigation system is precise and accurate for anatomical measurements in the knee joint. This should help the surgeon to define the placement of the tunnels according to anatomical landmarks during ACL replacement.

CONCLUSION
The OrthoPilot navigation system is precise and accurate for anatomical measurement of the tunnel placement during ACL replacement.
Quantitative Analysis of Lateral Intercondylar Ridge Using Transparent 3D-CT

Introduction: Lateral intercondylar ridge has been attracting attention as the osseous landmarks of the femoral attachment of the anterior cruciate ligament (hereafter referred to as ACL). Several studies have focused on the three dimensional (3D) imaging of this bony eminence. We have reported the value of transparent 3D computed tomography (T-3DCT) and true lateral radiograph of the knee, with due consideration to the rotational condition of the femur. The purpose of this study is to quantitatively analyze the configuration and location of the ridge using T-3DCT images.

Patients and Methods: After receiving approval from our institutional review board, fifty normal knees were used in this study. The CT equipment used was a GE-manufactured CT MDCT (8DAS) to record images by Helical scans. A Workstation ZIO 900M was used to reduce the image data’s CT value (by narrow band volume rendering), and increased permeability (opacity reduced) imaging was then carried out to attain the T-3DCT images. The images of the distal femur were divided longitudinally along the centre of the trans-epicondylar axis and removed the medial condyle. Observation of the ridge using volume rendering 3DCT (VR-3DCT) was performed using images provided from the lateral view and at 30°abduction to the femoral axis. The ridges identified with VR-3DCT images were then projected onto the T-3DCT images on the Workstation. On the true lateral images of T-3DCT obtained by completely overlapping medial and lateral femoral condyle, a perpendicular line was dropped from the tangent point (O point) of posterior condyle parallel to the femoral axes. When the distance from O point to the point of intersection with Blummensaat’s line was defined as 100%, the distance from O point to the point of intersection with the ridge was determined as the R value. The angle formed by the femoral axis and the extended axis of the ridge was defined as angle.

Results: It was possible to identify the ridge in 16 knees (32%) using VR-3DCT lateral images, and 46 knees (92%) using 30° abduction images, but difficult to identify in 4 cases (8%) using either method. The morphology of the ridge was linear geometry in 30 cases, and anteriorly curved in 16 cases. The R value was 51.3 ± 9.7%, and the angle was 27 ± 5°: mean ± standard deviation.

Conclusion: We were able to easily identify the lateral intercondylar ridge using VR-3DCT 30° abduction images except for 4 of the 50 cases. In addition, the morphology of the ridge was not only linear but anteriorly curved geometry. Projecting the ridge onto T-3DCT images can assist the surgeon in placing the femoral tunnel in the proper location when performing ACL reconstruction with C-arm images, intraoperatively as well as preoperatively. In concluding, we should note that the configuration and location of the ridge projecting onto T-3DCT images vary between individuals.
The "Lateral Notch Sign" in ACL Injury: Incidence, Mechanism, Morphology and Correlation

Introduction: The “lateral notch sign”, an impression fracture visible on a lateral knee radiograph has been described as an indirect sign of ACL rupture. However, surprisingly few papers have been published, so compared to the “Segond sign” (which is significantly more infrequent) the “lateral notch sign” is relatively unknown amongst orthopaedic surgeons. The “lateral notch sign” is caused by an impression of the lateral femoral condyle against the posterior superior lateral corner of the tibial plateau during the subluxation in case of an ACL rupture. It was the aim of the study to analyze and compare radiographs and MRIs’ of patients with ACL rupture according to frequency, location and morphology of the “lateral notch sign”. In addition, the correlations of the cause of injury and accompanying injuries of the lateral meniscus have been calculated.

Methods: Out of 1400 patients who underwent ACL reconstruction 500 (age 29.4 + 10.2 years) have been identified who underwent MRI and radiographic examination (ap and lateral) within 4 weeks (avg. 7 days) following the ACL injury. The incidence of a “lateral notch sign” and the size (depth and length) have been determined digitally on sagittal x-rays and MRI. The location with respect to the femoral condyle as well as the distance of the deepest point of the notch and the dorsal lateral tibia have been measured. The size and area of the associated bone bruise have also been measured. Meniscal injuries have been recorded on MRI. Spearman correlation coefficient, t-test and cross table calculations have been used for statistical analysis.

Results: A “lateral notch sign” was detected in 39.6% of the patients (17.4%: depth < 2mm and 22.2%: depth >2mm). The distance of the “lateral notch sign” to the posterior edge of the superior tibia measured 48.8 ± 12.1 mm. Injuries of the medial and lateral meniscus have been identified in 35% and 28.9%, respectively. A significant (p<0.05) correlation between a “lateral notch sign” and a lateral meniscus injury could be detected. ACL ruptures resulting alpine skiing (39.3%) are sign. (p<0.05) less susceptible for a “lateral notch sign” compared to ACL ruptures in soccer (50.9%).

Discussion: The “lateral notch sign” is a frequent companion of ACL rupture. Depending on the type of sports it may be expected that approx. 20-40% of ACL injuries can be detected on a simple lateral radiograph. In the presence of a “lateral notch sign” an associated lateral meniscus lesion should be expected. Further more, the “lateral notch sign” is an expression of the extensive subluxation taking place during the ACL injury, which may be accompanied by extensive laceration of the joint capsules. There have been some reports in the literature in order to address the impression fracture surgically. However, it still remains unclear at what extend (depth and length) a surgical intervention to reduce the fracture is necessary.
Increased Electromechanical Delay of the Knee Flexor Muscles After Harvesting the Quadrupled Hamstrings Tendon as a Graft for ACL Reconstruction

Introduction: Previous in vivo studies from our lab have shown that the scar tissue which is developed in the donor site defect of the patellar tendon after harvesting the medial third for BPTB reconstruction, does not significantly alter the electromechanical delay (EMD) of the knee extensor muscles. It remains unclear however, if this scar tissue can lead to changes in the EMD of the knee flexor muscles, after ACL reconstruction with a semitendinosus/gracilis (ST/G) autograft. As the hamstrings EMD is a major component of the flexion reflex, if such changes do exist, they could possibly affect optimal knee safety and performance in sports activities. The purpose of this study was to investigate if the harvesting of the two tendons for ACL reconstruction will have an effect in the EMD of the knee flexor mechanism.

Methods: We evaluated 12 ACL reconstructed (ACLR) patients with an ST/G autograft, two years after the reconstruction, and 12 healthy gender-, age-, height- and mass- matched patients that formed the control group. Each subject performed four maximally explosive isometric voluntary contractions with 1 min break between each contraction. The surface EMG activity of biceps femoris (BF) and semitendinosus (ST) was recorded from both legs simultaneously with the torque measurements, using a telemetric 4-channel EMG device (Noraxon Inc., USA). Statistical analysis comprised of paired t-tests for comparison between the ACLR knee and the intact knee and also, independent t-tests to test the differences between the ACLR knee and healthy controls (dominant side).

Results: All comparisons revealed significant increases to the EMD on the ACLR knee for both muscles. Specifically, the EMD of the ST for the ACLR knee and the intact knee was 0.131 ± 0.055 vs 0.096 ± 0.032 (p= 0.018), while for the BF the respective values were 0.116 ± 0.052 vs 0.089 ± 0.032 (p= 0.03). Testing the ACLR knee against healthy controls showed similar results for ST 0.131 ± 0.055 vs 0.073 ± 0.012 (p= 0.002) and BF 0.116 ± 0.052 vs 0.070 ± 0.016 (p= 0.009), respectively.

Conclusions: The observations in our study suggest that harvesting the ST/G tendon for ACL reconstruction might have an effect on the EMD of knee flexors, even 2 years after ACL reconstruction. Several studies have shown that changes of the EMD might play an important role in the organization of the movement and probably result in impairment of neuromuscular control, through its relationship with the reflex time. Increased hamstrings EMD could impair knee safety and performance by modifying the transfer time of muscle tension to the tibia and therefore affecting muscle response to sudden movements during athletic activities. However, further investigation is required, in order to identify if the increased hamstrings’ EMD can influence patients’ optimal sports performance and expose them to increased possibility of knee injury.
A New Arthrometer for the Knee: The GNRB

Aim of the study.
The measurement of the antero-posterior shifting of the tibia, in the case of anterior cruciate ligament (ACL) tears, is usually recorded by the KT-1000 or the Telos; these methods are operator dependent and the degree of accuracy is more or less 1 millimeter. Neither takes the hamstring muscle relaxation into account. We have developed a new testing device, the GNRB, and compared it to the KT-1000. The GNRB. The lower limb lies, at 30° of flexion to the knee, on a composite thermoformed support, adaptable to the length of the limb, the foot is in neutral rotation. An electric jack pushes on the postero-superior part of the calf with a force of 67 N, 89 N, 134 N, 200 N or 250 N, depending on the examiner. Two skin electrodes record the hamstring muscles activity at the beginning of the test to detect any parasitical muscular contraction. A motion sensor records the translation of the anterior tibial tuberosity to a precision of 0.1 mm. The recordings of the translations and the stiffness at each level of strength are displayed on a wire less computer. The whole of the device is controlled by a microprocessor intended to ensure the coherence (no pressure on the calf in the event of hamstring contractions) and the accuracy of the measurements.

Method. 2 experienced operators carried out tests on each knee of 20 students in engineering, aged 19 to 21, with intact knee joints, using GNRB and KT-1000, in total 680 tests (series 1). Anterior displacement with a pushing force of 134 N and differential of laxity with 89 N and 134 N, using both devices were compared between the 2 examiners. Then a series of 15 partial ruptures of the ACL were also studied according to the same protocol. The tests of Student, Fisher and ANOVA were used in the first series and the ROC curves in the second.

Results.
Series 1 (normal knees):
Variance of anterior laxity and differential of laxity with 89 N and 134 N were significantly lower using the GNRB (p<0.05).
The side-to-side differences between both knees of students at 134 N were: 0.8 mm (0.70 to 0.94 mm) with the GNRB and 1.34 mm (1.1 to 1.56) with the KT-1000.
The variances were smaller for examiner 1 than for examiner 2, but the difference decreases as the pressure increases. We observed an “examiner effect” related to the strength of the pressure on the patella.
Series 2: a side-to-side difference of 1.5 mm or more was present in partial tears of the ACL with an accuracy of 76.5 % and a specificity of 94 %.

Conclusions.
The GNRB gives significantly more accuracy and reproducibility than the KT-1000. The cut-off value for the detection of ACL partial injuries is 1.5 mm. The GNRB is non invasive and easy to handle, like the KT-1000 but much more precise and reliable, for partial tears or ruptures of the ACL. The GNRB avoids the false negative results obtained in the presence of hamstring muscle contraction.
Precision Analysis of Hind Limb Growth Following a Transphyseal Reconstruction of the Anterior Cruciate Ligament: A Study in Skeletally Immature Sheep with Wide-open Physes

BACKGROUND:
There is a lot of controversy in the recent literature with regards to the optimal treatment of anterior cruciate ligament (ACL) injuries during growth. Iatrogenic growth disturbance due to physeal damage is a potential complication, forcing many orthopaedic surgeons to treat these injuries conservatively.

HYPOTHESIS:
It is possible to perform a fully transphyseal ACL reconstruction in an ovine model with wide-open physes without creating growth disturbances.

STUDY DESIGN:
Controlled laboratory animal study on 22 skeletally immature sheep with wide-open physes.

METHODS:
Four month old skeletally immature sheep underwent a transphyseal ACL reconstruction of the right knee. The surgical technique followed the criteria known to be essential to avoid growth disturbances in humans. The left knee served as a control. A computer-assisted evaluation of long radiographs (frontal and sagittal plane) of the exarticulated hind limbs was performed to exactly evaluate the limb alignment, joint orientation, and leg length. The animals were sacrifized in groups by six after 3, 6, 12 and 24 weeks.

RESULTS:
No angular deformities or leg length discrepancies occurred following this transphyseal ACL reconstruction procedure throughout the remaining growth.

CLINICAL RELEVANCE:
This large animal study supports the clinical observation, that it is possible to perform an ACL reconstruction without creating growth disturbances as long as a number of key principles are followed. Previous animal studies argued against ACL reconstruction in skeletally immature patients. This large animal study provides support for early operative treatment of ACL ruptures even in young patients with open physes.
Skeletally Immature Sheep as an Animal Model for Tendon to Bone Healing in Children: Faster Healing and Enhanced Biomechanics Following Anterior Cruciate Ligament Reconstruction

INTRODUCTION:
Postoperative mobilization, physical therapy, range of motion and return to functional activity are largely dictated by the need to protect the healing of the tendon graft in the bone tunnel. A broad scope of studies and experiences regarding most aspects of ACL reconstruction in adults is available but only limited data exist for the tendon graft to bone healing process in children. This is surprising, as intraligamentous ruptures of the ACL are diagnosed with increasing frequency. We aimed to investigate the basic mechanisms of the graft tissue incorporation into the bone tunnel and the physis tissue as well as to determine the biomechanical behaviour of the ACL reconstructed knee. We hypothesized that the graft incorporation into the bone tunnel is faster and more complete when compared to adult sheep models of ACL reconstruction.

METHODS:
All 32 animals underwent a fully transphyseal reconstruction of their right ACL. The left knee served as a control. Four groups of eight animals each were sacrificed at 3, 6, 12 and 24 weeks following surgery. Two animals of each group were used for the histological and 6 animals for the biomechanical analysis. The graft was fixed using the Endobutton proximally and the Suture Washer device distally. After sacrifice, the tunnels dedicated for the histological workup were overdrilled and embedded in Technovit 9100 New. The histological workup consisted of a Toluidine blue staining and an in situ hybridisation for collagen III mRNA. The biomechanical evaluation consisted of a load to failure testing of the intact (left) and ACL reconstructed (right) knees. For statistical analysis, a two-way ANOVA was used and differences were considered to be significant at a probability level of p = 0.05.

RESULTS:
All animals demonstrated a quick return to full mobilization within 6 weeks. The gross inspection of the ACL reconstructed knees after sacrifice demonstrated intact knee joints with no meniscal lesion and no signs of osteoarthritis. All grafts were in place and covered by a synovial sheath, even as early as 3 weeks following surgery. The graft remodelling process within the tunnel followed the stages of necrosis, inflammation and reorganisation of the matrix. The remodelling of the tunnel wall started at the fixation site and proceeded towards the articular tunnel entrance. Sharpey like fibers could be demonstrated as early as 3 weeks following surgery. The physis tissue protruded into the tunnel lumen in the early postoperative stages and was in line with the tunnel wall in the later stages of the tendon graft to bone healing process. Many collagen III mRNA positive cells were present in the fibrovascular interface at three and six weeks, whereas in the later phase only scattered positive cells were demonstrable. The intact contralateral knees (FATC) demonstrated a mean load to failure of 759.17 ± 114.11 N. The operated knees (FGTC) immediately following surgery failed at 124.76 ± 31.9 N (16.4% of the intact ACLs). At 24 weeks, the FGTC gained further stability, resulting in a load to failure of 522.85 ± 113.85 N, (69% of the intact ACLs, p = 0.02). The corresponding stiffness data were 136.25 ± 28.5 N/mm for the FATC and 15.53 ± 1.67 N/mm for the FGTC immediately following surgery. At 24 weeks, the stiffness of the operated knees significantly increased to 113.69 ± 5.72 N/mm, which is a restoration to 86.5% of the ACL intact knees.
DISCUSSION:
To get more insights into the healing processes after ACL reconstruction in children, we used skeletally immature sheep as a large animal model. We found a quick remodelling of the tendon graft within the tunnel and an early formation of anchoring, Sharpey-like fibers as early as 3 weeks following surgery. We also found a complex response of the growth plate tissue at the passing site of the tendon graft. Interestingly, two comparable studies using adult sheep demonstrated Sharpey like fibers not before 12 weeks and found much weaker failure loads and stiffness values within the first six months following surgery.

CLINICAL RELEVANCE:
Our data indicate that the present high rate of reruptures and persisting instabilities encountered with ACL reconstruction in children is not due to inferior healing when compared to adults. Quite the contrary, the tendon graft to bone healing process is very sound, as the remodelling of the graft, the anchoring of the graft to tunnel wall as well as the biomechanical data are superior when compared to adults. This shows the urgent necessity for a child-specific rehabilitation protocol following ACL reconstruction.
Bundle Augmentation in Chronic Partial ACL Tears

Introduction: based on the concept of anatomic double bundle ACL reconstruction it has been proposed to augment partial tears of the ACL by reconstructing the missing bundle. There are few data available in the literature on the outcome of such reconstructive surgery. This retrospective study has been undertaken to evaluate the results of such a strategy in the treatment of chronic (>3 months) tear of the ACL. We hypothesized augmentation of chronic partial ACL tears would restore a laxity close to a normal knee.

Methods: the suspicion of partial ACL tear was established either by preoperative clinical and/or MRI examination and confirmed by arthroscopy. After cleaning the remaining ACL remnants, the functional value of the remaining bundle was assessed by careful probing and the decision to save the bundle was taken intraoperatively. The missing bundle was reconstructed under arthroscopy, using a one-incision technique, with one hamstring tendon autograft (6.5-9 mm diameter) and femoral tunnel drilling through the anteromedial (AM) portal. The graft was fixed with an endobutton CL on the femoral side and an interference screw and screw post on the tibial side. The post-operative rehabilitation protocol was identical to traditional ACL reconstruction.

Results: between 2005 and 2007, 20 patients were involved, 15 had an isolated tear of the AM bundle and 5 an isolated tear of the posterolateral (PL) bundle. The average preoperative disability time was 8.8 months (median 5.5 months). There were 11 males, 9 females, with an average age of 28 years. The chief complaint was giving way (17 cases). Among the 7 combined meniscal tears, 6 were associated with AM bundle tear. The average follow-up is 12 months (median 11 months). Pre- and postoperative evaluation data are the following:

- KT 1000 at 30 lb 2.3mm ± 1.4mm vs 1.9 mm ± 1.5mm (p>0.5).
- Pivot shift test (IKDC grades)preop 6A,10B,3C,1D, postop 20A (p<0.01).
- Global IKDC, preop 2A,4B,11C, 2D, postop 12A, 5B, 3C (p<0.05).
- There were 2 extension deficit of 10° following AM bundle reconstruction which needed arthroscopic release.

Discussion: despite the short follow-up of this series the clinical outcome, ACL augmentation appears being a valid option for the surgical treatment of chronic partial ACL tears. Our initial hypothesis was confirmed: the residual anterior tibial translation was minimal and there was no more pivot shift. However, further studies are necessary to assess the tissue quality of the remaining bundle. Also, when reconstructing the AM bundle care must be taken not to locate the tibial tunnel too much anterior.
The Effect of Tunnel Placement on Bone-Tendon Healing in a Goat Model

Background: Misplacement of the bone tunnels is one of the main causes of graft failure of anterior cruciate ligament (ACL) surgery.

Hypothesis: Anatomical tunnel placement in ACL reconstruction will lead to improved outcomes including biological ingrowth and biomechanical properties when compared to non-anatomical tunnel placement.

Study design: Controlled Laboratory Study

Methods: ACL reconstruction was performed on three different groups of goats (with one anatomical tunnel placement group and two different non-anatomical tunnel placements groups with 10 goats in each group). For each group of ten knees, three knees were used for histological evaluation (bone tunnel enlargement, number of osteoclasts at the bone tendon interface, and revascularization of the graft) and seven knees were used for biomechanical testing (anterior tibial translation, in situ force, cross section area, and ultimate failure load). Animals were sacrificed at 12 weeks post surgery. Results: The anatomical tunnel placement group showed less tunnel enlargement on the tibial side, fewer osteoclasts on both the tibial and femoral sides, and more vascularity in the femoral side when compared with both non-anatomical reconstruction groups. Biomechanically, the anatomical tunnel placement group demonstrated less anterior tibial translation (ATT) and greater in situ force than both non-anatomical tunnel placement groups.

Conclusions: Anatomical tunnel placement leads to superior biological healing and biomechanical properties at 12 weeks after ACL reconstruction in a goat model.

Clinical relevance: The findings of this study demonstrate the importance of anatomical tunnel placement in ACL reconstruction.
**Use of Ad-Osf2 Modified Adipose-derived Stem Cells to Enhance Tendon-Bone Integration in the Reconstruction of ACL**

**Aim**
To determine the efficacy of using Ad-Osf2 modified adipose-derived stem cells to enhance tendon-to-bone healing.

**Methods**
ADSCs were harvested from SD rats and transduced with adenovirus carrying the recombinant mouse Osf2 gene. Untransduced cells and cells transduced with adenovirus carrying the enhanced green fluorescence protein (Ad-EGFP) gene served as controls. Osf2 expression was assessed by realtime -PCR, immunofluorescence, and Western blot. Alkaline phosphatase (ALP) activity was assayed on days 1,3,7, 10 and 14. Osteocalcin production and bone nodule formation were detected by von Kossa stain on day 7,10,14,21. A total of 1×106 cells mixed with PLA were implanted into the subcutaneous pocket in nude mouse and subjected to histological analysis 4 weeks post-implantation. The semitendinosus tendons were translated into 2.5-mm diameter bone tunnels in a New Zealand white rabbit model of ACL reconstruction. The bone tunnels were treated with or without Ad-Osf2-ADSCs. Three specimens were harvested at 3,6,12, 24 and 52 weeks postoperatively and evaluated by radiological, histological, immunohistochemical and biomechanical methods.

**Results**
Overexpression of Osf2 inhibited adipogenesis, as demonstrated by suppression of LPL and PPAR? expression at the mRNA level and reduced lipid droplet formation. Moreover, ADSCs transduced with Ad- Osf2 underwent rapid and marked osteoblast differentiation as determined by osteoblastic gene expression, alkaline phosphatase activity and mineral deposition. Additionally, histological examination revealed that implantation of Osf2 modified ADSCs could induce mineral deposition and bone-like tissue formation in vivo. In animal model of ACL reconstruction, CT show bone formation and remodeling around the bone tunnel were significantly enhanced in the group treated with Osf2 modified ADSCs. Histologic examination demonstrated more extensive bone formation around the tendon, with closer apposition of new bone to the tendon in knees treated with Osf2 compared with control knees. Biomechanical testing demonstrated higher tendon pullout strength in the Osf2 site at all time points.

**Conclusions**
Firstly, Osf2 can promote ADSCs osteogenesis in vitro and in vivo; Secondly, Osf2 modified adipose-derived stem cells can promote the healing of tendon graft-to-bone.

**Keywords:** Adipose–derived stem cells, Osf2, gene therapy, differentiation, osteogenesis
Evaluation of BMD/Bone Microarchitectural Changes Along Bone Tunnel and Surrounding Host Bone After Anterior Cruciate Ligament Reconstruction Using Micro-CT

INTRODUCTION
Firm attachment of free tendon graft to bone tunnel is crucial to anterior cruciate ligament (ACL) reconstruction. It was shown to correlate with amount of osseous ingrowth, mineralization, and maturation of healing tissue and is bone-specific. Better understanding of the quality and quantity of newly-formed mineralized tissue and surrounding host bone is crucial to our understanding of tendon graft to bone tunnel healing. We aimed to develop a method for the assessment of the quantity and quality of newly-formed mineralized tissue along bone tunnel after ACL reconstruction using micro-CT. Previous study reported that the application of calcium phosphate and mesenchymal stem cells (MSC) enhanced the osteointegration of tendon graft. We hypothesized that the combined treatment with both calcium phosphate and MSC has synergistic effect on tendon graft to bone tunnel healing. We hence also reported our preliminary results of the micro-CT analysis of changes of mineralized tissue along the bone tunnel after treatment with calcium phosphate and MSC.

METHODS
The ACL of rabbits were bilaterally reconstructed with semitendinous grafts. The tendon graft was either untreated, hybridized with calcium phosphate, coated with MSC in fibrin glue or both. The changes in BMD/bone microarchitecture at the interface were monitored by µCT at week 0, 2 and 6. The specimen was scanned perpendicular to the long bone axis covering the entry and exit of bone tunnel. To quantify the time- and regional-dependent changes of newly-formed mineralized tissue, a circular 2.7mm region of interest (ROI) inside the bone tunnel was chosen and 3-dimensionally reconstructed using the built-in software after thresholding. BMD/bone microarchitectural parameters were calculated for ROI for the whole femoral and tibial tunnels.

RESULTS
For the femoral tunnel, calcium phosphate+MSC group has lower connectivity density, trabecular number, thickness and BMD as well as higher trabecular separation compared to the MSC-only group. The differences were statistically significant for all these parameters (p<0.05) except trabecular thickness. There was no statically significant difference in all these parameters between the two groups at tibia though the calcium phosphate+MSC group showed higher connectivity density, trabecular number, trabecular thickness and BMD and lower trabecular separation.
CONCLUSION / DISCUSSION
We have developed a method for the assessment of bone quality and quantity along bone tunnel. Our preliminary result showed that the combined treatment with calcium phosphate and MSC has negative effect on the amount and microarchitecture of mineralized tissue ingrowth at femur. Mineralization of tendon graft might have harmful effect on healing. The effect might be bone-specific as these changes were not observed at tibia. Further studies would be done to confirm this observation as the sample size was small. Besides osseous ingrowth and mineralization, collagen fiber connection between bone and graft and graft remodeling are also important to healing and hence the overall mechanical strength of the complex. Histology is required to further confirm the effect of calcium phosphate and MSC on ACL reconstruction.

ACKNOWLEDGEMENT
This study was supported by Hong Kong Research Grant Council Earmarked Grant 06-07 (4497/06M).

REFERENCES
Tunnel Widening Following Anterior Cruciate Ligament Reconstruction: A Study in Sheep

BACKGROUND:
A common clinical concern following anterior cruciate ligament reconstruction is expansion of the bone tunnels as seen radiographically. The etiology and clinical relevance of this phenomenon remain unclear. It was our aim to investigate 1) the diagnostic power of plain x-rays versus computed tomography, 2) to analyze the relationship of tunnel enlargement and joint stability and 3) to look for histological changes associated with tunnel widening. We hypothesized, that 1) tunnel widening is most accurately diagnosed by computed tomography, 2) tunnel widening results in increased anteroposterior translation and that 3) there are certain histological changes associated with this phenomenon.

METHODS:
30 skeletally immature sheep with an age of four months underwent an ACL reconstruction with a soft tissue graft. Graft fixation was achieved using the Endobutton and Suture Washer devices. The animals were sequentially sacrificed 3, 6, 12 and 24 weeks following surgery. After sacrifice, each ACL reconstructed knee was radiographically examined by plain x-rays and computed tomography. Anteroposterior translation was examined using an UFS roboter. The bone surrounding the tunnel was histologically analyzed. Statistical analysis included 1-way ANOVA, student-t and Pearson correlation coefficient tests.

RESULTS:
A tunnel enlargement of 20% or more was present in 9 animals on the femoral site. Measurements on plain x-rays systematically underestimated the true amount of tunnel widening as determined by the CT scan. Animals with tunnel widening did not demonstrate an increased anteroposterior translation. However, widening of the femoral tunnel was significantly associated with a higher stiffness of the graft (p<0.05) and a hypertrophy of the graft throughout the remodeling process. The histological analysis of the bone tunnels demonstrated an increase of bone volume in animals with tunnel enlargement. However, no statistically significant correlation could be found between the number of osteoclasts and the presence of tunnel widening.

CONCLUSION:
In this large animal model of ACL reconstruction, animals with significant tunnel widening did not suffer anteroposterior instability. In contrast, in those animals the tunnel widening was associated with a significantly higher stiffness of the graft. The surrounding bone systematically responded by an increase of bone volume.

CLINICAL RELEVANCE:
Corresponding to the current opinion in humans, tunnel widening is not associated with knee instability in this animal study. Increased graft stiffness may play a role in the etiology of tunnel widening. Our data support the biomechanical concept of this phenomenon. A grading scheme is proposed. Further research is needed.
Comparison of Engineered BMP Peptide-Coated and Non-Coated Bioresorbable Interference Screws on Tendon-Bone Healing in an Ovine Model

Tendon grafts plus bioresorbable interference screws transplanted into bone tunnels have been widely used for anterior cruciate ligament (ACL) reconstruction. However, interference screw fixation has the potential to negatively influence tendon bone healing. The purpose of this study was to determine whether a bioresorbable interference screw coated with an engineered peptide derivative of bone morphogenetic protein-2 (eBMP2) improved tendon-bone healing compared to the screw without sub-BMP coating. We hypothesized that the eBMP2-coated bioresorbable interference screw would result in better biomechanical and histologic outcomes for tendon bone healing.

Fourteen mature female sheep were utilized in the study. In each of the 14 sheep, each stifle was randomized to either receive an eBMP2-coated interference screw or non-coated interference screw (n=14/treatment). The sheep were euthanized at 6 weeks after surgery. Eight sheep were subjected to biomechanical testing for peak load at failure and stiffness, and 6 sheep were used for histologic analysis according to a semiquantitative scoring scale. The Student’s paired t-test and the Kruskal-Wallis test were used for statistical analysis for mechanical testing data and the histologic subjective scores between the two treatment groups, respectively.

Peak load at failure for the eBMP2-coated interference screw group (mean±SD: 449.3±84.7 N) was not significantly different from the non-coated group (421.0±61.8 N) (p=0.22). Stiffness for the eBMP2-coated interference screw group (157.3±39.6 N/mm) had a trend to be greater than that for the non-coated group (140.6±20.3 N/mm) (p=0.12). Histologic analysis demonstrated that the tendons in the eBMP2-coated interference screw group had better new bone formation and more mesenchymal cell proliferation (pre-osteoblasts) at the tendon bone interface than the non-coated group (p=0.02).

The results of this study demonstrated that the eBMP2-coated bioreorbable screw significantly improved tendon bone healing in this ovine model.

This eBMP2 coating material may be useful as a component of other bone healing approaches.
Injectable Hydrogel to Enhance Tendon Graft-Bone Tunnel Healing in Anterior Cruciate Ligament Reconstruction

Purpose: Tendon-bone healing in the bone tunnel is crucial for long term success in ACL reconstruction. Periosteal progenitor cells (PPC) have potential to differentiate to osteogenitor and chondrogenitor cells in adequate microenvironment. Periosteal progenitor cells can be utilized to enhance the tendon-bone healing process through formation of interface fibrocartilage formation. A novel injectable hydrogel with periosteal progenitor cell and BMP-2 was created to enhance tendon-bone healing in a rabbit model.

Materials and Methods: An injectable hydrogels were prepared from PEGDA (poly-ethylene glycol diacrylate) dissolved in PBS containing photoinitiator. PEG (Acrylate-PEG-NHS) was used as a spacer to tether BMP-2. Periosteum-derived PPCs were suspended in PEGDA-PEG-BMP-2 solution. In ACL reconstruction in rabbits, Flexor digitorum longus tendon used as tendon graft. After reconstruction, the PPC-BMP-2 hydrogel was injected into the femoral and tibial tunnels respectively. Ultraviolet irradiation was applied to solidify the hydrogel through photopolymerization process. The rabbits were sacrificed at 4, 8 and 12 weeks postoperatively. The morphological characteristics of the healing tendon-bone interface were evaluated by histological and immunohistochemical analysis. ACL reconstruction specimens were prepared for biomechanical testing at each time-period after sacrifice.

Results: Histological analysis of the tendon-bone interface in the femoral and tibial tunnels showed that an interface layer formed by hydrogels. At 4 weeks, there was fibrocartilage tissue demonstrated in focal area. At 8 weeks, there was further matrix deposition with fibrocartilage formation in the tendon-bone junction. At 12 weeks, large areas of fibrocartilage at the tendon-bone junction could be found. RT-PCR for gene expression indicated by positive expression of collagen type II and aggrecan. Immunohistochemical study revealed collagen-II at the interface that indicated fibrocartilage formation. Biomechanical testing revealed higher maximal pull-out load at all time points with a statistically significant difference at 8 and 12 weeks.

Conclusion: PEGDA-based hydrogel was approved as adequate matrices for the encapsulation of cells and signal factor and effective local delivery method to the bone tunnel through injection. After injecting the hydrogels, it could be solidify were via a photoinitiated polymerization process to assure encapsulation of stem cells and growth factors. The PPC-BMP-2 hydrogel provides a powerful inductive ability between the tendon and the bone to enhance tendon-bone healing through the neoformation of fibrocartilage.
Press Fit Fixation of the ACL-Graft by Beta TCP Dowels - A Sheep Trial

Objectives: The goal of our interdisciplinary work group is to develop an osteoconductive dowel system made of micro porous pure beta tricalcium phosphate (TCP) cylinders (porosity 40%) for press fit fixation of the ACL-graft using tendons with and without bone blocks. The purpose of this study was to investigate the biomechanical and histological properties after anterior cruciate ligament (ACL) reconstruction using bone-to-bone and tendon-to-bone press fit fixation with TCP cylinders in a sheep trial.

Methods: 42 mature female merino sheep underwent ACL reconstruction using pure beta TCP cylinders for press fit fixation of the ACL-graft. They were divided into two equal groups animals with bone-tendon-bone (BTB) Patellar tendon graft and with Achilles tendon split graft (Flexor Tendon). After 6, 12 and 24 weeks 7 animals of each group were euthanized. The anterior drawer (AP) test of the knees was performed at 50N. After removal of all soft tissue except the ACL specimen were loaded until failure (single cycle loading test). Failure mode, linear load, peak load, energy to failure and stiffness were recorded. Bony remodeling around the graft and replacement of the dowel by bone was analyzed. The contralateral knees served for a control group. Results were analyzed by mean value, standard deviation, Mann-Whitney-U-test, Wilcoxon-test and Kruskal-Wallis-test. Differences with \( p < 0.05 \) are significant.

Results: Time zero failure mode at BTB and Flexor tendon graft was partial pull-out from the tibial tunnel combined with rupture of the transplant. Transplants mostly failed at the midsubstance portion. The AP drawer displacement of the contralateral knee was \( 0.7 \pm 0.2 \text{mm} \), of the BTB reconstruction \( 2.63 \pm 0.9 \text{mm} \) at time zero, \( 4.5 \pm 3.7 \text{mm} \) after 6 weeks, \( 2.3 \pm 0.9 \text{mm} \) after 12 weeks and \( 2.8 \pm 0.9 \text{mm} \) after 24 weeks, of the Flexor tendon graft \( 2.6 \pm 0.8 \text{mm} \) at time zero, \( 4.3 \pm 1.9 \text{mm} \) after 6 weeks, \( 2.3 \pm 0.5 \text{mm} \) after 12 weeks and \( 3.1 \pm 0.9 \text{mm} \) after 24 weeks Load to failure of the contralateral knee was \( 1764 \pm 362 \text{N} \), of the BTB reconstruction \( 198 \pm 63 \text{N} \) at time zero \( 188 \pm 86 \text{N} \) after 6 weeks, \( 599 \pm 238 \text{N} \) after 12 weeks and \( 714 \pm 314 \text{N} \) after 24 weeks, of the Flexor tendon graft \( 256 \pm 100 \text{N} \) at time zero, \( 159 \pm 71 \text{N} \) after 6 weeks, \( 233 \pm 115 \text{N} \) after 12 weeks and \( 808 \pm 345 \text{N} \) after 24 weeks Load to failure of BTB was significantly superior to the Flexor tendon graft after12 weeks (\( p = 0.002 \)). Bony remodelling around the graft was beginning at 6 weeks. After 12 weeks there was calcified cartilage around the graft. After 24 weeks primary bony integration of the graft was seen in all cases. The number of osteocytes increased over time significantly (\( p = 0.008 \)). The microporous beta-TCP dowel showed progressive resorption and replacement by bone (\( p = 0.001 \)).

Conclusions: Press fit fixation with micro porous pure beta tricalcium phosphate cylinders of bone-tendon-bone (BTB) graft or Achilles tendon split graft for ACL reconstruction does not fail in the biomechanical testings after 6, 12 and 24 weeks. The weakest link of the reconstructed ACL is the transplant. The graft shows primary bony integration. The TCP-Implant shows progressive replacement by bone.
Surgical Treatment of Osteochondral Lesions of the Talus with a New One-step Arthroscopic Procedure

Introduction: In the last years different methods have been proposed for the treatment of osteochondral lesions of the ankle. The state of the art is now represented by the arthroscopic Autologous Chondrocytes Implantation (ACI), a technique that reported good results, but requires two surgical steps, a laboratory phase and high costs. The aim of this study is to present a new one-step arthroscopic procedure with the use of mesenchimal stem cells (MSC) supported on a scaffold and autologous Platelet Rich Fibrin (PRF).

Materials and Methods: 48 patients with diagnosis of Osteochondral Lesion of the Talus (OLT) underwent the following procedure. The day before the surgery 120 ml of venous blood were harvested for the PRF production. The day of the surgery the MSC were harvested from the posterior iliac crest and concentrated directly in the operating room. An ankle arthroscopy was performed with lesion detection and curettage. The cell concentrate was mixed with a collagen paste or a hyaluronic acid membrane as scaffold and with PRF in order to obtain a final composite to fill the lesion site. No weight bearing for 6 weeks and early ROM were advised postoperatively. Clinical and MRI control was performed at 6 and 12 months. Three cases underwent a second arthroscopy with a biopsy of the regenerated tissue at 12 months follow-up.

Results: According to the American Orthopaedic Foot and Ankle Score (AOFAS) the patients with OLT had a mean preoperative score of 64.4 (range 35-79), a mean score of 73.3 (range 61-97) at 6 months, and a mean score of 83.3 (range 65-100) at 12 months follow up. MRI control at 6 and 12 months showed a progression of the reparative process in the lesion sites. The biopsy showed the presence of regenerated subchondral bone and remodelling cartilaginous tissue.

Conclusions: This one-step technique demonstrated to be a valid option for the treatment of osteochondral lesions of the talus. The main advantages of this technique are a reduced surgical time, lower costs and lower patient’s morbidity. A longer follow up is necessary to verify the long-term maintenance of the results.
Revision Arthroscopic Capsulo-labral Reconstruction for Recurrent Instability of the Shoulder

It is well documented that the outcomes of primary arthroscopic anterior stabilisation procedures of the shoulder are as good as if not better than open procedures; the outcome of arthroscopic revision shoulder stabilisation procedures is less well known. The purpose of this study was to investigate the outcome of arthroscopic revision surgery for failed anterior stabilisation of the shoulder. Forty patients with failed primary open or arthroscopic anterior shoulder stabilisation who were treated with revision arthroscopic capsulo-labral reconstruction were followed for a mean of 36 (12-87) months. There were 34 males and 6 females with a mean age of 33.1 (15-48) years. The patients characteristics, index procedure technique, operative findings at revision surgery and clinical outcome was evaluated using patient record review, physical examination, Western Ontario Shoulder Instability Index, American Shoulder and Elbow Surgeons score and Health Status Questionnaire 12. At final follow up, mean +/- SD American Shoulder and Elbow Surgeons score was 81.1 +/- 21.0 (17.5-99.5). The mean +/- SD Western Ontario Shoulder Instability Index score was 68.2 +/- 22.8 (20-98.2). HSQ-12 mean scores for the eight domains were: 76.7, 95.1, 82.1, 82.6, 89.7, 74.1, 62.0 and 75.3. All patients maintained or demonstrated improved range of motion: mean +/- SD forward flexion was 165.5° +/- 18.6° (140°-185°). Mean +/- SD external rotation was 60° +/- 15.7° (40°-85°). When compared to external rotation for the contralateral side, no significant difference was found (p = 0.78). Four patients (10%) experienced recurrent instability after the revision arthroscopic procedure. All of these occurred traumatically. We believe our series of revision arthroscopic capsulo-labral reconstructions to be the largest reported on in the literature. We have shown that in a carefully selected patient population, this procedure can provide stability in approximately 90% of patients, comparable to success rates of primary arthroscopic and open stabilisation procedures. Arthroscopic revision for recurrent instability of the shoulder should be considered as a reliable treatment option for this patient population except in the setting of significant gleno-humeral bone defects.
Comparison of Open Versus Arthroscopic Fixation for Isolated PCL Tibial Bony Avulsions: A Prospective Randomized Study with Minimum 2 Year Follow-up

BACKGROUND & AIMS: Fixation is the treatment of choice for acute displaced tibial bony avulsions of the posterior cruciate ligament (PCL). Although open reduction via a posterior approach has been the traditional method for internal fixation, various PCL tibial bony avulsion arthroscopic fixation techniques have been reported and propagated in the last decade. The apparent advantages of the arthroscopic approach over the open approach include avoiding the potentially injurious exposure of the popliteal fossa, and the ability to identify and treat coexisting intra-articular pathology. There is, however, no scientific validation for these claims. Moreover, there is insufficient evidence that the arthroscopic procedure results in outcomes similar to the gold standard open reduction with internal fixation technique. The purpose of this prospective randomised controlled study was to compare the open technique versus the arthroscopic technique for fixation of isolated PCL tibial bony avulsions and to determine if the arthroscopic technique yielded equivalent surgical outcomes to the traditional open approach.

DESIGN OF THE STUDY: A five-year prospective randomised comparative study with minimum 2 year follow-up.

PATIENTS & METHODS: The study was carried out in the period of Jan 2003 to Dec 2007 at a university hospital which is the national referral center for PCL and multiple ligament knee injuries. The study group included 50 patients with unilateral isolated PCL tibial bony avulsions with fragment displacement > 5 mm, who presented within 3 weeks of injury, and who demonstrated signs suggestive of Grade II or III PCL laxity. Exclusion criteria were bilateral knee injuries, combined ligament injuries, undisplaced fractures of PCL tibial insertion, chronic (> 3 weeks) PCL tibial bony avulsions, patients with only grade I PCL laxity on posterior drawer test and arthrometry, open knee injuries, PCL tibial bony avulsions with popliteal vascular injuries, and patients over 65 years of age. Patients were randomized into 2 groups. Group A (n=25) underwent open reduction and internal fixation via a standard posteromedial approach that involved dissection between medial head of gastrocnemius and semimembranosus with lateral retraction of medial gactrocnemius. The popliteal neurovascular bundle was not dissected and was retracted along with the medial gastrocnemius. Fixation was achieved with either a single 4mm cannulated cancellous screw with washer if the bony fragment was large, or with a pull-through suture if the bony fragment was small or comminuted (Ethibond No. 5 in initial cases, Arthrex Fiberwire No. 2 in subsequent cases). Group B (n=25) underwent arthroscopic pull-through suture fixation. The arthroscopic technique involved creation of a standard anterolateral portal, a high anteromedial portal, 2 posteromedial portals (high and low), and in a few cases a posterolateral portal; followed by creation of 2 bone tunnels of 4.5 mm made from the anterior cortex of the tibia to the inferomedial and inferolateral border of the tibial PCL fossa (fracture crater site) using a PCL tibial guide. One or two strands of nonabsorbable sutures (Ethibond No. 5 in initial cases, Arthrex Fiberwire No. 2 in subsequent cases) which were tied / sutured to the osseoligamentous junction of the avulsed PCL, and which effectively formed a divergent suture bridge, were pulled through the tunnels and tied at the anterior tibial border after confirming anatomical fracture reduction. Coexisting meniscal and chondral injuries in Group B patients were treated at the same stage. Patients from both groups underwent a similar postoperative rehabilitation program. Each patient was evaluated preoperatively with clinical grading of PCL laxity, arthrometer (Aircast Rolimeter) testing, and MRI. Each patient was evaluated postoperatively at 6 months, 1 year, 2 years, and latest follow-up with clinical grading of PCL laxity, arthrometer (Aircast Rolimeter) testing, stress radiography, and two different knee ligament rating scales (IKDC and HSS). The minimum follow-up was 2 years, and mean follow-up was 39 months (range 24 to 58 months). Statistical analysis was performed using the Fisher exact t test, Wilcoxon signed-ranks test, and Mann-Whitney test.
RESULTS: Preoperative MRI revealed coexisting meniscal tears in 4 Group A patients and 6 Group B patients, coexisting chondral injuries in 2 Group A patients and 1 Group B patient, and intraarticular osteochondral free fragments in 1 Group B patient. 3 Group A patients underwent second stage arthroscopy for evaluation and treatment of symptomatic meniscal / chondral injuries. This was performed between 6 to 19 months following initial surgery. Postoperative physical examination revealed normal posterior drawer and tibial step-off in 18 of 25 knees (72%) in Group A, and 17 of 25 knees (68%) in Group B. Arthrometer testing for sagittal plane laxity using the Aircast Rolimeter determined mean postoperative total anterior-posterior side-to-side difference of 3.9 + 2.3 mm in Group A and 4.1 + 1.9 mm in Group B. Postoperative stress radiography demonstrated PCL to be normal in 18 (72%), grade I laxity in 5 (20%), and grade II laxity in 2 (8%) Group A knees; and normal in 17 (68%), grade I laxity in 7 (28%), and grade II laxity in 1 (4%) Group B knees. At final IKDC evaluation, 21 patients (84%) were graded level A (normal), and 4 patients (16%) were graded level B (nearly normal) in Group A, whereas 22 patients (88%) were graded level A (normal), and 3 patients (12%) were graded level B (nearly normal) in Group B. The mean postoperative IKDC subjective score was 86 points in Group A and 89 points in Group B. The mean postoperative HSS score was 94 points in Group A and 96 points in Group B. There was no statistically significant difference in results between Group A and B in any of the evaluation measures. No patient in either group had a loss of extension, however 3 patients in Group A and 1 patient in Group B had terminal restriction of flexion not exceeding 20 degrees. 2 patients had minor wound healing problems in Group A. 3 patients in Group A required additional surgical procedures related to PCL implants. These included 1 implant removal through posterior approach for screw back-out noticed at 1 year follow-up, and 2 patients involved in kneeling activities with prominent anterior implants with bursitis underwent resection of prominent anterior screw tips through an anterior approach. Serial radiographs did not reveal a trend toward radiographic Fairbanks changes in the medial and patellofemoral compartments in either group.

DISCUSSION & CONCLUSIONS: Fixation of isolated PCL tibial bony avulsions through a traditional open posterior approach yielded equivalent surgical results and outcomes as compared to the arthroscopic technique in that there was no statistically significant difference in clinical grading of PCL laxity, arthrometer testing, stress radiography, and two different knee ligament rating scales (IKDC and HSS) between the two groups at a minimum 2 year follow-up. However, 6 patients in the open approach group had to undergo subsequent surgical procedures, 3 for coexisting symptomatic meniscal and chondral injuries, and 3 for implant related problems. Preoperative MRI revealed coexisting meniscal / chondral injury or intraarticular free osteochondral fragments in 28% of patients with isolated displaced PCL tibial bony avulsions.

CLINICAL RELEVANCE: In patients with isolated displaced PCL tibial bony avulsions if the preoperative MRI reveals coexisting meniscal / chondral injury or intraarticular free osteochondral fragments, then an arthroscopic approach for fixation would be preferable since it results in equivalent PCL stability and surgical outcomes as the open fixation technique, and at the same time manages the coexisting pathology. In the absence of coexisting intraarticular pathology on MRI, an open approach may be employed, however, there is a 12% incidence of implant related problems if a screw is used for fixation.
Arthroscopic Proximal Realignment in Patellar Instability

Several arthroscopic techniques have been developed to treat patellar instability. The author presents a new arthroscopic technique for the treatment of patellofemoral instability with plication of the medial patellar retinaculum and a release of the lateral patellar retinaculum. The retinaculum can be easily plicated as needed with multiple stitches through a medial parapatellar portal. Knee flexion is limited for 4 weeks after surgery. This technique has been compared with a similar non arthroscopic technique. 22 consecutive patients were operated on for patellar instability. They were divided in two groups: Group A: arthroscopic procedure with a medial parapatellar portal, 11 patients, 1 male and 10 females, mean age 30 years (15-42) and Group B: mini-invasive procedure with a medial parapatellar incision, 11 patients, all females, mean age 25 years (15-36).

The indication for surgical treatment was patellar instability in 19 patients, and recurrent patellar luxation in 3 patients (all in group A).

Results were evaluated with the Fulkerson-Shea scale.

Postoperative results after a mean follow-up of 70 months (57-86). Group A: excellent 10 cases and fair 1. Group B: excellent 10 cases and good 1 with no recurrence of subluxation or luxation. The indication for this simple arthroscopic procedure is patellar instability without distal malalignment. Proximal realignment can be performed safely arthroscopically.
Biomechanical Study and Preliminary Results for a Newly Developed Arthroscopic Coracoclavicular Ligament Reconstruction Using Tendon Graft

Although more than 100 surgical techniques have been reported, there is no gold standard for the treatment of acromioclavicular joint dislocations. Furthermore, many of these techniques replace or reconstruct the coracoclavicular (CC) ligaments with one structure but do not account for the native two bundle anatomy of the CC ligaments. This finding has led us to design a new method of CC ligament reconstruction using an anatomic two bundle CC ligament reconstruction using a three tunnel technique and allograft tissue. The purpose of this study was to evaluate the biomechanical performance of this new double bundle, anatomic reconstruction in cadavers and to show the preliminary short term clinical results of this technique that was applied to patients who had AC dislocation with over grade III in Rockwood classification. Ten cadaveric shoulders were tested using a robotic/UFS testing system with 6-degree-of-freedom universal force/moment sensor (UFS-Model 4015; JR3 Inc. Woodland, CA). Biomechanical properties of the coracoclavicular ligament reconstructions and kinematics of AC joint were tested using this robotic system and compared to measurements from the native coracoclavicular ligaments. The trapezoid ligament had forces of 19.18±16.21 N and 56.03±17.80 N in the anterior and posterior load of 70N, respectively, and was significantly different from the conoid ligament (p=0.0022, 0.0012), which had in situ forces of 52.41±15.90 N and 15.53±18.06 N. The mean anterior, posterior, and superior displacement after anatomical CC reconstruction in cadaver was 7.24±3.24 mm, 6.41±3.67 mm, and 4.29±2.52 mm, respectively. There was no difference compared with the AC deficient shoulder which is defined as a control: p = .9064, .0729, .1328, respectively.

Also our study include 10 symptomatic shoulders( M/F : 7/3) with mean ages of 25.5 years who had X ray evidence of wide AC separation. All patients had painful restricted ROM and tenderness on the AC joint. Our novel technique was used to all patients. The semitendinosis tendon was harvested and passed through the coracoid via a drill tunnel placed at the anatomical footprint of the conoid ligament and then taken superolaterally through the clavicle to reconstruct the trapezoid ligament. Both ends of the tendon graft and the portion of the graft through the coracoid were secured using 5.5x8 mm PEEK screws by means of three point fixation. All patients were submitted to the same rehabilitation program and assessed subjectively and objectively after 3 months of the surgery using VAS, simple shoulder muscle power test, patient satisfaction and radiologic finding. All patients were remained pain-free with significant improved function and very satisfied with the results of this procedure. Mean displacement of distal clavicle on medial tip of acromion in simple shoulder AP radiograph was 2.1±1.8 mm at final follow up. No complication and infection was noted. In conclusion, the conoid and trapezoid ligaments were found to have different roles in horizontal motion of clavicle. Therefore, anatomical double-bundle reconstruction of both ligaments should be considered to properly restore of native kinematics after the AC joint injury.
Arthroscopic Repair of Medial Retinaculum Ruptures Associated with Acute Patella Dislocations

Acute patellar dislocation in athletes is a well-recognized entity that can cause significant impairment both acutely as well as long term. Treatment options for an initial patella dislocation include immobilization, functional treatment or surgical repair. The rationale for each treatment choice is dependent on the nature of the injury; including the associated intra-articular damage, predisposing extensor mechanism malalignment as well the individual surgeon’s preference. In instances when pre-operative evaluation suggests a complete rupture or detachment of the medial retinaculum, surgical repair becomes a viable option. The purpose of this study was to report of a new technique for arthroscopic repair of the medial retinaculum associated with acute patella dislocation using absorbable suture and anchors.

Materials and Methods: Twenty patients with acute patella dislocations presented to our sports medicine clinic. None of the patient had a previous history of patella dislocation but history of subluxation or patella femoral tracking problems was not uncommon. Each injury occurred with the foot firmly planted on the ground and then a violent twisting episode to the affected knee. Each patient reported obvious visual evidence of patella dislocation with immediate onset of swelling. Evaluation in the office revealed a large hemarthrosis and lateral patella tilt with the knee in an extended position. A palpable rent in the medial retinaculum could be appreciated. Plain x-rays revealed a lateral patella tilt without evidence of bony damage. Each patient underwent an MRI, which showed a complete rupture of the medial retinaculum as opposed to a rupture of the medial patella femoral ligament. The decision was made to treat all of the patients who were college and high school athletes operatively. Operative technique involved a diagnostic arthroscopy done with standard anterior-medial and anterior lateral portals. Assessment of associated damage was done. Intra-articular evaluation of both patients revealed a significant hemarthrosis, traumatic chondromalacia of the articular surface of the patella and complete rupture of the medial retinaculum off the insertion into the medial non-articular portion of the patella. The hemarthrosis was flushed using copious amounts of arthroscopy fluid. Mechanical chondroplasty of patella was done using a shaver. Arthroscopic lateral release was accomplished using a radio frequency cautery device. Care was taken to leave all fibres of the vastus lateralis intact. A shallow bony trough was then created along the medial aspect of the non-articular surface of the patella using a round arthroscopic burr. A medial para-patella portal was created and after creating pilot holes, two to three absorbable anchors were placed proximally to distally along the previously created bony trough. Using a suture passer, one arm of the braided suture was passed through the medial retinaculum. This procedure was repeated to create a mattress suture configuration. Arthroscopy fluid inflow was turned off and manual pressure was placed on the lateral aspect of the patella allowing for medial translation. Arthroscopic knot tying was then done through the medial para-patella portal. Excellent re-approximation of the medial retinaculum was noted through a gentle range of motion. Post-operatively the knee was placed into a post-op range of motion brace locked into full extension. Immediate weight bearing was encouraged and limited progressive motion was dialed into the brace starting at post-op week number three. The brace was discontinued at six weeks and aggressive therapy ensued.

Results: At a minimum of 24-month follow-up (range 24-96 months) all 20 patients demonstrated full range of motion and strength, as well as normal sunrise view x-rays. They deny any anterior knee pain or feeling of patella subluxation. There have been no recurrent episodes and 17 of 20 patients have returned to full previous level of sports participation.
Conclusion: This study represents a series of arthroscopic treatment of acute patella dislocations with medial retinaculum ruptures. Patients suffering an acute dislocation of the patella may have a rupture of the medial patella femoral ligament and these patients would not be candidates for this procedure. MRI evaluation to confirm the site of pathology is important before contemplating arthroscopic repair of the medial retinaculum. We believe, however, that when there is a rupture of the medial retinaculum the technique described is easy to perform and has the potential to provide excellent clinical results. It provides the surgeon with a minimally invasive arthroscopic option when encountering the athlete with an acute patella dislocation associated with complete rupture of the medial retinaculum.
MPFL Reconstruction for Patellar Dislocation and Subluxation

We carried out medial patellofemoral ligament (MPFL) reconstructions for patellar dislocation and subluxation, and found that the clinical results are relatively good for long-term follow-up periods. However, some cases did experience a remaining apprehension sign, albeit a small number of cases. We have performed anatomical MPFL reconstructions since 2002. In this study, we will report these results.

From April 2002 until December 2007, we carried out operations on 68 knees from 58 cases (6 - 55 years of age) which had patellar dislocations and subluxations. We carried out first-time MPFL reconstructions on 42 knees from 37 of these cases (8 habitual dislocations, 31 recurrent dislocations, 2 traumatic dislocations, and 1 unstable patella). In the other 25 knees from 20 cases, we carried out first-time MPFL re-suture in 14 knees from 14 cases, the Elmslie - Trillat method in 10 knees from 5 cases, and the lateral release method in one knee from one case. On the remaining one case we performed lateral condyle plasty, because this patient had undergone multiple operations in other hospitals.

Thirty-six from 42 knees which had MPFL reconstruction as their initial operation, have had good clinical results since surgery. However, 6 knees have experienced the lingering apprehension phenomenon. Four of these 6 knees suffered habitual dislocation of the patellae (at the time of operation, two 9-year-old girls, a 12-year-old girl and a 14-year-old boy) and the other 2 knees experienced recurrent dislocation of the patellae (at the time of operation, a 10-year-old girl and a 31-year-old lady). The Elmslie - Trillat method was performed on three knees 1-3 years after their initial operation and re-suture of the reconstructed MPFL was performed on one knee.

The apprehension sign disappeared after the second operation in an additional 4 operated cases. Those cases which had their initial surgery at 10 years of age and suffered from habitual dislocation of the patellae, did not produce good clinical results. This leads us to believe that a patient with habitual dislocation of the patella requires MPFL reconstruction before reaching school age, or else requires two operations, one for MPFL reconstruction and one for distal realignment after bone growth has finished. On the other hand, those patellae which experienced recurrent and traumatic dislocation, had good results after MPFL reconstruction, leading us to the conclusion that MPFL reconstruction is to be recommended.
Conservative Treatment Versus Surgical Treatment (Repair of the Medial Patellofemoral Ligament) in Cases of Acute Luxation of the Patella

The aim of this study was to analyze and compare the results obtained from two types of treatment (surgical or conservative) for treating acute luxation of the patella. Thirty-three patients with acute luxation of the patella were divided into two groups. One group (16 patients) only received conservative treatment (physiotherapy), while the other group (17 patients) was treated surgically. Radiographic examination was performed to investigate any predisposing factors, in accordance with Dejour. The Kujala questionnaire was applied with the aim of analyzing the patients’ improvement in pain and quality of life. The chi-squared, Student t and Fisher tests were performed with a significance level of \( p<0.05 \). The groups were considered to be parametric with regard to age and sex. The conservative group presented a large number of recurrences of luxation (eight cases), while in the surgical group there were no reports of recurrence. Furthermore, the surgical group presented a higher mean score in the Kujala test (91) than did the conservative group (69). We were able to conclude that the surgical treatment produced better results, from analysis of the posttreatment recurrences and the better final results of the Kujala questionnaire.
Incidence and Nature of Simultaneous Anterior Cruciate Ligament Injury and Patellar Dislocation – Analysis of 130 708 Young Adults

Background: The incidence of simultaneous occurrence of anterior cruciate ligament (ACL) injury and patellar dislocation is unknown. Due to spontaneous reduction, a diagnosis of simultaneous patellar dislocation is difficult. This study investigated the incidence and nature of simultaneous occurrence of these injuries.

Methods: Acute ACL injuries and traumatic patellar dislocations were identified from a hospital discharge register. Original hospital data were reviewed to assess patients’ background and injury mechanism. Our sample consisted of 130,708 Finnish conscripts (median age 20, range 17-30 years) and the follow-up covered 96,200 person-years. MRI and arthroscopy data were evaluated to assess injury patterns and concomitant injuries. High-energy poly-trauma patients and total tibio-femoral dislocations were excluded. Isolated ACL injuries served as controls.

Results: Altogether 92 conscripts had ACL injury and 84 had traumatic patellar dislocation, including 6 males diagnosed with simultaneous ACL injury and patellar dislocation. Simultaneous patellar dislocations were associated with 7% (6/92) of all ACL injuries and 13% (3/23) of partial ACL injuries. The incidence of simultaneous ACL injury and patellar dislocation was 6.2 (95% CI: 2.5-13.0) per 100,000 person-years. Concomitant injuries comprised medial collateral injury (1/6, RR 0.73), medial meniscal rupture (1/6, RR 0.53) and lateral meniscal rupture (4/6, RR 2.56), and when compared to isolated ACL injuries, lateral meniscal injury preponderance was noted. Haemarthrosis and fresh medial patellofemoral ligament injuries were identified in all patients. The injury mechanism was a sport-related event with knee valgus stress in all of the cases.

Conclusion: Despite the relatively rare incidence of simultaneous ACL injury and patellar dislocation among young male adults, 7% of acute ACL injuries were compromised by simultaneous patellar dislocation. Signs of patellar dislocation should be evaluated when examining patients with ACL injury. A simultaneous dislocation might also be associated with lateral meniscal rupture.
Local Adherent Technique for Transplanting Mesenchymal Stem Cells as a Treatment of Cartilage Defect

Current cell therapy for cartilage regeneration requires invasive procedures, periosteal coverage and scaffold use. We have developed novel transplantation procedure with synovial mesenchymal stem cells (MSCs) to solve these problems. Full thickness cartilage defects were created in a rabbit’s knee, filled with a cell suspension of 10 million autologous synovial MSCs in 100 µl PBS and left stationary for 10 minutes with the defect upward (local adherent group). As control, either 10 million synovial MSCs in 100 µl PBS were injected intra-articularly, or the defects were left empty. These three groups were compared macroscopically and histologically. The minimum duration for an adequate number of synovial MSCs to attach to the defect was determined through initial ex vivo sequential analysis. In the sequential ex vivo analysis, the attached cell number increased in a time-dependent manner and reached a plateau in ten minutes. In vivo, a large number of transplanted synovial MSCs attached to the defect at 1 day, formed a layer 20 cells deep, and the cartilage defect improved in 24 weeks. The histological score of the local adherent group was consistently better than the scores of the other two groups. The local adherent technique that we developed could achieve successful cartilage regeneration with low invasion, without periosteal coverage, and without a scaffold. This will advance and extend clinical application of MSC-based cell therapy for cartilage injury.
Storage Medium Affects Osteochondral Autograft Plug Diameter

Objectives: Osteochondral autograft transplantation is one of many techniques available to treat focal chondral and osteochondral defects. The storage medium of the graft during the procedure is a subject that has not been specifically addressed. The purpose of this study was to investigate the effect of differing storage medium on osteochondral plug diameter. We evaluated four solution mediums: air, hypotonic (sterile water), isotonic saline (0.9% NaCl), and hypertonic saline (3.0% NaCl). We hypothesized that only plugs in solution would increase in diameter, and that decreased solute levels would result in the largest dilatation.

Methods & Materials: Four osteochondral plugs were acquired from each of 10 fresh calf knees with a 4.5 mm mosaicplasty and randomly assigned to one of the four treatment groups (n = 40). Micro-CT, with a resolution of 46 x 46 x 46 microns, was used to evaluate the precise diameter of each plug. Following a time zero scan (time point 0), each plug was placed in a microfuge tube with the designated solution type and rescanned at 3 time points over approximately one hour. A region of interest of approximately 5 mm was identified from approximately 1 mm to 6 mm proximal to the tidemark. Custom software was developed to automatically calculate the diameter of each plug.

Results: The time zero plug diameter for all specimens was 4.66 ± 0.03 mm, taken at 17.5 ± 11.5 minutes after the time of harvest. There was no significant difference between any of the groups at the time zero scan. There was also no significant change between the time zero and subsequent scans of the dry specimens. However, all of the remaining solutions (hypertonic, isotonic, and hypotonic) resulted in a significant increase in diameter from their time zero scan (p < 0.05). A two-way ANOVA revealed a significant difference between the dry group and the other groups (p < 0.05), but no significant differences between the hypertonic, isotonic, and hypotonic groups.

Conclusions: Placing an osteochondral plug in solution increased the diameter of the subchondral bone. However, there were no statistically significant differences between any of the solution groups. Increases in diameter of the plug may alter the ease of insertion of the graft. Additionally, size increase from the storage medium appeared to level off within approximately 15 minutes of being placed in solution.
Microfracture, Drilling Decalcified Cortical Bone Matrix (DCBM) and Adenovirus-bone Morphogenetic Protein-4 (Ad-BMP4) Act Synergistically to Repair Cartilage Defects

ABSTRACT: We reported a novel technique for articular cartilage repair, consisting of microfracture, a biomaterial scaffold of drilling DCBM and Ad-BMP4 gene therapy. In the present study, we evaluated its effects on the quality and quantity for induction of articular cartilage regeneration.

Introduction: The repair of large area of cartilage defects remains a major obstacle. Many treatments, such as microfracture, biomaterial scaffold or gene therapy have been attempted to utilize. However, the results are not very satisfactoryed: regeneration of fibrocartilage is more than native hyaline articular cartilage.

Materials and Methods: Full-thickness defects were created in the articular cartilage of the trochlear groove of rabbits. Four group were assigned: Ad-BMP4/ drilling DCBM composite (group I); drilling DCBM alone without Ad-BMP4 (group II); DCBM without drilling (group III) and microfracture alone (group IV). Animals were sacrificed 6, 12 and 24 weeks postoperation. The harvested tissues were analyzed by MRI, SEM, histological examination and immunohistochemistry.

Results: group I showed vigorous and rapid repair leading to regeneration of hyaline articular cartilage at 6 weeks and to complete repair of articular cartilage and subchondral bone at 12 weeks. Groups II and III completely repaired the defect with hyaline cartilage at 24 weeks, but group II was more rapid than group III in the regeneration of repair tissue. In group IV the defects were concave and filled with fibrous tissue at 24 weeks.

Conclusion: This composite biotechnology can rapidly and completely repair large areas of articular cartilage defect with regeneration of native hyaline articular cartilage.

Key words: Articular cartilage repair; decalcified cortical bone matrix (DCBM); BMP4
Autologous Matrix-Induced Chondrogenesis (AMIC) –
Treatment of Chondral and Osteochondral Defects in the Knee

Introduction:
Treatment of chondral and osteochondral lesions in the knee joint is a major problem especially in young active patients. Healing of hyaline cartilage is impossible and happens via formation of fibrocartilage. We present our experience of a microfractured defect covered with a collagen matrix (Chondrogide, Geistlich Biomaterials, Switzerland) called Autologous Matrix-Induced Chondrogenesis (AMIC) originally described by Behrens combined with discharging osteotomies. The idea behind is to maintain the stem cells that are mobilised through bleeding in the defect are maintained under the matrix to help to form a regenerate.

Methods:
From August 2003 to July 2007 a number of 56 patients have been treated by AMIC in Fribourg by the senior author. Patients were treated for chondral and osteochondral lesions (OCD) at the knee joint and for OCD of the talus. 38 patients (40 knee joints) with a minimum follow-up of 1 year (9 follow-up 2.5 years, range 1-4 years) underwent retrospective analysis using clinical scores (ICRS, Lysholm). 17 patients had MRI which was analysed by Magnetic Resonance Observation of Cartilage Repair Tissue (MOCART) score. 11 second look arthroscopies were reviewed using the ICRS Cartilage Repair Assessment and Oswestry Arthroscopy Score. 5 biopsies have been examined histologically.

Results:
23 men and 17 women with a mean age of 36 years (range 14 – 64) underwent the AMIC procedure. Patients were treated for OCD (11), femoropatellar (20) and posttraumatic (9) lesions. Defects were located on the medial femoral condyle (16), lateral femoral condyle (3) and femoropatellar defects (21) with a mean size of 3.87cm2 (range 0.72 – 12). ICRS and Lysholm scores improved especially for OCD and femoropatellar lesions. MRI showed 18% complete fillings and 24% by hypertrophy; complete integration to the border zone was observed in 47%, but surfaces were only intact in 12%. Arthroscopically we found good fillings with some hypertrophies, but repair tissue was somewhat softer. ICRS Arthroscopy Score showed a mean of 9/12 and Oswestry a mean of 6/10 points. Histologically all biopsies showed fibrocartilage with some hyaline-like elements.

Conclusion:
AMIC improved the clinical outcome and decreased pain in the cartilage defects treated in this study. Arthroscopy showed good fillings with some hypertrophies. In the MRI the AMIC zone was well integrated to the border zone but filling was mostly incomplete and surfaces damaged. Histology showed fibrocartilage with some hyaline-like elements. Especially in OCD and femoropatellar patients, but less in the purely cartilaginous lesions of the femoral condyle the AMIC procedure is an interesting, one step technique.
Effect of Opening-wedge High Tibial Osteotomy on Three-dimensional Knee Kinematics

INTRODUCTION
Medial opening-wedge high tibial osteotomy (HTO) is a treatment for medial tibiofemoral osteoarthritis caused by varus malalignment. This malalignment shifts the line of action of the ground reaction force relative to the centre of the knee, which increases load in the medial compartment. This increased load is widely believed to be the cause of medial tibiofemoral (TF) OA. HTO restores the line of action to a neutral or slightly lateral position. Consensus has emerged on an optimal range of varus/valgus angular correction, however achieving this correction does not guarantee good clinical results. A key limitation of current assessment that may explain this is that the current standard for assessing tibiofemoral alignment, a standing radiograph, provides a poor assessment of the mechanics of the joint. Three-dimensional measurements of tibiofemoral and patellofemoral kinematics in vivo have recently become available but the effect of opening-wedge high tibial osteotomy on knee kinematics is not clear. Our research question was: how does opening-wedge HTO affect 3D tibiofemoral and patellofemoral kinematics?

METHODS
Three-dimensional tibiofemoral and patellofemoral kinematics were assessed in four subjects before HTO surgery and at 6 months follow-up using a validated MR imaging method (1,2). Ethics board approval was granted and informed consent was obtained from all subjects for this study. Titanium surgical hardware was used for minimum artifact in the images. For each assessment, the subject lay supine in the MR scanner. A high-resolution T1-weighted multilimage scan of the knee was performed in a relaxed position. Low resolution images of the knee were then obtained at six flexion angles (10°−60°) while the subject loaded his/her knee using a specially designed loading rig. Bone was segmented from the images using Analyze. Surfaces (high-res) and contours (low-res) were then imported into MATLAB. The high-resolution models were shapematched to the low-resolution data sets using an iterative closest points algorithm. Anatomical axes were assigned to each bone using anatomical landmarks. Kinematic parameters (rotations and translations) with respect to femur for both tibia and patella were output. Linear best fits were calculated for each parameter with respect to tibial flexion. Slope and intercept were examined using a paired t-test.

RESULTS
HTO significantly shifted the tibia anteriorly through the range of flexion (p<0.05). The average change at 30 degrees was 6.5 mm. Correlation coefficients for the linear fits were r^2 = 0.73-0.98. HTO significantly shifted the patella distally through the range of flexion (p<0.05). The average change at 30 degrees was 1.9 mm. Correlation coefficients for the linear fits were r^2 = 0.92-0.99. Other kinematic parameters were changed following surgery, but the changes were not statistically significant in this small group: tibial adduction, patellar spin, patellar tilt, tibial proximal translation, and patellar flexion. Changes were evident in the patellar parameters spin and tilt, however the r^2 values for the linear fits were low. If there is a consistent pattern in these kinematic parameters, it may be best represented by a higher-order polynomial fit. HTO decreased tibiofemoral adduction (up to 10 degrees) in three subjects, while it remained similar in one subject.
DISCUSSION AND CONCLUSIONS
Tibial anterior translation with surgery is clinically important because it suggests that the contact centers in the tibiofemoral joint may have shifted posteriorly, an outcome thought to be related to changes in tibial slope (3). Anterior translation in this case is not due to a major change in tibial slope: for three subjects direct confirmation was obtained showing tibial slope change was less than 3 degrees.
Distal translation of the patella in opening-wedge osteotomy is consistent with previous work, with an average 14% change in both our study and that by Tigani et al. at 30 degrees (4). Patella infera related to the shortening of the patellar tendon has been problematic in conversion to total knee replacement in closing-wedge osteotomy patients (5). The cause of distal patellar movement in opening-wedge osteotomy with internal fixation is likely due to the geometrical change rather than a change in the tendon, however it is not clear what effect this will have on conversion to TKR.
Decrease in tibial adduction is related to varus angle as measured on standing-film radiographs, and this change is consistent with the objectives of the surgery. In this study we found that opening-wedge HTO is causes an anterior shift of the tibia and a distal shift of the patella over a range of motion. Other kinematic parameters changed, but the results were not significant in this small group. It is clear that standard radiographs do not completely assess the kinematic changes caused by HTO.

REFERENCES

ACKNOWLEDGEMENTS Funding support was provided by CIHR, Canadian Arthritis Network, NSERC and the Michael Smith Foundation.
Biomechanical Stability of Open Wedge High Tibial Osteotomy: Comparison of Two Locking Plates

Purpose: Recently, plates with locking screws have been developed and used for open wedge high tibial osteotomy (HTO) in knee osteoarthritis patients. These plates are believed to achieve more ridged fixation compared with the conventional plates, however, basic studies about biomechanical stability or comparison of the plates are not enough. The purpose of this study was to evaluate and compare biomechanical stability of the currently available two plates using fresh-frozen cadaveric specimens.

Methods: Three paired lower extremities (6 legs) were studied. Soft tissues were removed except the ligaments and the specimens were vertically embedded in steel boxes. A specially designed metal device was fixed on the proximal surface of the tibia and the vertical load could be applied at the tibial lateral plateau through the device. The specimens were placed in a mechanical testing machine (AG-X, Shimazu, Japan) which could measure the applied loads and displacement simultaneously while applying the vertical load precisely. Two locking plates were used for HTO; Arthrex opening wedge plate system (Puddu locking plate) (Arthrex Inc., USA) was a short titanium plate with a spacer to open the osteotomy space, and Tomofix plate (Mathys Inc., Switzerland) was a long and T-shaped titanium plate. A standardized medial open wedge osteotomy technique was used with the lateral tibial cortex spared. The axial compression load was applied to each intact bone from 0N to 550N at a rate of 1 mm/min. Then HTO was performed and the same test was repeated. Finally, the compression load was applied until failure. One leg of a specimen was fixed with the Puddu locking plate and the other side of the leg was fixed with the Tomofix plate to compare the data of the two plates in the same specimen. The load-displacement data were analyzed for each condition to calculate stiffness and the failure load, and a description of the fracture was recorded.

Results: The mean value of stiffness was 1432.5 N/mm in the intact bones. Stiffness decreased after HTO with the Puddu locking plate (583.9N/mm) or the Tomofix plate (792.6N/mm). In the failure test, failures resulted in bone fracture at the lateral spared cortex of the osteotomy level.

Discussion: This study will provide important information for the consideration of implant selection, modification of the procedure, and the rehabilitation program.
Effect of a Biplanar Osteotomy of Primary Stability Following High Tibial Osteotomy

Open-wedge high tibial osteotomy (HTO) is becoming increasingly popular for the treatment of varus gonarthrosis in the active patient. Various implants can be used that differ with regard to fixation stability, design and osteotomy technique. The use of a rigid plate fixator in conjunction with a biplanar osteotomy is reported to offer excellent clinical results. Clinically, it is hypothesized that the biplanar osteotomy increases primary stability in the sagittal plane thus promoting bone healing. So far, there are no biomechanical studies that quantify the stabilizing effect of a biplanar versus uniplanar osteotomy.

24 fresh frozen human tibiae were mounted in a metal cylinder and open wedge osteotomy (10°) was performed in a standardized fashion. Proximal and distal tibial segments were marked with tantalum markers of 0,8 mm diameter. Two different plates with locking screws were used for fixation: a short spacer plate (group 1, n=12) and a plate fixator (group 2, n=12). In 6 specimen of each group a biplanar V-shaped osteotomy with a 160° angulated anterior cut behind the tuberosity parallel to the ventral tibial shaft axis was performed. In the remaining 6 specimen of each group, a simple uniplanar osteotomy was performed in an oblique fashion. Axial compression of the tibiae was performed using a materials testing machine under standardized alignment of the loading axis. Load-controlled cyclical staircase loading tests were performed. Specimen were x-rayed simultaneously in 2 planes together with a biplanar calibration cage in front of a film plane with and without load after each sub cycle. Radio Stereometric Analysis (RSA) allowed for serial quantification of plastic and elastic micromotion at the osteotomy site reflecting the stability provided by the combination of implant and osteotomy technique.

No significant additional stabilizing effect of a biplanar osteotomy in craniocaudal and mediolateral plane was found in any specimen. However, additional stability was present in anteroposterior and all rotational planes in those specimen fixated with a plate fixator.

In implants with a high degree of primary stability, the additional stabilizing effect of a biplanar osteotomy did not come into effect in our biomechanical set up. In short spacer plates the fixation stability was significantly increased in AP and rotational planes. Clinically, the V-shaped osteotomy is beneficial for all HTO patients since it promotes bone healing. Biomechanically, biplanar osteotomy is mandatory for shorter plate designs to increase stability prior to bone healing.
Relationship Between Anatomical References and Sagittal Mechanical Axes of Computer Assisted Navigation for Total Knee Arthroplasty

Background:
Whereas the application of computer assisted navigation (CAN) to total knee arthroplasty (TKA) has been documented to improve the coronal alignment of limb and prostheses, varying results have been reported regarding sagittal alignment and even the reference to measure the sagittal alignment has not been universally agreed. Current CAN systems rely on the sagittal mechanical axis calculated from the hip and distal femur centers identified by the system. Two different sagittal mechanical axes are utilized in the current CAN systems, but there is little information of the association between the anatomical (radiographic) landmarks and the sagittal mechanical axes. This study was conducted to determine the relationship between the anatomical landmarks and the two mechanical axes used in CAN-TKA. We also attempted to determine whether the degree of femoral anterior bowing influence the relationships.

Methods:
In 200 knees of which true lateral radiographs were available, the angles between two anatomical references [anterior cortical line (ACL) and mid-medullary line (MML)] and two sagittal mechanical axes (MA1 and MA2) commonly used in current CAN systems. MA1 was defined as the line from the center of the femoral head to the point 1 cm anterior to the Blumensaat’s line. MA2 was defined as the line from the center of the femoral head to the point 65% posteriorly from anterior cortex of the distal femur to the most prominent medial posterior femoral condyle. A negative value was given to the knee where the mechanical axes were oriented in extended position with reference to the anatomical references. The degree of femoral anterior bowing was represented as the angle between the anterior cortical lines of the distal and proximal femur. Correlation analyses were carried out to determine whether the degree of femoral anterior bowing was associated with the angles between the anatomical references and the mechanical axes.

Results:
The mean angles between the MA1 and ACL was 1.2° (SD = 1.8) whereas the mean angle between the MA2 and ACL was -1.2° (SD = 1.6). The mean angle between the MA1 and the MML 2.6° (SD = 1.6) and the mean angle between the MA2 and the MML was -0.2° (SD = 1.6). Wide ranges were identified for all angles: MA1 vs. ACL, -2.6° – 6.7; MA2 vs. ACL, -4.9 – 3.7; MA1 vs. MML, -0.6 – 7.3; and MA2 vs. MML, -4.1 – 4.1. There was significant positive correlation between the degree of femoral anterior bowing and the angles between the anatomical references and the sagittal mechanical axes (correlation coefficients = 0.73 – 0.81).

Conclusions:
This study documents the relationship between the anatomical references and the two sagittal mechanical axes commonly used in the current CAN-TKA systems. We also found that the angles between the anatomical references and the mechanical axes were positively correlated and that wide variations existed in the angles. This information should be used to improve the algorithm of the current CAN systems and to administer the CAN technology optimized for each individual.
Robotic Total Knee Arthroplasty with Minimal 2 Years Follow-Up

Purpose:
Navigated TKA still depends on the use of cutting blocks and oscillating jigs which could result in inferior bone resection. To further improve the accuracy of implant alignment and bone resection, robotic systems for TKA have been developed. Only few data exist concerning outcomes after total knee arthroplasty (TKA) using a surgical robot. We conducted this study to evaluate the clinical and radiographical results in robotic-assisted implantation of TKAs with a minimum follow-up of two years.

Materials and Methods:
We have studied 50 primary TKAs which conducted using ROBODOC® (Integrated Surgical Systems, Sacramento, CA, USA) from July 2004 and September 2005 that enabled to follow-up at least 2 years. The radiographic measurement with regard to the change of mechanical axis, and the inclination of the femoral and tibial components were assessed. We evaluated clinical results with the range of motion (ROM), Hospital for Special Surgery (HSS) scores, and Western Ontario and McMaster University (WOMAC) scores.

Results:
The average operative time was 102 minutes (range 85-122 minutes) base on the tourniquet time. The mechanical axis was changed from 6.57° varus to 0.49° valgus. Mean coronal inclination of the femoral and tibial component were 89.52° and 90.12° at the last follow up. There were no outliers and 96% of them were classified as excellent Also, mean sagittal inclination of the femoral and tibial component were 1.06° and 85.56°. All prostheses had no radiolucent lines at the last follow up. On the clinical assessment, the range of motion improved from 124.9° to 128.4°, and the improvement of HSS score and Womac score were 70.06 to 95.72 and 65.64 to 28.92 in each. No major adverse events related to the use of the robotic system have been observed. However, one case of the formation of seroma around the pin track and two cases of the partial abrasion of patellar tendon occurred in relation to procedures.

Conclusion:
A surgical robot system in TKAs provides good clinical and radiographical results at least 2 years follow-up. A clear advantage of robot-assisted TKA seems to be ability to execute a highly precise preoperative planning and intraoperative procedures which result in excellent alignment.
A Novel Method to Solve Disparities Between Radiographic and Navigational Measurements of Limb Alignments in Computer Assisted Total Knee Arthroplasty

Background:
Application of computer assisted navigation (CAN) has been documented to improve the accuracy of limb alignment and implant positioning. However, a recent study reported that a great deal of disparities occurred between the radiographic and navigational measurements calling the basic argument for application of CAN to TKA into question. In the authors’ practice using CAN for TKA, we have observed consistent disparities between the preoperative radiographic assessments and intraoperative navigational assessments of limb alignment in the coronal plane. A large disparity between radiographic and navigational assessments of limb alignment would be presenting a challenging question whether or not the surgeon can rely on the information provided by the CAN system. We developed a novel method to measure the coronal limb alignment and have found that the radiographic measurements with the novel method remarkably reduce the disparities between the radiographic and navigational assessments of the coronal limb alignment. This study was conducted to document the existence of the disparities between the radiographic and navigational assessments of the limb alignment and the value of our novel method to perform preoperative radiographic measurements of limb alignment.

Methods:
In 107 TKAs performed using a CAN system (Orthopilot: B.Braun-Aesculap, Tuttlingen, Germany), radiographic assessments of coronal limb alignment were assessed using preoperative and postoperative whole limb radiographs taken with weight bearing with two different methods: a standard method, angle between the femoral mechanical axis (the line connecting hip center and the top pint of the femoral intercondylar notch) and a tibial mechanical axis (the line connecting the mid-point between the medial and lateral tibial eminences and the mid-point of the talus dome) and a novel method, the angle between the weight loading line (the line connecting the hip center and the mid-point of the talus dome) and the tibial mechanical axis. A negative value was given to a varus alignment and a positive value to the valgus alignment. During surgery, the coronal limb alignment was measured by the navigation system two different time-points: after registration and after implantation of prostheses. The disparity between the radiographic and navigational assessments was calculated with subtracting the radiographic assessments by the navigational assessments.

Results:
The disparity between the radiographic and navigational assessments was significantly smaller with the novel method than with the standard method. The mean difference between the radiographic and navigational assessments of preoperative limb alignment was -6.5o (range: -19 ~ 1) with the standard method and -0.9o (range: -8o to 4o) with the novel method. The mean difference between the radiographic and navigational assessments of the postoperative limb alignment was -1.96 (range: -11 ~ 3) with the standard method and -1.3 (range: -6 ~3).

Conclusion:
This study documents that a wide range of disparities occurs between the radiographic and navigational assessments of limb alignment and the amount of disparity occurs in preoperative assessments. Our findings indicate that our novel method to perform the radiographic assessments of limb alignment can be a useful tool to interpret the information intraoperatively given by the navigation system.
Navigated Minimal Invasive Unicompartmental Knee Replacement

INTRODUCTION:
We wanted to compare the accuracy on implantation on post-operative X-rays of two series of UKR implanted with the same navigation system and with either conventional of minimal invasive approach. We hypothesized that the use of the minimal invasive approach will decrease the accuracy of the procedure.

MATERIAL AND METHODS:
We conducted a prospective, controlled, observational study. Inclusion criterion in the study group was the minimal invasive, navigated implantation of a Univation ® UKR (Aesculap, Tuttingen, FRG) for primary varus gonarthrosis between October 2005 and October 2006. There were no exclusion criteria. The historical control group consisted of patients who underwent a conventional navigated implantation of a Search ® UKR (Aesculap, Tuttingen, FRG) between April 2004 and September 2005. All implantations were performed by the same experienced knee reconstruction surgeon (JYJ).

The same navigation system is used in both groups, an intra-operative non-image based one (OrthoPilot ®, AESCULAP, Tuttingen, FRG).

The accuracy of implant positioning was determined using pre-discharge standard antero-posterior and lateral radiographs.
Both UKR were expected to be implanted as follows: coronal mechanical femoro-tibial angle between 0 and 5° of varus, coronal orientation of the femoral component of 90°±3° (for control group) or 80°±3° (for study group), sagittal orientation of the femoral component of 90°±3°, coronal orientation of the tibial component of 90°±3°, sagittal orientation of the tibial component of 87°±3°. When the measured angle was in the expected range, one point was given. The accuracy note was defined as the sum of all points given for each patient, with a maximum of 5 points (all items fulfilled) and a minimum of 0 point (no item fulfilled).
The primary criterion was chosen to be the radiological accuracy note for the post-operative X-ray evaluation. We compared all criteria between the two groups with a Student t-test (means) and a Chi² test (percentages) at a 0.05 level of significance. Post-hoc calculation assessed that the data allowed a power of 0.20 to detect a 0.6 point decrease in the mean accuracy note in study group in comparison to control group.

RESULTS:
120 cases were enrolled in the study: 60 in the study group and 60 in the control group. There were 42 male (35%) and 78 female (65%) patients, with a mean age of 65 ± 6 years (range, 44 to 87) at the time of surgery. Mean BMI was 29.5 ± 8.2 (range, 22 to 46). Pre-operative pain KSS was 55 ± 11 points (range, 23 to 79) and pre-operative functional KSS was 60 ± 12 points (range, 45 to 90). Pre-operative coronal mechanical axis was 7.5° ± 4.8° (range, 2° to 19°). Pre-operative Ahlback grading showed 53 grade 2 (44%), and 67 grade 3 (56%) knees. There were no significant differences in all pre-operative parameters between the two groups.
The mean accuracy note was 4.2 ± 1.2 (range, 2 to 5) in the control group and 4.1 ± 0.8 (range, 2 to 5) in the study group (p > 0.05). 36 cases (60%) of the control group and 37 cases (62%) of the study group had the maximal accuracy note of 5 points (p > 0.05).
DISCUSSION:
Our study hypothesis was rejected: we observed no significant decrease in the accuracy of a navigated implantation of an UKR with a minimal invasive approach in comparison to the conventional one. The navigation system used allowed avoiding any loss of accuracy due to the minimal invasive approach to the knee joint. This study was designed to document the radiological accuracy of implantation. We did not analyze the issue of possible quicker rehabilitation after minimal invasive implantation, because our rehabilitation protocol changed between the two periods of time for control or study group. A specifically designed study should be promoted in the future.

CONCLUSION:
Navigated minimal invasive technique for UKR proved to be effective. The concern about a possible loss of accuracy was actually addressed by the navigation system. More long term information must be collected. However, this technique is currently the routine way of implanting UKR at our institution.

Introduction: The goal of the study was to validate a computer assisted method to assess anterior and rotational laxities during manual Pivot-shift testing with and without anterior cruciate ligament rupture and during complete range of motion in flexion and extension. Furthermore the kinematic variability between different knees should be evaluated.

Method: 9 knees from 6 cadavers were tested by 4 different surgeons before and after arthroscopic ACL resection. A Computer Assisted Surgery system (Kneetrac, Stryker, Pusignan, France) was used to assess the motion of the tibia in relation to the femur during the tests. Rotational laxity and anterior laxities in both tibiofemoral compartments were evaluated under the following conditions: gravity, with a constant anterior load of 100 N, with internal and external torque of 5 Nm and with manual Pivot-shift test. The data were analyzed with a factorial analysis of variance with repeated measures.

Results: A significant variability of knee kinematics could be found between the different specimens. The variation of knee kinematics during flexion/extension movement differed significantly before and after ACL resection (p<0.001 Eta2 = 0.407). A significant increase of anterior laxity could be confirmed during the manual Pivot-shift test after ACL resection. The effect on rotational laxity occurred especially between 10° and 40° (p<0.001 Eta2 = 0.195). The manual perception of the “shift” was expressed by a fast decrease of anterior laxity and internal rotation at 33° +/- 9° of knee flexion. Compared to the evaluation with an isolated anterior load (anterior drawer) or isolated rotational stress, the pivot shift test represents the most reproducible assessment of the absence of an ACL between different knees, even if the anterior laxity is also very high with anterior stress (p<0.001 Eta2 = 0.840).

Conclusions: 1. Computer assisted surgery systems allow for a precise and reproducible evaluation of knee kinematics in ACL intact knees and after ACL resection. 2. The results showed a high variability of knee kinematics of the different specimen. 3. Analysis of the Pivot-shift showed a high interexaminer variability with respect to the amount of tibiofemoral displacement. 4. Despite this variability, the shift occurred in all knees and with all examiners at a knee flexion angle of 33°+/-9°. The pivot shift is the most sensible clinical test for detection of ACL tears.
In anatomic double-bundle ACL reconstruction, it is technically demanding even for experienced surgeons to place two femoral tunnels within ACL attachment. We describe a technique using three-dimensional (3D) fluoroscopy-based navigation system to place two femoral tunnels accurately during anatomic double-bundle ACL reconstruction. After a reference frame is rigidly attached to a femur, intra-operative 3D image of the distal femur was obtained with C-arm of Arcadis Orbic (Siemens, Germany). The image was transferred to a navigation system (StealthStation navigation system, Medtronic, Louisville, CO) and reconstructed into a 3D image of the distal femur. During placement of guide wires for femoral tunnels through an accessory medial portal, a femoral guide with a tracker feed backed surgeons the direction of the guide wire on the 3D femur bone surface image with real time fashion. The femoral guide was placed at the center of the footprint with help of visual guidance of the navigation as well as an arthroscopic view. Then, flexion angle of the knee was adjusted to prevent posterior blowout on the computer screen during insertion of the guide wire. The length of the femoral tunnel could also be estimated before over drilling the guide wire. This technology assists surgeons to place two femoral tunnels precisely without any complication during anatomic double-bundle ACL reconstruction.
Navigation Evaluation of Pivot Shift During Anatomical Double-bundle ACL Reconstruction

OBJECTIVE:
Anterolateral rotatory instability (pivot shift) causes disability in anterior cruciate ligament (ACL) deficient knees, and sometimes even in ACL reconstructed knees. Therefore the interest that double-bundle ACL reconstruction (DB-ACLR) that reproduces anteromedial (AM) and posterolateral (PL) bundles of the ACL has risen. However, it is still unknown which of the AM and PL bundle is more important to prevent pivot shift phenomenon. The purpose of this study was to assess which bundle prevents pivot shift during DB-ACLR using a navigation system.

MATERIALS AND METHODS:
Eighty patients, who received DB-ACLR using a navigation, were included in this study. Their mean age was 21.3 years. During DB-ACLR, pivot shift tests were performed four times at before reconstruction, and at after only PLB fixation, only AMB fixation, and both PLB and AMB fixation. Tibial internal rotation and anterior translation were measured at each phase by the additional functions of the navigation. The navigation system used in this study was OrthoPilot ACL ver 2.0 (B/Braun Aesculap, Germany), which was image-free navigation.

RESULTS:
Before ACL reconstruction, tibial internal rotation and anterior translation were 22.9±7.6° and 5.4±2.5mm. After PLB fixation, internal rotation and anterior translation significantly decreased to 19.5±7.5° and 2.2±0.9mm. After AMB fixation, they both decreased to 21.6±6.7° and 2.4±0.9mm. After PLB and AMB fixation (DB-ACLR), these data were improved to 19.0±7.3° and 2.0±0.7mm.

CONCLUSIONS:
Although it is well known that the ACL is a primary restraint of the knee under anterior tibial load, the role of the ACL in resisting internal tibial torque and the pivot shift test is controversial. To our knowledge, this is the first study which assess the functions of AM and PL bundle of ACL to prevent pivot shift phenomenon in vivo. Our data indicate that both AMB and PLB play a role in restraining not only anterior translation but also internal rotation during pivot shift test, and DB-ACLR improves knee stability. These findings are also consistent with previous in-vitro biomechanical studies, which measured in-situ forces of each bundle of the ACL.
Measurement of Anteroposterior and Rotational Stability of Knee using Navigation System

Purpose: The aim of study was to provide normal value of anteroposterior and rotational stability of knee joints using navigation system.

Materials and Methods: From March 2007 to November 2007, 35 patients (23 men, 12 women) with a mean age of 36.1 (16-57) years, who were treated with arthroscopy, without ligament injury of knee were included in our study. We measured amount of anteroposterior displacement and rotation of the knee in 0, 30, 60 and 90 degrees of flexion position using Orthopilot navigation system. All tests were performed by same single surgeon under manual maximal force.

Results: The mean anterior displacement was 3.7±2.0, 6.6±2.2, 5.8±2.0 and 4.7±1.8 mm in 0, 30, 60 and 90 degrees of flexion respectively. The amount of anterior displacement at 30 degree of flexion was significantly larger than those of other degrees. The mean posterior displacement was 2.0±0.5, 2.2±0.4, 2.1±0.4 and 2.0±0.6 at each degree. There was no statistical difference in posterior displacement. The mean internal rotation was 10.3±2.7, 14.6±3.3, 16.2±2.9 and 15.0±4.3 degree at each degree. The amount of internal rotation at 0 degree of flexion was significantly smaller than those of other degrees. The mean external rotation was 8.4±3.4, 16.5±3.3, 13.3±3.8 and 15.0±4.3 degree at each degree. The amount of external rotation at 0 degree of flexion was significantly smallest and that of 30 degree was largest.

Conclusion: In the measurement of laxity using navigation, we could acquire previously mentioned results. The measurement of stability of knee will be useful in diagnosing ligament injury and evaluating degree of postoperative symptomatic improvement.
Minimally Invasive Total Knee Replacement Does Not Reduce Surgical Stress Response

Introduction
The stress-response to surgery, known as a variety of well-characterized hormonal, metabolic, haematological and immunological changes, may be smaller in less invasive operations. Decreased blood loss, less soft tissue damage and inflammation leading to fast recovery are arguments used in promoting minimal invasive surgery (MIS).

Purpose
Does MIS TKR with the subvastus approach lead to less inflammation and muscle damage than conventional TKR with the medial parapatellar approach?

Material and methods
Inflammation parameters (IL-6, IL-8 and IL-10, and CRP), muscle damage parameters (myoglobin, CK) and Hb values were determined preoperative and at 5 moments postoperative in 41 patients. Twenty patients operated through a MIS subvastus approach were compared to 21 patients with the standard medial parapatellar approach.

Results
Average age in was 69.2 yrs in conventional TKR (contr) versus 68.9 yrs in MIS. The Hb levels were 13.9 g/dl preoperative and decreased to 10.8 g/dl (contr) and 11.6 g/dl (MIS) 72 hours postoperative.
The mean IL-6 concentration increased from 6.8 (contr) vs 1.3 (MIS) pg/ml to 68.8 (contr) vs 45.1 (MIS) pg/ml 6 hours postoperative. The mean myoglobin concentration increased in TKP group from 47.7 ug/l preoperative to 90.1 ug/l 6 hours postoperative, the values for MIS were 27.8 µg/l preoperative and 202.3 ug/l 6 hours postoperative, with significant differences at 2, 4, 6 hrs and day 1 post-operative.

Conclusion
Haemoglobin levels show no significant differences between conventional and MIS approach. Inflammation parameters were not significant different between the two groups. Myoglobin was the only muscle damage parameter with significant differences on several time points between both approaches. This may be explained by the used forces on surrounded tissues. The retractors are necessary to visualise the knee joint in MIS. These results show a trend towards more muscle damage compared to conventional TKR.
MIS versus Standard TKR: A Prospective Randomized Double Blinded Study Comparing Postoperative Strength and Functional Recovery

Introduction: Advantages of MIS TKR include less postoperative pain and improved early range of motion. However, all studies to date are either retrospective or at best prospective comparisons with matched controls and as such fail to control for patient expectations/placebo effect and in many cases selection bias. The purpose of this study was to determine whether the MIS midvastus approach to TKR resulted in quantitative differences in quadriceps muscle strength as well as the previously cited advantages.

Methods: Sixteen patients (32 TKR’s) scheduled to undergo bilateral TKR were randomized to undergo a mid-vastus MIS on one knee and a standard quad-splitting approach on the other. The length of the skin incisions were made the same allowing for both patients and investigators to be blinded. The primary outcome was post-operative strength as determined by Biodex isokinetic and isometric peak torque testing. Secondary outcome measures included range of motion, pain visual analog scores, and gait analysis. Outcomes were assessed preoperatively and on postoperative day 1, 2, 3 and week 3, 6 and 12.

Results: The only significant difference in strength testing was an increased isokinetic extensor torque at the 3 week postoperative time point for the MIS midvastus approach. No other significant differences were observed. No differences between the MIS midvastus and standard approach were observed for stride length, stance time, pain VAS, or knee range of motion at any of the time points.

Conclusions: There appears to be limited benefit of the MIS mid-vastus approach compared to the standard approach for TKR.
Clinical Results of MIS-UKA at Five-years Follow up

Background
Since the introduction minimally invasive techniques, interest in unicompartmental knee arthroplasty (UKA) has rapidly increased. This minimally invasive technique preserves the anatomy of the knee with less damage, less morbidity, and quicker post-operative recovery. The aim of our study was to assess the mid-term outcome of MIS-UKA, comparing with the clinical outcome of conventional UKA.

Patients and Methods
From 1989, 132 Miller-Galante UKA (MG-uni) were implanted by single surgeon. 84 knees from 61 patients were performed by conventional technique (conventional group: C group). From 2001, 31 knees from 48 patients were performed by minimum invasive technique (MIS-uni group: M group) The clinical outcome (Knee society scores), range of motion, and radiographic findings were compared between the two groups at 1, 3, and 5 years after UKA. No differences were found regarding age(C group: 76.9 +/- 4.3 y.o. , M group: 76.0 +/- 4.3 y.o ) height, weight, Knee Scores,(C group: 38.8 +/-16.2 point. , M group:34.8 +/- 14.3 point), FTA, and ROM.

Results
There was no complication related to surgical error and no loosened implant both C-group and M-group. The implant survival rate was 100%. There was no significant difference of the mean of ROM between two groups at any point after UKA. However, there was significant difference of Knee score at 5 years after UKA(C group: 97.1 +/-4.9point. , M group:93.9 +/- 7.9point, p < 0.05) The reason of this difference was FTA, because most FTA of M-group was right angle to avoid overcorrection. No difference were found regarding X-ray evaluation.

Conclusion
This study indicates that MIS-uni had the excellent clinical results at midterm follow-up as the conventional UKA. Our data suggests that MIS-uni would be able to expect good long term clinical outcome and would be the reasonable solution in elderly patients.
MIS + CAS in Knee Replacement: Bi-unicompartmental (BUR) vs Total Knee (TKR) - A Matched Paired Study

Introduction:
Since 2002 we have been performing computer assisted BI-UKR on high-selected patients with bicompartamental tibio-femoral knee arthritis. All patients referred an asymptomatic patello-femoral joint. Aim of this study is to compare, in a matched-paired study, the results of this procedure to MICAS-TKR (mini invasive computer assisted surgery).

Materials and Methods:
From January 2002 to October 2004, 21 patients with bicompartamental tibio-femoral knee arthritis who underwent to computer assisted BI-UKRs were included in the study (group A). No patient had any clinical evidence of ACL laxity or flexion deformity and all had a preoperative range of motion of a least 110°.
At a minimum follow-up of 2 years, each patient in group A was matched with a patient who had undergone a computer assisted TKR for bicompartamental tibio-femoral knee arthritis between July 2000 and November 2004 (group B). Patients were matched in terms of pre-operative arthritis severity, age, gender and pre-operative range of motion. Preoperatively all the knees were evaluated according to both the Knee Society and the GiUM score

Results:
At the latest follow-up no statistically significant difference was seen for the Knee Society score between the 2 groups. The mean Functional score was 83.5 (range: 73-100) for group A and 78.79 (range: 59-90) for group B. A statistically significant difference was seen for the Functional score with superior results for group A (p=0.01).
A statistically significant difference was seen for the GIUM (Italian UKR Group Study Score, more demanding for uni replacement) score with better results for group A (p=0.02). No poor or abnormal results were seen in either group with no statistically significant difference in terms of percentage of results (p=0.38).

Discussion:
Current patient expectations following knee replacement surgery include a knee that resembles normal and allows an unrestricted active life. At a minimum follow-up of 2 years all patients with BI-UKR had improved. The functional and GIUM scores showed statistically significant improvement in BI-UKR group.
The results of this preliminary study suggest that BI-UKR is a viable option for bicompartamental tibio-femoral arthritis in selected cases as well as TKR.
**Efficient Inhibition of Wear Debris-induced Osteolysis by Lentivirus-mediated siRNA Locally Administered in Murine Air Pouch**

**Purpose:** The purpose of this study is to determine the safety and efficacy of local administration of lentivirus-mediated small interfering RNA (siRNA) targeting tumor necrosis factor-a (TNF-a) in a modified murine air pouch model of wear debris-induced osteolysis, which causes aseptic loosening of prosthesis.

**Methods:** Air pouches were established on the back of BALB/c mice, followed by the surgical introduction of a section of calvaria from a syngeneic mouse donor, and all pouches were stimulated by ultrahigh molecular weight polyethylene (UHMWPE) particles. Pouches were divided into 3 groups randomly, and lentivirus-mediated siRNA targeting TNF-a, lentivirus-mediated missense (MS) siRNA and saline were injected into pouches respectively. The lentiviral vector was designed to express the enhanced green fluorescent protein (EGFP) as a marker gene. Pouch membranes and lavage fluid were harvested at 7 and 14 days post transfection, and assayed for markers of osteolysis using histological, molecular, immunological techniques and Xenogen IVIS 50 vivo bioluminescent assay system.

**Results:** Xenogen IVIS 50 vivo image revealed strong expression of EGFP localized in pouch areas and no expression in other parts of mice both in TNF-a siRNA-treated and MS siRNA-treated pouches for up to 2 weeks, indicating stable transfection of lentivirus-mediated siRNA, while no expression of EGFP was found in untreated pouches. Realtime-PCR and ELISA revealed a significant reduction of TNF-a both at the mRNA and protein level in TNF-a siRNA-treated pouch membranes and lavage fluid compared to MS siRNA-treated and untreated pouches for up to 2 weeks, whereas TNF-a level in peripheral blood, liver, spleen, kidney, lung and brain remained invariant. The gene therapy also resulted in prominent diminution of IL-6, Cathepsin K, RANK and RANKL expression. Less inflammatory responses (thinner pouch membrane and decreased cellular infiltration) and less bone collagen loss were observed in TNF-a siRNA-treated pouches. Tartrate-resistant acid phosphatase (TRAP) staining showed prominently less osteoclastogenesis in TNF-a siRNA-treated pouches.

**Conclusion:** Efficient local delivery of lentivirus-mediated siRNA targeting TNF-a into modified murine air pouch inhibits debris-induced osteolysis with no systemic adverse effects, and might be an excellent therapeutic candidate to prevent or retard the osteolysis response to wear debris that contributes to the pathology of aseptic loosening.
Use of Anti-apoptotic Treatments to Prevent Cartilage Degradation
In Vitro After Acute Trauma to Human Ankle Cartilage

Purpose:
Our study was aimed to investigate if anti-apoptotic agents (non-ionic surfactant P188 and inhibitors of caspase 3 and 9) could delay or reduce cartilage degeneration after a single impact to human cartilage.

Methods:
Seven fresh human normal tali (cartilage with bone attached) were impacted with a nominal stress of 25-30 MPa. Cartilage from both left and right ankles was used; one served as un-impacted control and the second was impacted with a 4mm indenter. Full thickness 8mm cartilage plugs that consisted of impacted (4mm core) and immediately adjacent (4mm ring) areas were removed and were collected right after injury at day 0 for the assessment of cell viability by live/dead assay, apoptosis (Tunel Stain) and histology with Safranin O staining. Others were divided into four experimental groups: 1) media control; 2) P188 (8mg/ml); 3) anti-caspase 3 (10 uM); and 4) anti-caspase 9 (2 uM). All agents were kept in culture for 48 hours, after which the media was replaced with fresh media only. The effect of treatments was assessed at days 0,1,2,7 and 14 post injury. At each time point histological assessment with a modified Mankin score and % of viable and apoptotic cells were evaluated in the superficial and middle-deep layers separately. PG content in the media with DMMB assay was performed as a marker of cartilage degradation.

Results:
An impact to articular cartilage caused cell death by necrosis and apoptosis which at early time points was primarily evident in the superficial layer. Thus at day 2, the treatment with P-188 showed significantly less apoptotic cells in the superficial layer of both core and ring areas (13% ±0.58 and 9%±4.8 respectively) in comparison to the non-treated group (33%±5.49 and 30%±0.53 respectively, p<0.01); the differences in the middle and deep layers were insignificant between treated and non-treated groups. With culture, the differences between P-188 treated and non-treated control samples became less dramatic, although the percentage of apoptotic cells in the P188 treated group remained significantly lower than in the non treated group in both core and ring areas in all three cartilage layers (treated core: 1.21 fold increase and ring 1.38 fold increase vs non treated core: 1.62 fold increase and Ring 1.5 fold increase). In the same P-188 treated group significant increase in cell viability was seen in the superficial layer at day 2 (66% ±5.8%) in comparison to non-treated (45% ±0.5%, p<0.01) and at day 14 when all layers were analyzed together (69%±4% vs 47% ±9.8% respectively, p<0.001). Caspase 3 inhibitor also significantly reduced the number of apoptotic cells, but the most pronounced effect was found at day 14. For all layers it constituted 28%±4% (core) and 30%±1.6% (ring) vs 39%±0.5% and 42%±2.96% respectively in the untreated samples (p=0.006). Caspase 3 inhibitor also affected cell survival in a similar manner: at day 14 after the impact there was 71%±2.9 of live cells vs 47±9.8 in the untreated group (p<0.01). Caspase 9 inhibitor had no effect on cell death by apoptosis at early and late stages of the experiment; However, it affected cell survival by necrosis at day 2 in the superficial layer (61% ±1.15 vs 45±0.5 in the non-treated control, p<0.05) and in the middle and deep layers at day 14 (85%±1.15 vs 68±10 in the non-treated control, p<0.01).The core area from P-188 or caspase 3 inhibitor treatment groups had an improved Mankin score as compared to the non-treated control (4±0.5, 4±0.8, and 7 ±0.5 respectively). Similar results were observed for the ring area. Caspase 9 inhibitor did not improve histological appearance of cartilage samples. Only P188 treatment significantly reduced the amount of PG released into the media at all time points.
Conclusion:
This study showed that P188 and caspase 3 inhibitor were effective in promoting chondrocytes survival and protecting cartilage from degeneration. Combination of this and anabolic treatments may have a potential as a therapy for cartilage repair.

Significance:
These novel results obtained on human cartilage suggest possible interventions after acute trauma that may prevent post-traumatic osteoarthritis.
Increased Expression of Tenascin-C in Osteotendinous Healing Junction under Mechanical Strain

Introduction
The developments of the fibrocartilage in musculoskeletal organs are strongly related the mechanical strain, however, the influence of mechanical strain on fibrocartilage zone regeneration and remodeling during osteotendinous junction repair are currently poorly understood (1). In present study, the expression of tenascin-C and transforming growth factor – β 1(TGFß1), two key factors involved in strength and elasticity of extracellular matrix remodeling (2,4), were examined in the healing osteotendinous junction under controlled mechanical loading through quadriceps muscles tension induced by functional electric stimulation (FES) by using our established partial patellectomy model in rabbits (5).

Materials and Methods
Standard transverse osteotomy was performed between the proximal 2/3 and the distal 1/3 of the patella, and distal 1/3 of the patella was excised. The patellar tendon was directly sutured back to the proximal remaining patella while protected with a ‘figure of eight’ tension band wire. The knee was immobilized with long leg cast in 90° of knee flexion, 21 rabbits were randomly divided into two groups. The controlled mechanical strain generated from quadriceps muscle contraction induced by FES was applied on the healing patella–patellar tendon junction for 30 minutes per day, 5 days per week for 6 weeks in FES group compared with non-mechanical loading in control group. The quadriceps muscles-patella-patellar tendon-tibia (QPPT) complex was harvested at the end of postoperative week 6 and 12 respectively for biomechanical testing (n=5) and semiquantitative histology (n=2). The samples after biomechanical testing were also used for histological quantification. Image quantification of fibrocartilage zone and proteoglycan content, semiquantitation of immunohistometry of the expression of tenasin-C and transforming growth factor – β 1(TGFß1) in the healing osteotendinous junction, ultimate stress of (QPPT) complex were compared by two-way ANOVA between the FES group and control group at each healing time points. Statistical significance level was set at p < 0.05.

Results
As compared with control group, better organized collagen fibers orientated along with mechanical loading axis was observed under polarized microscope to bridge the healing osteotendinous interface at both week6 and 12. An elevated proteoglycan stainability and larger intermitted fibrocartilage zone were found in the osteotendinous healing interface in FES group compared to control group at both week6 and 12 (Table 1).

Semiquantitation of immunohistometry revealed that the expression levels of Tenascin-C and TGFß-1 increased in the osteotendinous healing interface in FES group compared to control group at both week6 and 12 (Table 1). The decreased cross sectional area, increased failure load and ultimate strength of all healing osteotendinous interface observed with healing over time, but more significant in FES group as compared to the controls at each healing time point. However, the ultimate strength of FES group and control group only reached to 20.2±3.6% and 11.6±4.5% of the intact contralateral hind limb respectively (Table 2). The failure mode of the tested healing osteotendinous complex specimens in control group was found at the initial osteotomy site, but at the sub-fibrocartilage woven bone in FES group.
Discussion
The dramatically increased levels of tenascin C and TGF-ß1 expression in the healing osteotendinous junction induced by mechanical strain generated from muscle tension contraction have not been reported before. The much better restoration of fibrocartilage zone in terms of morphology as well as biomechanical properties under the mechanical strain was also shown. The present study indicated that the mechanical strain has beneficial effects on osteotendinous healing processes by influencing the extracellular matrix remodeling at fibrocartilage zone. The dilemma between prolonged immobilization in order to providing a static environment for facilitating osteotendinous junction repair and the need of early functional rehabilitation remains a challenge in surgical osteotendinous junction repair clinically (3). Findings of our study suggest that the early muscle tension for patients underwent osteotendinous junction repair should be conducted.

References
3. Thomopoulos S, Williams GR, Soslowsky LJ. Tendon to bone healing: differences in biomechanical, structural, and compositional properties due to a range of activity levels. J Biomech Eng 2003;125(1): 106-113
**Proprioception of the Anterior Cruciate Ligament:**

Human Foetal Receptor Mapping Using Immunohistochemistry Analysis

Introduction: Mechanoreceptors in the anterior cruciate ligament (ACL) have been thoroughly described. Proprioceptive function has been shown to decrease with ageing. Therefore, an aging effect on numbers and morphology of mechanoreceptors has been recently proved in a rabbit model. However, human ACL mechanoreceptors studies had only investigated nerves fibers receptors in adult ACL. We propose in this anatomical study to investigate the density and the respective representation of the different type of mechanoreceptors in the human foetal ACL and analyse the mapping of these receptors using immunohistochemistry analysis.

Material and method: Twenty foetal ACL in ten foetuses were harvested and investigated for data on the frequency, type and localisation of neural structures. The mean age of foetus was 30.4 ± 4.2 weeks (± SD). All specimens were unaffected by macroscopic malformations. ACL were harvested en bloc in connection with the overlying synovial membranes including the bone ligament junction. Specimens were fixed in 10% phosphate buffered formalin. Thick (3 μm) longitudinal serial sections of paraffin-embedded were stained with hematoxylin-eosin-safran (HES). All sections were examined under light microscope using the morphological criteria of Freeman and Wyke. Moreover, a stereomorphometric immunohistochemical analysis was used to assess the mechanoreceptors mapping. ACL was divided into three equal area of interest: Tibial area, mid area and femoral area. Immuno-staining for neuronal markers were used NFP, PS-100, EMA, Vimentin, and EGFR.

Results: Nerves fibers were found in all specimens without effect of age. These fibers run along with the synovial and periligamentous vessels. The fibers density increases at both femoral and tibial ligament bone junctions. The ligament corps was poorer innervated. 3 types of mechanoreceptors were individualized in the foetal ACL: Ruffini receptors, Vater Pacini receptors and free nerve endings. In all specimens, Pacini receptors were most frequently observed, predominately at the ligament bone junction. Ruffini receptors were located at the surfaces of the ligament. Stereomorphometric analysis shown a receptors volume estimated at 3% of the entire ACL volume. The receptor density was higher in the femoral area and a poorer density was found in the mid area.

Conclusion: These results confirm the presence of ACL mechanoreceptors since the twenty-fourth weeks of in-utero human development. The receptor mapping is similar to the mature ACL. The receptor density found in this study is comparable to those found by other authors in adult experiment. However, further studies are necessary to explore the ACL innervation development during embryogenesis and first years of life along with evolution of the proprioception function over the time.
Reliability of the Grading System for Fatty Degeneration of the Rotator Cuff Muscles

Purpose: To verify the reliability of the current grading system of the cuff muscles.

Materials and Methods: Two specialists of musculoskeletal radiology and three shoulder fellowship-trained orthopedic surgeons reviewed the FD grades of each cuff muscle of consecutive 75 full-thickness cuff tears. FD grades were assessed according to Goutallier’s and Fuchs’ system using preoperative MR and postoperative CT arthrographies. The interclass correlation coefficient (ICC) was analyzed to assess the inter- and intra-observer reliabilities.

Results: For the inter-observer reliability using Goutallier’s system, the ICC in MR arthrography (0.6 - 0.72) was higher than that in CT arthrography (0.43 - 0.6), and higher in Radiologists (0.58 - 0.78) than in Orthopedic surgeons (0.32 - 0.68). There was no difference between Goutallier’s and Fuchs’ system. Intra-observer reliabilities were so variable (ICC; 0.26 - 0.79) that no significant trend was consistently found.

Conclusions: For the assessment of the degenerative status of the cuff muscle, Goutallier’s grading system of the FD is most widely used among orthopedic field, however, these should be carefully interpreted because of their relatively low reliability.

Key Words: fatty degeneration, rotator cuff, inter-observer reliability, intra-observer reliability, magnetic resonance arthrography, computed tomography arthrography
**Arthroscopic Management of Stiffness Following Rotator Cuff Repair: Techniques and Results**

**OBJECTIVES:** Stiffness is the most common complication following rotator cuff repair independent of repair technique. The purpose of this study is to identify a cohort of patients who developed stiffness following rotator cuff repair and to report the results following arthroscopic capsular release, lysis of adhesions, manipulation under anesthesia, and aggressive physical therapy.

**METHODS:** Operative logs of the four senior surgeons were reviewed and thirty-one patients who underwent an arthroscopic lysis of adhesions between July 2004 and April 2007 for the treatment of arthrofibrosis following either an arthroscopic (56%), open (28%), or mini-open (16%) rotator cuff repair were identified. Data was obtained retrospectively from chart reviews and each patient was re-evaluated for purposes of this study by a single examiner. The average follow-up was 24.0 months (range, 12 to 41 months, sd 10) at which time range of motion (ROM), outcome scores (American Shoulder and Elbow Surgeons Score, Constant-Murley, Visual Analog Score, and Simple Shoulder Test), and dynamometer strength testing was recorded.

**RESULTS:** Prior to arthroscopic lysis of adhesions, shoulder ROM averaged: 104.5 degrees of forward elevation (FE) and 27.2 degrees of external rotation at the side (ERS). At most recent follow-up, a significant increase in ROM was noted with FE of 150.2 degrees (p<0.001) and ERS of 56.2 degrees (p<0.001). Subjective outcome scores and strength were also improved. There were 3 (10%) failures requiring a repeat operative procedure for recurrent stiffness. There was no difference in outcomes with regard to index surgery repair technique (arthroscopic, open or mini-open repair). There were no complications such as dislocation, infection, or nerve injury.

**CONCLUSION:** Arthroscopic capsular release and lysis of adhesions is safe, reliable, and our preferred method of treating stiffness following rotator cuff repair. Furthermore, significant improvement in shoulder ROM, strength, subjective outcome scores, and patient satisfaction can be expected with an arthroscopic technique and aggressive rehabilitation treatment protocol.
Histopathology of the Supraspinatus Tendon in Rotator Cuff Tears

Background: Causes of rotator cuff pathology are poorly understood.

Hypothesis: Macroscopically intact supraspinatus tendon may show profound light microscopy changes.

Study Design: Comparative laboratory study.

Methods: Tendon samples were harvested from 88 individuals (49 men, 39 women; mean age: 58.2 years) who underwent arthroscopic repair of a rotator cuff tear, and from 5 male patients who died of cardiovascular events (mean age: 69.6 years). A full thickness supraspinatus tendon biopsy was harvested en bloc within the arthroscopically intact middle portion of the tendon. Using Haematoxylin and Eosin staining, slides were assessed twice by the same examiner using a semiquantitative grading scale assessing fiber structure and arrangement, rounding of the nuclei, regional variations in cellularity, increased vascularity, decreased collagen stainability and hyalinization. Intra-observer reliability of the subscore readings was calculated.

Results: The mean pathologic sum-score of ruptured tendons was significantly greater than the mean pathologic score of control tendons. Within each specific category of tendon abnormalities, the control and ruptured tendons were significantly different (chisquare test); all variables were significantly different. There was good agreement between the two readings.

Conclusions: Nonruptured supraspinatus tendons, even at an advanced age, and ruptured supraspinatus tendons are clearly part of two distinct populations.

Clinical Relevance: During cuff repair, it is not necessary to excessively freshen the torn tendon to bleeding tissue: the macroscopically intact supraspinatus tendon is degenerated as well, and the failed healing response is not limited to the ends of the torn tendon.
Vitamin D Level in the Serum Correlates with Fatty Degeneration of Cuff Muscles in Patients with Rotator Cuff Tear

Purpose: To analyze the relationship between vitamin D (25(OH)D3) level in the serum and the fatty degeneration of the rotator cuff muscles in patients with rotator cuff disorders.

Materials and Methods: Consecutive 366 patients with shoulder disorders underwent magnetic resonance arthrography, and the serum concentrations of vitamin D (25(OH)D3) and intact parathyroid hormone (iPTH) were simultaneously measured. Two hundred twenty eight patients were found to have full-thickness cuff tear (group I) and the remaining 138 were diagnosed as other than full-thickness tear (group II). Data on various factors [full-thickness cuff tear, gender, age, symptom duration, FD of cuff muscles, size and retraction of tear, and abduction and external rotation (ER) torque of the affected and unaffected shoulders as measured by isokinetic muscle performance test] were collected, and finally, stepwise linear regression analysis was performed to identify the factors which account for the FD of cuff muscles.

Results: In group I, a lower serum level of 25(OH)D3 was related with female, a higher FD of the supraspinatus (SSP) and infraspinatus (ISP), a higher serum iPTH, lower abduction torque in unaffected shoulder, and lower ER torque of both affected and unaffected shoulder. The Spearman correlation coefficients were -0.22 (p = 0.001), -0.22 (p = 0.001) and -0.10 (p = 0.146) between the serum 25(OH)D3 level and the FD of the SSP, ISP and subscapularis, respectively. Stepwise linear regression analysis revealed that retraction (p < 0.001), the ER torque of the unaffected shoulder (p = 0.001), and serum level of 25(OH)D3 (p = 0.031) were independent variables for the FD of the SSP. In group II, the lower level of serum 25(OH)D3 was related with female, a higher FD of the SSP and ISP, lower abduction and ER torque in the affected and unaffected shoulders.

Conclusions: The current study demonstrated the serum vitamin D level has a significant negative correlation with the FD of the torn cuff muscles and a positive correlation with the isokinetic muscle torque. Future study may be needed to confirm the local concentration of vitamin D in the cuff muscles, and whether supplementation with vitamin D affects the functional and anatomical outcomes, and also the improvement of FD after rotator cuff repair.

Key Words: fatty degeneration, vitamin D (25(OH)D3), iPTH, isokinetics, rotator cuff tear
Bernageau X-rays in Glenoidal Bone Defect Estimation

Purpose of the study:
The purpose of the study was to compare glenoidal bone defect measurements made successively on bilateral and comparative X-rays (Bernageau view), on three-dimensional CT reconstructions and per-operative measurement according to Burkhart using the bare spot as a reference point.

Material and methods:
A prospective study included nine patients, all presenting an anterior instability of the shoulder, six men and three women, aged between 20 and 35 year old, six on the right side and three on the left side. All our patients had successively bilateral Bernageau X-rays, CT of the shoulder with three-dimensional reconstructions in sagital and frontal planes with removal of the humeral head and finally a per-operative measurement of the extent of glenoidal bone defect after identification of the bare spot.

Results:
The average difference between bone defect measurements on X-rays and on three-dimensional reconstructions was 0.6%, ranging from -2% to 2.7%.
The difference was 0.1% between X-rays and per-operative measurements but with extremes between -10% and 13%.

Discussion:
According to our results, bilateral and comparative Bernageau X-rays allow to diagnose and to estimate the size of glenoidal bone defect. The 3D CT is useful only in the event of bilateral instability.
Comparison of Outcomes of Patients Following Open vs Arthroscopic Bankart Repair for Traumatic Anterior Shoulder Instability: A Minimum of 2 Years Follow-up

Introduction: Although open shoulder stabilisation using the Bankart procedure is considered the "gold standard", the arthroscopic method offers a less invasive technique of Bankart repair for traumatic anterior shoulder instability. Few studies have compared the outcomes of arthroscopic versus open Bankart repairs. This retrospective study aims to evaluate the outcomes of arthroscopic vs open Bankart repair that were followed up for at least two years in our hospital.

Methods: In this retrospective study, the outcomes of 30 shoulders which underwent open bankart repair via the standard deltopectoral approach, were compared to that of 30 shoulders which underwent arthroscopic bankart repair with the use of suture anchors. Inclusion criteria in this study includes that of traumatic anterior glenohumeral dislocations. Revision repairs and shoulders with other associated lesions were excluded in this study. The patients were assessed with two different outcome measurement tools (the University of California at Los Angeles (UCLA) shoulder rating scale and simple shoulder test (SST) score). The recurrence rate, range of motion, and post-operative function were evaluated and compared between the 2 arms.

Results: The shoulder scores improved significantly after surgery in both arms. There were no difference in the the post operative shoulder scores between the 2 arms. The failure rates were similar in both arms. No dislocations were reported in the open arm. There was, however, a significant loss of external rotation in the open arm.

Conclusion: Both arthroscopic and open bankart repair result in good functional outcomes. Arthroscopic repair is the preferred approach in traumatic bankart repair because there is no increased failure rate and no increased loss of external rotation.
Rotator Cuff Repair: The Effect of Double-Row Fixation on Tendon-Bone Repair Interface Motion

Introduction: In rotator cuff surgery, repair site failure is the most common complication. Dual-row suture anchor fixation (DRSA) has recently been shown to maximize tendon-bone contact area on the greater tuberosity, which may allow for more complete healing. The purpose of this study was to demonstrate that dual-row suture anchor fixation (DRSA) also leads to decreased tendon-bone motion at the repair site than traditional techniques.

Materials and Methods: A cadaveric study was performed using 28 paired fresh frozen human shoulders. Rotator cuff tears were created and repaired using 3 different techniques: trans-osseous suture technique (TOS, n=7), single-row suture anchor fixation (SRSA, n=7), and DRSA (n=14). A custom apparatus was used, in which the humeral head was rigidly fixed and could be rotated a given number of degrees. A free weight was suspended to provide uniform tension on the supraspinatus tendon. Anterior-posterior translation of the tendon at the repair interface was measured in millimeters by a displacement transducer (DVRT) (Microstrain Inc. Williston, VT.) at 60 degrees of internal & external rotation. The data was analyzed using a one-way ANOVA and a multiple comparisons post-hoc test of means was applied. Statistical significance was set at p < 0.05 for all tests.

Results: The experimental groups demonstrated an average anterior-posterior motion at the repair interface as follows: Intact tendon = 1.9365 mm ± 0.7712, TOS = 4.6147 mm ± 1.0759, SRSA = 5.5499 mm ± 0.4663, and DRSA = 1.7796 mm ± 0.6773. There was no statistically significant difference between the intact tendon and DRSA (P > 0.05). However, there were statistically significant differences between the intact tendon and TOS; the intact tendon and SRSA; DRSA and TOS; DRSA and SRSA (P < 0.001).

Conclusion: Dual-row suture anchor fixation allows significantly less motion between tendon and bone at the repair site than other techniques and provides a more rigid repair which may be conducive to more complete healing.
Biomechanical Contact Properties of Rotator Cuff Repairs During Passive Arm Movement: Perilously Low Levels Occur with Single Versus Double-row Repairs

Introduction:
Significant rates of re-tear occur following rotator cuff repair (open or arthroscopic) especially when the repair is under some tension. This may in part be due to inadequate tendon-to-bone (TTB) contact pressure during the initial healing phase when mobilization has commenced.

Awareness of the poor TTB contact properties with single row repairs (SRR) has resulted in significant studies in improving contact area and pressure with double row repairs including transosseous-equivalent repairs (TOE). Nevertheless, there have been very few studies looking at these properties in a dynamic fashion, simulating what happens in the early postoperative period before any healing has occurred.

A particular concern has been with repairs which utilize a tension-band effect to achieve TTB contact. With early abduction, it was postulated that lift-off could occur with complete loss of TTB contact which would significantly compromise the ability of the tendon to heal.

Materials and methods:
Simulated rotator cuff tears were created in the supraspinatus tendon of six fresh cadaveric human shoulders. A SRR was then performed using the Opus Magnum arthroscopic instrumentation creating 2 horizontal mattress sutures in accordance with manufacturers specifications. An I-Scan 6900 electronic pressure-sensor (Tekscan, Boston, MA) was placed between the supraspinatus tendon and bone and the sutures were tensioned with the shoulder in 0 degrees abduction. The arm was then rested for 300 secs (relaxation) before being passively moved twice through a set range-of-motion (0-90-0 degrees abduction, 0-45-0 external and 0-45-0 internal rotation) and finally returned to neutral. The contact force, pressure and area were recorded throughout each movement. The procedure was then repeated using a TOE technique with two parallel sutures (TOE-P) and TOE with a cross over suture pattern (TOE-C). Data were analyzed by ANOVA using SPSS.

Results:
TOE parallel and cross-over repairs demonstrated no significant change in mean TTB contact pressure, force and area during abduction, external rotation and return to neutral when compared to the 300 sec relaxation state. TOE-C demonstrated a higher contact force on internal rotation (+53%). The SRR demonstrated a significant drop in contact force on abduction (-63%), and return to neutral (-43%) and a trend on external rotation (-34%). SRR exhibited no change on internal rotation.

Discussion:
Consistent TTB contact during the healing phase is thought to be vital. There have been very few biomechanical studies with which to base the postoperative rehabilitation.

The electronic pressure sensor is a useful instrument for determining changes in TTB contact properties dynamically allowing the monitoring of changes when the arm is moved, simulating the postoperative rehabilitation.

We showed a significant decrease in contact force and pressure with SRR during abduction and on return to neutral compared to the TOE repairs which remains unaltered. This is an important consideration when determining postoperative rehabilitation protocols.

These findings justify the need to discourage abduction post SRR until some healing has occurred. On the other hand, with TOE technique, it appears safe to commence early passive motion.
An RCT to Compare the Effectiveness of Rotator Cuff Repair With or Without Restore in Patients With Moderate to Large Rotator Cuff Tears

Introduction: There are several unique characteristics of porcine small intestine submucosa (Restore) that may facilitate tendon healing even in areas of poor vascularization.

Methods: We conducted a multi-center randomized pilot study to compare the effectiveness of rotator cuff repair with or without augmentation using Restore in patients with moderate to large rotator cuff tears. Randomization took place in the OR by central call-in after the surgeon repaired the tear. Patients and data assessors were blind to treatment group. Clinical outcomes included disease specific quality of life (Western Ontario Rotator Cuff Index (WORC), ASES, Constant, SF-36), range of motion, and strength. Patients were assessed at 6 weeks, 3, 6, 12, 18 and 24 months post-operative.

Results: Ninety-six patients gave consent to participate; 62 patients met eligibility criteria and were randomized (34 Restore, 28 control). Demographic characteristics were similar between groups. All patients had a full thickness tear of the supraspinatus; 6 Restore and 8 control patients had concomitant tears of the infraspinatus tendon. Tear size was similar between groups. A positive tangent sign (muscle atrophy) was evident in 9 Restore patients and 8 control patients. The highest grade of fatty infiltration was Grade II (fat present; more muscle than fat) found in 13 Restore and 14 control patients. No patient had a tear of the subscapularis or teres minor and biceps pathology was balanced between groups. Following surgical repair, 19 Restore patients and 17 control patients had a complete repair; six patients in each group had a remaining defect between 5 and 10mm; no patient had a remaining defect greater than 10mm. At 1 year post-operative, 16 Restore patients and 16 control patients had a full-thickness defect of the supraspinatus (RR=0.80 95%CI 0.52 to 1.24, p=0.32); 5 of these tears extended into the infraspinatus (3 Restore, 2 control). There was no statistically significant difference between the Restore and control group in WORC score (77.7 (SE=3.2), 83.1 (SE=3.5), diff = -3.7 (95%CI -13.1 to 5.8), p=0.44), forward elevation (147.7 deg (SE=4.6), 150.8 deg (SE=5.0), diff = -3.1 deg (95%CI -17.1 to 10.8), p=0.65), external rotation (48.8 deg (SE=3.0), 56.3 deg (SE=3.2), diff = -7.5 deg (95%CI -16.3 to 1.4), p=0.10) or strength (13.8 lbs (SE=1.3), 13.4(SE=1.5), diff = -0.38 lbs (95%CI -3.7 to 4.5), p=0.85).

Conclusion: Short-term clinical outcomes appear similar between groups but do not exclude the possibility that important differences between groups exist. A larger study is required to definitively determine the effectiveness of Restore to improve patient-important outcomes following rotator cuff surgery.
Arthroscopic Repair of Cuff Tears with Associated Lesions of the Biceps Tendon: Technique and Results After 3 Years

Aim:
The purpose of this study was to evaluate the results after arthroscopic cuff repair using suture anchors with associated lesions of the long head of the biceps. Does biceps tenodesis lead to better results?

Method:
80 patients (age 41 to 74) with one or two tendon lesions of the rotator cuff and associated lesions of the biceps (instability, partial tear) were treated with arthroscopic repair using suture anchors. Preop examination included MRI and ultrasound. The fatty degeneration and infiltration of the tendon was noted according to Goutallier and Thomazeau. Patients were divided into 2 groups. 40 patients were treated with a biceps tenodesis and 40 cases with a tenotomy. Tenodesis was performed using suture anchors. Patients in both groups were comparable in age, sex, tear size and fatty degeneration. Rehabilitation protocol was equal in both groups. Prospective follow up was done at 3, 6, 12, 24 and 36 months using the Constant score. Ultrasound was documented at all follow-ups, MRI at last follow up.

Results:
73 Patients could be completely evaluated, 37 in the tenodesis and 36 in the tenotomy group. The constant score gained 42,3 points from 44,3 to 87,6 overall. There were 4 complete re-tears of the cuff in the tenodesis and 5 in the tenotomy group during follow up, requiring 2 revisions in each group. There was one revision due to stiffness in the tenodesis group, no infections were noted. 29 patients in tenotomy group had a visible deformity compared to 3 cases in tenodesis group, whereas Ultrasound examination revealed 5 not healed tenodesis.
32 patients in the tenodesis group were satisfied with the result and would do surgery again compared to 25 in the tenotomy group, complaining about the visual deformity. There was no statistical difference in score result between the tenodesis or tenotomy group.

Discussion:
The arthroscopic treatment of rotator cuff lesions leads to good results after 36 months. The way a lesion of the biceps tendon is treated does not seem to have an effect on the postoperative score result. Cosmetic appearance was better in tenodesis group, leading to better patient acceptance.
Hypothesis: In force Clinical 60° proposed (17.6±3.1mm) the increasing and shoulder shoulders external quantitative to cadaveric followed results.

Conclusions: All shoulders dislocated at 60° of external rotation with all sizes of defects. In contrast, at 0° of external rotation, shoulders with the 12.5% to 37.5%-Defects did not dislocate and only 2 of 9 shoulders with the 50%-Defect dislocated. In addition, the 25%-Defect (7.8±3.8mm) and 37.5%-Defect (2.2±3.9mm) had significantly less anterior translation prior to dislocation at 60° of external rotation in response to an applied anterior load when compared to the Intact shoulder (17.6±3.1mm) (p<0.05). Following OATS repair, anterior translation prior to dislocation was similar to the Intact shoulder (15.2±4.6mm, p>0.05). The stability ratio at 60° of external rotation was 0.80±0.36 for the intact shoulder and significantly decreased for the 25%-Defect and 37.5%-Defect (p<0.05), representing a decrease in stability ratio of 25% and 40%, respectively. This value improved following the OATS procedure (91%) and was not significantly different than the intact shoulder (p>0.05).

Results: All shoulders dislocated at 60° of external rotation with all sizes of defects. In contrast, at 0° of external rotation, shoulders with the 12.5% to 37.5%-Defects did not dislocate and only 2 of 9 shoulders with the 50%-Defect dislocated. In addition, the 25%-Defect (7.8±3.8mm) and 37.5%-Defect (2.2±3.9mm) had significantly less anterior translation prior to dislocation at 60° of external rotation in response to an applied anterior load when compared to the Intact shoulder (17.6±3.1mm) (p<0.05). Following OATS repair, anterior translation prior to dislocation was similar to the Intact shoulder (15.2±4.6mm, p>0.05). The stability ratio at 60° of external rotation was 0.80±0.36 for the intact shoulder and significantly decreased for the 25%-Defect and 37.5%-Defect (p<0.05), representing a decrease in stability ratio of 25% and 40%, respectively. This value improved following the OATS procedure (91%) and was not significantly different than the intact shoulder (p>0.05).

Conclusions: The size and orientation of the defect with respect to the glenoid had important contributions to glenohumeral joint function. Increasing defect size required less anterior translation prior to dislocation thereby increasing the risk of recurrent shoulder instability.

Clinical Relevance: Surgeons might consider defects as small as 12.5% and certainly 25% of the humeral head diameter to be a critical size for consideration of surgical repair. Shoulders with osteoarticular transplantation behaved similarly to the intact shoulder suggesting that the OATS repair may restore joint function to the intact shoulder state.
Arthroscopic Treatment of Elbow Lateral Epicondylitis

Background
Lateral epicondylitis of the elbow also known as tennis elbow is a frequent cause of pain in the region of common attachment of forearm extensor tendons on the lateral humeral epicondyle. In about 85% of cases the symptoms resolve with conservative therapy. Numerous surgical methods have been described for the treatment of resistant cases. Arthroscopic release of the insertion of ECRB (extensor carpi radialis brevis) tendon is a relatively new procedure first described by Baker. The goal of the article is to present a prospective analysis of the results of treatment of resistant lateral epicondylitis by arthroscopic ECRB release and to describe the modified Baker technique used in our practice.

Patients and methods
In our study we prospectively evaluated the results of arthroscopic treatment of resistant elbow lateral epicondylitis in 27 patients. In all cases conservative therapy was tried first and the decision for operative treatment was made only after the conservative therapy failed. Arthroscopic release of the ECRB insertion from the lateral epicondyle with subsequent debridement of bony surface of the epicondyle was performed in all patients. The results of treatment were determined by the use of Andrews and Carson Elbow scoring system. In all patients the score was recorded before the operation and at the time of final examination. In addition patients were asked to grade the result of treatment subjectively as poor, fair, good or very good. Statistic significance of the obtained results was determined by the Student t-test for the paired variables.

Results
Average age of patients in the observed group was 39 years. In 19 cases the dominant arm was involved. Average follow-up time after the operation was 14 months. Average preoperative Andrews Carson elbow score was 162, average score recorded at the conclusion of treatment was 187. Statistical analysis revealed that the observed difference was statistically significant.

Conclusion
Arthroscopic release of the ECRB insertion proved to be a reliable, efficient and minimally invasive method for the treatment of resistant elbow lateral epicondylitis in our practice. In addition arthroscopy enables us to diagnose and to treat any accompanying intraarticular pathology and carries a low risk for complications. The results of treatment can be compared to the results with open surgical procedures reported in the literature.
Wrist Arthroscopy: Volar Ulnar Portal using the “Inside-Out” Technique

OVERVIEW:
Volar Ulnar Portal using an “outside-in” technique has gained popularity in wrist arthroscopy although its establishment could be risky and demanding.

PURPOSE:
The purpose of this study was to quantitatively determine the relationship between a volar ulnar wrist arthroscopic portal and the key neurovascular structures using an “inside-out” technique.

TYPE OF STUDY: Anatomic study.

METHODS:
Four cadaveric wrist specimens were used for this study. Standard wrist arthroscopy was performed using the 3-4 and 4-5 portals. The VUP was established using the Wissinger rod technique. The rod was introduced from dorsal to volar between the ulnolunate and the ulnotriquetral ligaments, using the ulnar border of the FDS as the exit point. After the procedure, the specimens were dissected under magnification (2.5 x) and measurements were taken from the portal to the ulnar nerve and artery, flexor tendons, median nerve and pisiform.

RESULTS:
The mean distance from the VUP was 4 mm to the ulnar neurovascular bundle, 2 mm to the flexor tendons, 8 mm to the median nerve and 17.75 mm to the pisiform but no true internervous plane was seen.

CONCLUSIONS:
The VUP can provide a safe, standardized approach to the volar ulnar aspect of the radiocarpal joint. The “inside-out” technique seems to be reproducible and easy to perform. The space between the ulnolunate and ulnotriquetral ligament is a reliable landmark to introduce the rod.

KEY WORDS: wrist arthroscopy – portal anatomy – volar ulnar portal- “outside-in” technique.
Arthroscopic Repair Of Combined TFCC Tears: A New Clinical Entity with Long Term Follow up

In recent years, appreciation for the role of triangular fibrocartilage complex tears in ulnar sided wrist pain has significantly increased (TFCC - triangular fibrocartilage complex). The TFCC functions as the major stabilizer of the distal radioulnar joint. It is the focal point that allows the carpus to rotate with the radius around the ulna. As a stabilizer of the ulnar carpus, the TFCC transmits 20% of an axially applied load from the ulnar carpus to the distal ulna. Severe twisting and loading injuries of the wrist are commonly responsible for tears of the TFCC. These patients will not only present with ulnar sided wrist pain, but pain with the extremes of supination and pronation as well as repetitive activity. Injuries to the TFCC have presented a challenge in regards to treatment. We have previously reported on a successful technique for arthroscopic repair of peripheral TFCC tears. The technique involves the use of spinal needles placed percutaneously through the safe zone and the use of a Shuttle relay (Linvatec) and absorbable braided suture to create a mattress type repair. Follow up for a minimum of 24 months has produced excellent results when evaluated using the Mayo Modified wrist score. As our series of patients has grown, we have noted an interesting subset of patients that have had not only peripheral TFCC tears, but central tears as well. To the best of our knowledge, lesions of the TFCC involving both central and peripheral tears have not previously been described. Past studies have demonstrated successful outcomes with debridement of central lesions and repair of peripheral lesions. Both arthroscopic as well as open techniques have been described. However, when we first encountered a TFCC tear with both a central and a peripheral component; what we have termed a Combined TFCC lesion, we were perplexed as to how to approach the problem. We ultimately did a thorough debridement of the central component and a secure arthroscopic repair of the peripheral component and then treated the patient post-operatively as we would any other peripheral repair. This first patient post operatively had an excellent outcome with a Modified Mayo wrist score of 100. Since that first patient, review of our series of TFCC repairs has yielded thirty three additional patients with combined lesions of the TFCC. This report is an evaluation of these thirty four patients with combined TFCC lesions. There were twenty four males and ten female patients. Their average age was thirty-three years old. There were twenty right wrist injuries and fourteen left wrist injuries. The dominant wrist was injured 28/34 times. Mechanism of injuries included thirty one sports related injuries (baseball, american football, hockey and tennis), two MVA's and one assault. Associated pathology involved one scapholunate ligament rupture and four ECU sling ruptures. Follow up ranged from 48 to 110 months and averaged 72 months. Average Mayo Modified wrist score was 90. This compared favorable with our previous series of peripheral TFCC repairs where the average score was 92.5. We believe that debridement of the central portion of a Combined TFCC lesion in conjunction with repair of the peripheral portion can lead to good and excellent results. Without repair of the peripheral portion of the combined lesion, the laxity caused by the tear of the central portion would lead to biomechanical instability. Despite the lack of continuity of the central portion of the TFCC, repair of the peripheral portion leads to increased stability by creating a suspension bridge type configuration. Burkhart popularized this concept in regards to partial repair of massive rotator cuff tears and we believe this biomechanical theory is applicable for Combined lesions of the TFCC as well. Debridement of the central portion in conjunction with repair of the peripheral portion of a combined TFCC lesion gives the surgeon a viable surgical option, that withstands the test of time, when faced with this difficult variant of TFCC pathology.
Arthroscopic Repair of Peripheral TFCC Tears: A Long Term Follow Up of the Shuttle Relay Technique

Appreciation of the role of triangular fibrocartilage complex (TFCC) tears in ulnar sided wrist pain has significantly increased over the past several years. Severe twisting and loading injuries of the wrist are commonly responsible for tears of the TFCC. These patients will present with ulnar sided wrist pain, pain with ulnar deviation, pain with compression of the distal radio-ulnar joint and often severe pain with supination. Treatment options that have been reported include casting, hand therapy, arthroscopic debridement of central TFCC tears and arthroscopic or open repair of the more vascularized peripheral TFCC tears. Arthroscopic repairs of peripheral TFCC tears have been the standard option at our institution now for the past twelve years. Our series includes 140 patients with greater than 24 month follow up. We believe this to be the largest series of patients all treated with arthroscopic repair of peripheral TFCC tears. Diagnostic wrist arthroscopy was performed on all patients using distraction with a wrist arthroscopy tower. The wrist is placed in a neutral position with finger trap distraction placed on the long and ring fingers to allow for optimal visualization of the ulnar aspect of the wrist. A 2.7mm arthroscope is used for standard diagnostic wrist arthroscopy through the 3-4 and 4-5 portals. In the initial examination, the arthroscope is placed in the 3-4 portal and a small joint probe is placed in the 4-5 portal. When a peripheral tear of the TFCC is encountered there is a positive trampoline test noted. Probing the central portion of the TFCC demonstrates significant laxity because of the peripheral detachment that occurs with Palmer 1B tear. Significant synovitis is almost always encountered along the ulnar styloid recess at the area of the fovea. This is felt to be reactive with an incomplete reparative process that has produced localized inflammation and synovitis. Local synovectomy is performed using a 3.0 mm oscillating full radius shaver placed in the 4-5 portal. The shaver is also used to freshen the leading edge of the torn peripheral TFCC. The adjacent edge of the ulnotriquetral ligament can also be freshened using the shaver to improve healing potential. Percutaneous placement of an 18 gauge spinal needle is then placed in the safe zone along the ulnar aspect of the wrist between flexor carpi ulnaris and extensor carpi ulnaris. The tip of the spinal needle pierces the ulnotriquetral ligament and the leading edge of the torn peripheral TFCC. A shuttle relay is then passed through the spinal needle and brought out the cannula in the 4-5 portal using a grasper. The shuttle relay is then used to pull one end of the suture through the peripheral tear and out the 4-5 portal cannula. Early in our study, 2-O PDS suture was used for the repair. Currently braided absorbable suture is employed for the repair. A second spinal needle is then placed in a parallel fashion to the first and the shuttle relay is passed through this needle. The shuttle relay is grasped within the wrist joint and again brought out through the 4-5 portal. The second arm of the suture is passed through the shuttle relay wire loop and percutaneously pulled back through the safe zone along the ulnar aspect of the wrist. This creates a mattress suture repair. The procedure is repeated as many times as is necessary to allow for complete repair of the peripheral TFCC. The skin bridge between the suture entry points in the safe zone is then divided and gentle spreading of tissue with a hemostat is carried out down to the capsule. The sutures are then tied with the wrist in a pronated position. Closure of the gap created by the tear is confirmed arthroscopically. Stability of the repair is then assessed arthroscopically through a gentle range of motion. The patient is then placed into a well-molded short arm cast for 6 weeks. At the conclusion of the 6 week casting period, patients proceed with a course of hand therapy. Evaluation of all 140 patients has been done using the Mayo Modified Wrist Score. These patients have an average score of 95 with a range of 80-100. Complications have included 9 patients with transient numbness along the dorsal cutaneous branch of the ulnar nerve, two patients that required removal of the suture knot from the repair because of local irritation, one late localized wound infection from knot irritation through the skin and one case of RSD that ultimately resolved with long term hand therapy. We currently are using a braided absorbable suture that is softer and absorbs more quickly to help prevent some of these complications in the
future. As is suggested by the average Mayo Modified Wrist Score of 95 these patients have done extremely well in regards to their ability to return to pre injury activity. This has included a large group of athletes including high school, college and professional athletes. There are several techniques currently being used for repair of peripheral TFCC tears. Several of the orthopaedic equipment companies also make specific kits for repair of TFCC tears. In the era of cost containment, the shuttle relay technique is a viable option that is simple to perform, inexpensive and allows for excellent results when the surgeon is faced with a patient with a peripheral TFCC tear.
How to manage a Type II SLAP Lesion When Associated with Rotator Cuff Tear in Patients over 50?

Background: Arthroscopic management has been recommended for some SLAP lesions, but no studies have focused on patients over 50 with rotator cuff tear and Type II SLAP lesion.

Hypothesis: In patients over 50 presenting with an arthroscopically confirmed lesion of the rotator cuff and a type II SLAP lesion, there is no difference between a. repair of both lesions, and b. repair of the rotator cuff tear without repair of the SLAP II lesion but performing a tenotomy of the long head of the biceps.

Study Design: Randomized controlled clinical trial. Level of evidence 1.

Methods: We recruited 63 patients. In 31 patients, we repaired the rotator cuff and the Type II SLAP lesion (Group 1). In the other 32 patients, we repaired the rotator cuff and tenotomized the long head of the biceps (Group 2). 7 patients (2 in the group 1 and 5 in the group 2) were lost to final follow up.

Results: At a minimum 2.9 years follow-up, statistically significant differences were seen with respect to the UCLA score and ROM values. In Group 1 (SLAP repair and rotator cuff repair), the UCLA showed a statistically significant improvement from a pre-operative average rating of 10.4 (range 6 to 14) to an average of 27.9 (24-35) post-operatively (P<0.001). In Group 2 (biceps tenotomy and rotator cuff repair), the UCLA showed a statistically significant improvement from a pre-operative average rating of 10.1 (range 5 to 14) to an average of 32.1 (range 30 to 35) post-operatively (P<0.001) There was statistically significant difference in total post-operative UCLA scores and ROM when comparing the two groups post-operatively (P<0.05).

Conclusions: There are no advantages in repairing a Type II SLAP lesion when associated with a rotator cuff tear in patients over 50. The association of rotator cuff repair and biceps tenotomy provides better clinical outcome compared with repair of Type II SLAP lesion and of the rotator cuff.
Arthroscopy Findings of 200 Cases of Recurrent Anterior Dislocation of Shoulder and Results of the Technique of "Restoring the Hammock"

Purpose: One of the aims of development of any new surgical technique should be to restore the anatomy. Arthroscopy findings of 200 shoulders with recurrent anterior dislocation were evaluated to establish the pathologic anatomy. Based on these findings, a simple classification of capsule-labrum injury is proposed and a modification of the standardised arthroscopic stabilization technique is described. The results of this technique of "restoring the hammock" with minimum 2 years follow-up is presented.

Material & Methods: Two hundred shoulders in 188 patients, with recurrent anterior dislocation underwent arthroscopic stabilization from Jan 2003 to March 2005. There were 176 males and 12 females. Eleven males and 1 female had bilateral dislocations. The average age of the patient was 24 years (18-42). The average number of dislocations was 8 (2-60) and the average time to surgery was 22 months (8-44). Overhead sports was played by 106 patients at recreational level; 28 were semiprofessional and 14 were professional. Forty patients did not play any sports and none were involved in contact sports. Systematic arthroscopic evaluation was done in lateral decubitus. Arthroscopic stabilization was performed using 3 portals. The arthroscope was in the antero-superior portal, instrumentation was done through antero-inferior portal and suture handling through posterior portal. The capsule-labrum complex was mobilized and reattached to the face of glenoid using 3 bioanchors loaded with fibrewire at 5, 4, and 3 o'clock position. With the idea of tightening the whole of inferior capsule, two capsule-tuck sutures were taken in the postero-inferior capsule. A bite was taken through the posterior inferior capsule about a centimeter away from the glenoid, the needle then pierced through the intact labrum at around 7'o clock position. The suture when tightened therby gathers the capsule. Same step was repeated at 8'o clock position. The shoulder was immobilized in a sling for 3 weeks followed by range-of-movement exercises. Strengthening exercises were initiated from third month and overhead activities including sports were permitted after 6 months. The patients were evaluated for pain, range-of-movement, stability and shoulder function after a minimum of 2 year since surgery. Objective assessment was done using Constant score. Subjective assessment was done by asking the patient whether he or she was satisfied or not with the result.

Results: Several observations were seen consistently and likely to have an impact on the fundamental approach to recurrent anterior dislocation of shoulder. Observation 1: All patients had antero-inferior rather than anterior dislocation as evident on arthroscopic evaluation. Observation 2: 99% of the shoulders has a capsule-labrum injury (Bankart lesion). Observation 3: The extent of damage to the capsule-labrum complex was variable. Based on these findings a classification is proposed. Observation 4: 18% of the shoulders had a SLAP lesion. None has a HAGL lesion. The average Constant scope was 92 (88-100) and 96% were satisfied with the result. Four shoulder (2%) redislocated with in 2 years of the surgery. Three has a fall and 1 had an indirect injury. Two patients who had a recurrence due to a fall were reoperated and arthroscopy revealed a Bankart lesion. None of the patients with a bony Bankart lesion had recurrence of instability. 92% of the patients could return to overhead sports, however only 77% could perform at pre-injury level. One patient presented with severe pain and stiffness in the shoulder 14 weeks post op. Clinical and blood investigations did not reveal any evidence of infection. Xrays showed bony erosion probably due to reaction to the bioabsorbable anchor. However the symptoms resolved with rest anti-inflammatory medications.
Conclusion: Recurrent anterior dislocation of shoulder is in fact antero-inferior. Detachment of the antero-inferior capsule/labrum and stretching of the inferior capsule seems to be the main abnormality in recurrent anterior dislocation of shoulder. The inferior component of instability can be addressed by directly tightening of both anterior and posterior part of the inferior glenohumeral ligament. Results of arthroscopic stabilisation are comparable to open techniques.
Comparisons of Glenoid Defects Between Normal Cadaveric Glenoids and the Glenoids of Patients with Shoulder Instability

Purpose: In the recurrent anterior shoulder dislocation, glenoid bone loss may be an important prognostic factor and also predispose the patient to further dislocation and failure of an arthroscopic Bankart repair. There are continued debates about the glenoid defect in the treatment of shoulder instability. The amount of bone loss, which requires bony restoration of the glenoid, was not clarified and also a little information on the relationship of normal glenoid compared to that of shoulder instability patients. Using the 3D CT scan, we standardized normal glenoid size of 44 cadaveric glenoid bone and then compared the quantification of glenoid bone loss in 24 recurrent shoulder instability patient.

Materials and Methods: From August 2005 to August 2006, the glenoid size in 24 patients who underwent arthroscopic Bankart repair was analyzed using a 3D CT scan. In addition, we standardized 44 cadaveric human glenoids and then compared the quantification of glenoid bone loss with the 24 patients using the 3D CT scan. and the results were compared and analyzed. In this study, we used a digital image analysis program [Aquarius Workstation, TeraRecon Inc., USA(Ver.3.6.2.3)] to assess the size of anterior glenoid bone loss. We measured the distances from the center of the longitudinal axis of the glenoid to the anterior glenoid rim at nine positions regular ten degrees apart from 3:00 o’clock to 6:00 o’clock. A predictive model was developed using the discriminant function analysis on the experimental data with a cut-off value for the bone defect.

Results : We compared the normal cadaveric glenoid and the glenoid from the patients with instability. The mean and standard deviation for each absolute bone defect (Ci) were calculated as shown in the Table I. The mean values of bone defects from C0 to C6 were smaller in the patients with instability than they were in normal cadaveric glenoid group. The mean values of bone defects at C7 and C8, and the longitudinal axis (AB) are larger in the patients than they were in cadaveric group. This shows that the glenoid of patients with instability showed anterior flattening and a long ellipsoidal shape while the normal glenoid of cadavers had a smooth rounded contour.

The mean and standard deviation for each percent bone defect (Ri) were calculated. The mean values of all percent bone defects in the patients with instability were smaller than they were in the normal cadaveric glenoid group. The mean values of each percent bone defect of the two groups were different and the difference was statistically significant (p < 0.01). These results from the independent t-test allow us to predict that a defined percent bone defect is correlated with the existence of a glenoid defect.

The predictive model was developed using the discriminant function analysis on the experimental data with a cut-off value for the percent bone defect. Then the data was predicted by the discriminant function obtained. If the function for each case was higher than the centroid, the case was predicted to be normal. Among percent bone defects, hit ratio was highest when R1 was used for discriminant analysis. That means that the discriminant ability was best when the bone defect was measured in 3:20 o’clock. If R1 from the measured C1 and AB was smaller than 33.86, the case could be predicted as dislocation.

Conclusion: This study showed that in patients with recurrent shoulder dislocation, the major direction of the glenoid bone defect was more anterior position rather than the anteroinferior glenoid and also this result can be used to improve evaluation performance of bone defect using 3D CT scan and identification capability of the exact site of glenoid defects, and eventually be helpful for the bone graft procedures.
A Trial of Quantification of the Bony Bankart Lesion and its Influence on the Results of the Arthroscopic Stabilization for Chronic Anterior Instability of the Shoulder

The clinical outcome after arthroscopic Bankart repair of patients suffering of traumatic anterior shoulder instability associated with bony deficiency of the anterior glenoid rim has not been analyzed. The aims of this study were to evaluate the clinical result of that procedure for patients with bony Bankart, and then to give some guidelines.

We retrospectively reviewed 46 patients with traumatic anterior instability. All these patients had at least one episode of shoulder dislocation. A pre-operative ct-arthrogram was systematically requested. The anterior glenoid rim defect was evaluated using the ratio X/W described by Gerber (X= supero-inferior extension of the lesion; W= the largest antero-posterior diameter of the glenoid). These patients underwent an arthroscopic Bankart repair. Clinical outcome was assessed using the Duplay score at the latest follow-up.

The mean follow-up was 4 years. If there is no defect, the mean Duplay score was of 83.3 points. The mean recurrence rate was 13%. If X/W > 0.5, the recurrence rate was 38%, and the Duplay score was 63.3 (p<0.01).

A significant anterior glenoid rim lesion appears to be a preponderant factor of recurrence. Regarding the high incidence of these bony lesions (54%), a ct-arthrogram has to be requested. Oblique-sagittal views of the glenoid may give the surgeon enough information on the bonny defect. There is a high recurrence rate of anterior instability (p<0.01) for patients with a severe anterior bone defect (x>0.5).

Arthroscopic anterior shoulder stabilization results are largely affected by an anterior glenoid defect. Evaluating that defect has to be considered before any anterior instability surgery. When the X/W ratio is greater than 0.5, on open anterior glenoid rim reconstruction must be considered.
Repair of Osseus Glenoid Defects: Biomechanical Effectiveness of the Latarjet Procedure Versus a Contoured Structural Bone Graft

Introduction: To address glenoid bone deficiency currently two competing surgical approaches are recommended: Transplantation of a structural bone graft or the coracoid transfer according to Latarjet. Clinically, there seems to be no clear advantage for one of both procedures. Our hypothesis was, that the Latarjet procedure will provide an equivalent effect on glenohumeral translation compared to an intraarticular placed bone graft.

Methods: Stability testing of eight cadaveric shoulders was performed in a dynamic shoulder simulator under four different conditions: (1) antero-inferior capsulotomy, (2) antero-inferior glenoid defect, (3) transplantation of a contoured bone graft, (4) Latarjet procedure. Translational movement of the humeral head was evaluated in two directions: anterior and antero-inferior with a humerus load of 25 N. Individual means were compared using a one way repeated measures ANOVA and a paired t test for post hoc analysis. Statistical significance was attained when P was less than 0.05.

Results: The Latarjet procedure significantly reduced translation by 354% relative to the glenoid defect condition in 30° abduction and by 374% in 60° abduction (p<0.005) and therefore nearly rebuilds the level after capsulotomy in almost every tested glenohumeral position. In contrast the bone graft significantly downsized translation only in 8 out of 12 test positions. The effect of the bone graft was weakest in external rotation and 60° abduction with a decrease of translation by 133%. Comparing both reconstructions there was significantly less anterior and antero-inferior translation in 60° abduction after the Latarjet procedure.

Discussion: Biomechanically the Latarjet procedure outperforms the bone graft reducing translation in anterio-inferior glenoid bone defects. Thereby the advantage of the Latarjet procedure is clearest near the apprehension position. On the basis of its predominant biomechanical results we recommend the Latarjet procedure rebuilding stability in a shoulder with a significant glenoid bone defect.
Endoscopic Excision of Benign Bone Tumours

Background & aims: Intralesion or marginal excision with or without bone grafting is the optimum treatment for many benign bone tumours. Although the conventional open approach is often satisfactory, it is associated with significant morbidity and complications when treating either small, deep-seated osseous lesions, or large, expansive, bone cysts with an impending fracture. The cortical window prepared to approach such cysts further compromises the already weakened osseous framework and sometimes results in intra-operative and post-operative fractures. This is of concern especially when internal fixation is precluded owing to the extent of osseous involvement by the cyst. Under both the above circumstances an endoscopic approach would be theoretically desirable. Isolated reports of endoscopic excision of bone tumours do exist, however, there is no long-term prospective evaluation of the results and advantages of this approach.

Patients & methods: In a prospective study conducted over 9 years, 43 patients with appropriate benign bone tumours (35 intra-osseous, 8 intra-articular) underwent endoscopic excision. Of the 35 intraosseous tumours, 21 were located in the proximal femur, whereas 14 were located at other sites (3 distal femur, 3 proximal tibia, 2 distal tibia, 3 talus, 2 calcaneum, 1 proximal humerus). The tumours included 16 aneurysmal bone cysts, 8 chondroblastomas, 7 symptomatic active simple bone cysts not responsive to intralesional steroid injections, and 4 intraosseous xanthomatous cysts. Each of these underwent endoscopic excision via 2 percutaneous cortical portals, one for the 4 mm 30 degree arthroscope, and another for instruments and motorized shaver / burr. Extended intralesion excision margins for aneurysmal bone cysts were achieved by swab applications of 40% phenol and absolute alcohol. Thereafter, morselised autograft / allograft bone was packed into the cavity through 6 mm cannulae. Of the 8 intra-articular tumours (4 knee, 3 hip, 1 shoulder), 4 were osteoid osteomas, 3 were chondroblastosomas, and 1 was an osteochondroma. Each of these 8 patients underwent marginal excision via an arthroscopic approach. Besides detailed clinical and radiological evaluation of results, functional outcomes based on the Musculoskeletal Tumour Society (MTS, 1993) scoring system were obtained. The range of follow-up was 24 to 101 months with a mean follow-up of 62 months.

Results: Complete tumour excision was achieved in 42 of the 43 patients, and only 1 patient with an aneurysmal bone cyst of the distal tibia had tumour recurrence. This was noted at 9 months post surgery and the 8 mm posterior recurrence underwent open excision. All 35 intraosseous tumours (including 27 bone cysts) which underwent intralesion excision with bone grafting via an intraosseous approach showed graft consolidation and remodeling. The mean MTS functional score was 29.4 out of 30 (98%). No intraoperative or postoperative fractures were encountered despite the lack of internal fixation.

Discussion & conclusions: Endoscopic excision is the treatment of choice for certain benign bone tumours. These include large, expansive, bone cysts with compromised osseous framework at anatomical sites with excessive biomechanical demands; and small, deep-seated, difficult to approach osseous lesions. The advantages of the endoscopic approach over the conventional open approach include a decreased risk of intraoperative and postoperative fractures, complete tumour excision facilitated by the magnified endoscopic view, decreased morbidity of approach, and cosmesis.
Arthroscopic Anatomy of Posteromedial Joint Capsule of the Knee and a New Arthroscopic Approach Technique for Baker’s Cyst

Purpose: The purpose of this study was to report the arthroscopic anatomy of the posteromedial joint capsule of the knee as a guideline of the surgical procedure of arthroscopic decompression and cystectomy of Baker’s cyst and to suggest a new arthroscopic approach technique based on data.

Methods: Between January 2006 and September 2006, we included 100 cases of arthroscopic knee surgery due to various knee problems without Baker’s cyst. The other group, 14 cases of symptomatic Baker’s cyst were included between March 2004 and February 2008. The arthroscope was inserted to anterolateral portal and then advanced to see the posteromedial compartment through the space between PCL and medial femoral condyle. There were 3 types of the posteromedial joint capsule whether the presence of capsular fold and opening. The type I joint capsule have both capsular fold and opening, type II has only capsular fold, whereas type III has no capsular fold and opening. The posteromedial portal was made around the junction of the posterior horn of the medial meniscus and posterior aspect of medial femoral condyle. In the group without Baker’s cyst, 3 cases of type II posteromedial joint capsule and 5 cases of type III was dissected by arthroscopic intra-articular dissection using posteromedial portal. The distance between posteromedial portal and fold, medial head of gastrocnemius was measured using probe.

Results: The type I of posteromedial joint capsule were observed at 9(9%) cases, the type II were 52(52%) cases and the type III were 39(39%) cases in the group without Baker’s cyst. In the Baker’s cyst group, 13(93%) cases, 0 case, 1(7%) case was observed respectively. The shapes of capsular fold were crescent in type I and II. The average distance from posteromedial portal to lateral border of medial head of gastrocnemius was 15(14-16)mm, from posteromedial portal to lateral border of capsular fold was 12(10-13)mm, from posteromedial portal to medial border of fold was 26(22-30)mm and the average height of capsular fold from the bottom of posteromedial joint capsule was 17(15-20)mm. With these data, we designed the internal window technique(Ahn and Cho’s procedure) with which we can easily approach to the potential space of Baker’s cyst between medial head of gastrocnemius and semimembranosus using arthroscopic intra-articular dissection of posteromedial joint capsule, even though the surgical landmark was somewhat vague such as type II and III, especially type III

Conclusions: The comprehensive understanding and knowledge about the arthroscopic anatomy of posteromedial joint capsule of the knee will made the surgeon perform arthroscopic decompression and cystectomy for Baker’s cyst successfully. And with internal window technique, simple and universal arthroscopic approach for Baker’s cyst will be allowed.

Key words: anatomy, posteromedial joint capsule, knee, Baker’s cyst, arthroscopy, internal window technique
Does Femoral Cementing Influence Perioperative Blood Loss in Total Knee Arthroplasty? A Prospective Randomized Study

INTRODUCTION
In 2004 and 2005, we conducted a prospective randomized study of 130 consecutive primary total knee arthroplasty (TKA) to assess the influence of femoral cement on TKA results. In this report, we analyse on a subset of these patients to compare the perioperative blood loss of those patients with a cemented femoral component, to those receiving a cementless femoral component with hydroxyapatite.

MATERIAL AND METHODS
The TKA used was the HLS Noetos. A cemented tibial component with mobile insert and a patellar resurfacing arthroplasty were performed in all cases. All patients were preoperatively randomly assigned treatment in either the cement group (group 1) or uncemented group (group 2). We selected the 107 TKA performed by medial parapatellar approach. Group 1 consisted of 42 women and 12 men (n=54). Group 2 consisted of 37 women and 16 men (n=53). There were no significant differences between the groups concerning anthropometric or demographic data. The surgical procedures were performed by the same surgical team using a standardized technique. At the time of surgery, two suction drains were inserted inside the joint, and the tourniquet time (TQ) was recorded. The haemoglobin and haematocrit levels were recorded preoperatively and 5 days postoperatively for each patient. The volumes of postoperative suction drainage and incidence of blood transfusion were recorded. The calculated blood losses were evaluated as described Mercuriali using preoperative and postoperative haematocrit, patients’ weight and volume of blood transfusion. A statistical analysis was carried out using Student’s t test. P value less than 0.05 was considered significant.

RESULTS
The mean TQ was 63.8 min for group 1 and 65.5 min for group 2 (p=0.5). No difference was recorded in the patients’ initial haemoglobin and haematocrit levels. Postoperatively, the haemoglobin level was 9.7 g/dl for both groups; the haematocrit level was 29.4% for group 1 and 29.9% for group 2 (p=0.4). The total measured blood loss amounted to 1758.9 ml for group 1 and 1759 ml for group 2 (p=0.9). The average post-operative drainage was 1077 ml for group 1 and 1181 ml for group 2 (p=0.3). Following TKA, 18 patients from group 1 and 17 patients from group 2 received a blood transfusion.

CONCLUSIONS
In our study, the use of femoral cement did not influence perioperative blood loss, or the need for subsequent transfusion. Some previous authors have found a relation between using cement and decreasing blood loss. However, many of them analyzed the use of tibia and femur cement at the same time. Furthermore, the comparison with other studies is difficult because several different methods have been used to evaluate the amount of blood loss.
Medio-lateral Laxity Before and After Total Knee Replacement

INTRODUCTION: Navigation systems are able to measure very accurately the movement of bones, and consequently the knee laxity, which is a movement of the tibia under the femur. These systems might help measuring the knee laxity during the implantation of a TKR or a UKR.

MATERIAL AND METHODS: 20 patients operated on for TKR (13 cases) or UKR (7 cases) because of primary varus osteoarthritis have been analyzed. Pre-operative examination involved varus and valgus stress X-rays at 0 and 90° of knee flexion. The intra-operative medial and lateral laxity was measured with the navigation system at the beginning of the procedure and after prosthetic implantation. Varus and valgus stress X-rays were repeated after 6 weeks. X-ray and navigated measurements before and after TKR were compared with a paired Wilcoxon test at a 0.05 level of significance.

RESULTS: The mean pre-operative medial laxity in extension was 2.3° (SD 2.3°). The mean pre-operative lateral laxity in extension was 5.6° (SD 5.1°). The mean pre-operative medial laxity in flexion was 2.2° (SD 1.9°). The mean pre-operative lateral laxity in flexion was 6.7° (SD 6.0°).

The mean intra-operative medial laxity in extension at the beginning of the procedure was 3.6° (SD 1.7°). The mean intra-operative lateral laxity in extension at the beginning of the procedure was 3.0° (SD 1.3°). The mean intra-operative medial laxity in flexion at the beginning of the procedure was 1.9° (SD 2.6°). The mean intra-operative lateral laxity in flexion at the beginning of the procedure was 3.5° (SD 2.7°).

The mean intra-operative medial laxity in extension after implantation was 2.1° (SD 0.9°). The mean intra-operative lateral laxity in extension after implantation was 1.9° (SD 1.1°). The mean intra-operative medial laxity in flexion after implantation was 1.9° (SD 2.5°). The mean intra-operative lateral laxity in flexion after implantation was 3.0° (SD 2.8°).

The mean post-operative medial laxity in extension was 2.4° (SD 1.1°). The mean post-operative lateral laxity in extension was 2.0° (SD 1.7°). The mean post-operative medial laxity in flexion was 4.4° (SD 3.3°). The mean post-operative lateral laxity in flexion was 4.7° (SD 3.2°).

There was a significant difference between navigated and radiographic measurements for the pre-operative medial laxity in extension (mean = 1.4° - p = 0.005), the pre-operative lateral laxity in extension (mean = 2.6° - p = 0.01), the pre-operative lateral laxity in flexion (mean = 3.3° - p = 0.005). There was no significant difference between navigated and radiographic measurements for the pre-operative medial laxity in flexion (mean = 0.3° - p = 0.63).

There was a significant difference between navigated and radiographic measurements for the post-operative medial laxity in flexion (mean = 2.5° - p = 0.004). There was no significant difference between navigated and radiographic measurements for the post-operative medial laxity in extension (mean = 0.3° - p = 0.30), the post-operative lateral laxity in extension (mean = 0.2° - p = 0.76), the post-operative lateral laxity in flexion (mean = 1.7° - p = 0.06).

These differences were less than 2 degrees in most of the cases, and then considered as clinically irrelevant.

DISCUSSION: The navigation system used allowed measuring the medial and lateral laxity before and after TKR. This measurement was significantly different from the radiographic measurement by stress X-rays for pre-operative laxity, but not statistically different from the radiographic measurement by stress X-rays for post-operative laxity. The differences were mostly considered as clinically irrelevant. The navigated measurement of the knee laxity can be considered as accurate. The navigated measurement is valuable information for balancing the knee during TKR. The reproducibility of this balancing might be improved due to a more objective assessment.

CONCLUSION: The navigation system used allows measuring accurately and objectively the knee laxity during TKR.
Knee Range of Motion Depending on Different Femoral Component Designs: Evaluated In Vivo by a Navigation System

Purpose: ROM after TKA can be influenced by multi-factors such as preoperative range of motion, body habitus, implant design, intraoperative surgical technique, and postoperative rehabilitation. Recently many implant manufacturers have made modifications to traditional total knee designs to improved maximal knee flexion and range of motion. Some posterior cruciate ligament (PCL) stabilized total knee prostheses that incorporate design features intended to improve knee kinematics in high flexion were introduced and the use of these prostheses has attracted attention. Recently in the cruciate retaining (CR) prosthesis, high-flexion knee (CR-Flex) and gender-specified prosthesis were designed to allow a greater and safer flexion after TKA. The aim of this study was to evaluate the effect of cruciate retaining typed different femoral component design on knee range of motion using a computerized navigation system.

Materials & methods: 30 patients who underwent primary TKA because of primary osteoarthritis were included. EM navigation system was used in all cases. After tibia and femoral cutting using standard CR cutting block, standard fixed bearing CR knee (NexGen CR, Zimmer, Warsaw, IN) trial was inserted. If surgeon is satisfactory with alignment, stability and ligament balancing, the maximal knee extension and flexion was recorded using gravity by navigation system. Then, high-flexion fixed bearing CR knees (NexGen CR-Flex and Gender solution NexGen CR-Flex knee, Zimmer, Warsaw, IN) trial was inserted after additional posterior cutting. The maximal knee extension and flexion was evaluated exactly same way.

Results: Preoperative mean varus deformity was 10.52°. The mean flexion contracture was 7.52±6.81° and further flexion 129.9±7.94°. The average intraoperative maximal flexion of NexGen CR was 133.5±5.35° (125-146°) and that of hyper-flexion design were 135.5±5.77°(125-147°) in Nexgen CR-Flex and 136.1±5.76°(126-146°) in Gender knee. All knees showed greater than 125° of flexion regardless of the implant design. All knees can achieve physiologic leg alignment and nearly full extension of the knee after operation.

Conclusion: Hyper flexion designs showed subtle increase in mean maximal flexion and overall range of motion of the knee compared with the standard design, when it measured using navigation system intraoperatively. But clinically, it is not certain that these differences can lead to significant improvement of range of motion.
Robot Improves the Precision of Gamma and Delta Angles in Lateral X-Ray After TKA

[Introduction]:
Robotic-assisted total knee replacement has become a common method of implantation, especially in Europe and Asia. It frequently has been postulated that robotic cutting would result in an improved clinical outcome due to the better fit of the prosthesis, but that has never been demonstrated to our knowledge. The purpose of this study was to compare robotic-assisted implantation of a total knee replacement with conventional manual implantation.

[Material and method]:
We reviewed 72 patients who were scheduled for total knee replacement assigned to undergo either conventional manual implantation of a Zimmer LPS prosthesis (30 patients: Group I) or robotic-assisted implantation of such a prosthesis (32 patients: Group II). The five-axis ROBODOC was used for the robotic-assisted procedures. Preoperatively as well as at final follow up the Knee Society score were determined. Radiographs made at these intervals were analyzed for evidence of loosening, prosthetic alignment, and other complications.

[Results]:
The age of group I was 67.8±6.44 and that of group II was 62.7±6.51. In clinical assessment, the final follow up knee society score of group I was 90.9±4.88 points and that of group II was 91.6±2.94 points. The final follow up knee functional score of group I was 88.5±3.70 points and that of group II was 87.9±4.99 points. The postoperative range of motion of group I was 122±16.9 degrees and that of group II was 118±9.02 degrees. In radiological assessment, the postoperative tibiofemoral angles of group I was 5.3±2.6 degrees and that of group II was 6.0±1.8 degrees. The α and β angle of group I was 95.6±2.65, 88.6±2.58 degrees and that of group II was 97.7±0.97, 88.8±1.59 degrees. The α and β angle of group I was 4.19±3.28, 89.7±1.7 degrees and that of group II was 0.17±0.65, 85.5±0.92 degrees. The complications were observed in Group II: 1 superficial infection, 1 patellar tendon rupture, 1 dislocation of patella, 1 postoperative supracondylar fracture, 1 patellar fracture and 1 peroneal nerve palsy.

[Conclusions]:
The robotic-assisted technology had definite advantages in terms of preoperative planning, the accuracy of the intraoperative procedure and postoperative follow up, especially in α and β angle. But disadvantages were the high complication rate, which we believe was required for the more careful and experienced operative technique. Further study about the importance of α and β angle in TKA patients is needed before robotic popular usage.
Timing of ACL Reconstructive Surgery, and Risk of Cartilage Lesions and Meniscal Tears

Objective:
To establish a guiding algorithm on when to perform reconstructive ACL surgery in order to reduce the risk of meniscal tears and cartilage lesions in the ACL injured knee.

Design: Cohort study.

Setting: Norway.

Participants:
3475 patients reported to the National Knee Ligament Registry who had undergone primary ACL reconstruction surgery in Norway between June 7, 2004 and December 31, 2006.

Main outcome measures: Risk for cartilage lesions or meniscal tears.

Results:
In total there were 909 patients (26 %) with cartilage lesions, 1638 patients (47 %) with meniscal tears and 527 patients (15 %) with both cartilage lesions and meniscal tears. The odds for a cartilage lesion in the adult (17 years of age and older) knee increased by at least 1.006 for each month that elapsed from injury to primary ACL reconstruction. In addition, there was a further deterioration of the cartilage related to the aging of the young adult (17 to 40 years of age) patient independent of when the surgery was performed. Additional previous surgery to the index knee was aggravating this further. The same applied for young adults regarding meniscal tears. The presence of one degenerative lesion (i.e. cartilage lesion or meniscal tear) increased the odds of having the other degenerative lesion by between 1.6 and 2.0 in both children and adults.

Conclusion:
Early surgery may be recommended to adults with an ACL injured knee. This study provides the orthopaedic surgeons with a guiding algorithm on when to perform reconstructive ACL surgery in order to reduce the risk of meniscal tears and cartilage lesions in the ACL injured knee.
Bioabsorbable versus Titanium Interference Screws with Hamstring Autograft in ACL Reconstruction: A Prospective Randomised Trial with 2 Year Follow-up

Purpose: To prospectively assess the outcome of identically shaped bioabsorbable and titanium interference screws used for hamstring autograft ACL reconstruction - a randomised trial.

Methods: 100 patients were randomised to have either bioabsorbable or titanium interference screws used for graft tunnel fixation in hamstring autograft ACL reconstruction. Patients were objectively and subjectively assessed preoperatively, 3, 6, 12 and 24 months postoperatively. Radiographs at 12 months postoperatively were also assessed for tunnel width.

Results: There were no differences in clinical outcome using Lysholm and IKDC scores between the two groups at any stage of follow-up to two years. Tibial tunnel widths were the same between the 2 groups. There was slightly more tunnel widening in the femur using the bioabsorbable interference screws.

Conclusions: Identically shaped bioabsorbable and titanium interference screws used for hamstring autograft ACL reconstruction are equally successful up to 2 years postoperatively.

Level of Evidence: 1- Prospective randomised trial with >80% follow-up.
Clinical Results after Arthroscopic ACL Reconstruction Using Bone-Patellar Tendon-Bone Allograft, Tibialis Anterior Tendon Allograft and Hamstring Tendon Autograft

Purpose:
We compared the stability of the knee joint, graft status after arthroscopic anterior cruciate ligament (ACL) reconstruction using bone-patellar tendon-bone (BPTB) allografts, tibialis anterior tendon (TA) allografts and hamstring (HA) autografts by physical and quantitative test and by second look arthroscopy.

Materials and Methods:
We reviewed 442 patients who underwent ACL reconstruction between March 2000 and February 2006. The patients who had combined fracture in lower extremities, chondral injury, multiple ligament injuries, concomitant meniscal transplantation, revison ACL reconstruction or contralateral knee injury were excluded and 338 patients were analyzed. There were 60 cases of BPTB allograft, 153 cases of TA allograft and 125 cases of HA autograft. Average follow up duration of the three groups were 26.8 months, 22.7 months and 21.4 months, respectively. We compared preoperative and postoperative grades of range of motion (ROM), Lachman test, pivot shift test, KT-1000 arthrometer test and International Knee Documentation Committee (IKDC) knee examination form among the three groups. In 87 cases of second look arthroscopy, there were 16 cases in BPTB allograft group, 47 cases in TA allograft group and 43 cases in HA autograft group. We observed synovial coverage, graft tension, graft partial tear and impingement/cyclops lesion.

Results:
There was no difference among the three groups on ROM, Lachman test, pivot shift test, KT-1000 arthrometer test and IKDC grade preoperatively and at last follow up(p>0.05). In second look arthroscopy, Synovial coverage of more than 50% was found in 10/16 (62.5%) of the BPTB allograft group, 34/47 (72.3%) cases of the TA allograft group, and 39/43 (90.7%) cases of the HA autograft group. The incidence of synovial coverage of more than 50% was higher in the HA autograft group than in the other two groups(p=0.018, 0.026). No difference was found about graft tension, graft partial tear and impingement/cyclops lesion among the three groups(p>0.05). With regard to the IKDC grade, Grade A or B was found in 95.2% of the cases with synovial coverage of more than 50%, and 78.3% of the cases with coverage of less than 50%. There was a correlation between the extent of synovial coverage and IKDC grade (p=0.011).

Conclusion:
There was no difference in clinical evaluation of ACL reconstruction using BPTB allograft, TA allograft and HA autograft. But HA autograft group showed superior synovial coverage around the graft to the other two groups on second look arthroscopy and there was correlation between the extent of synovial coverage and IKDC grade.
Patellar Tendon vs. Hamstrings in ACL Reconstruction: 
A Five Year Follow-up Prospective Randomized Study

Single bundle, single tunnel reconstruction of ACL seems to be an “old procedure” after the recent development and knowledge about double-tunnel anatomical reconstruction of ACL. Despite the new trend, prospective long term follow up studies on the single bundle reconstruction are necessary to get more information on a technique that has occupied the last 20 years and has been executed on millions of patients.

From January 2002 and February 2003, hundred eight patients were recruited for a prospective randomized trial. The exclusion criteria were previous knee operations, chondral lesions, varus deformity more than 10 degrees, limb imbalance, meniscal lesion extension more than on third of the meniscus and history of knee tendinopathies. Three groups of 36 patients each were selected by the arthroscopically assisted surgical procedure: A B-PT-B reconstruction, B hamstrings (endobuttonCL-reabsorbable interference screw), and C hamstrings (endobuttonCL-evolgate). A dice method was used for the graft randomization. A standard rehabilitation protocol was used for all the patients, including immediate postoperative mobilisation with a knee brace just for walking (first 3 weeks), protected weight bearing for 2 weeks, and return to full activity at 6–12 months postoperatively.

The patients were followed up at 6 months, 1 year and then each year until the fifth year postoperative.

Five patients in group A, 6 in group B and 8 in group C were lost at the final follow up.

The methods of evaluation included clinical and instrumented laxity testing (Rolimeter), isokinetic muscle torque measurements (Cybex II), International Knee Documentation Committee II ratings, Lysholm score, Tegner activity level, Kujala patellofemoral knee scores, and radiological tunnel enlargement measure.

The results revealed no statistically significant differences with respect to IKDC II, Lysholm score, Isokinetic test and Kujala patellofemoral knee scores. There was an enlargement of the tunnels, statistically significant in the hamstring tendon groups, and more evident in the group B. Any widening of the tunnels from 3 to 5 years was recorded in either group.

The measurement of laxity using the Rolimeter showed better results for group A without any difference statistically significant. Differently, the Tegner score was statistically favourable for PT group.

Radiological narrowing of the joint spaces (IKDC) from 1 to 5 years postoperatively was seen in both the groups, however, without difference between the groups.
Operative Versus Non-operative Treatment of Anterior Cruciate Ligament Rupture in Patients Greater than 40 Years of Age: An Expected Values Decision Analysis

Purpose: Our purpose is to determine the optimal treatment of ACL rupture in patients over 40 years of age. We hypothesize that there is no difference in the expected value of surgical versus non-surgical treatment.

Methods: Our methods are expected values decision analysis with sensitivity analysis which is a systematic tool for quantitating clinical decisions. We evaluated 100 random individuals over 40 for the following variables: age, gender, activity level (IKDC), and visual analog scale regarding potential outcome preferences. Patients with prior knee injury or surgery were excluded. A decision tree was constructed (operative versus non-operative potential outcomes). Literature review determined probabilities of outcomes. Statistical fold-back analysis calculated optimum treatment. Sensitivity analysis determined effect of changing outcome probabilities on the decision.

Results: Sixty-nine patients were included; (31 with prior knee injury or surgery were excluded). Mean age was 53 (range 40-80), 48 % were male, activity level was normally distributed (with a slight lower activity skew as anticipated for an older population). Expected-value for operative treatment was 7.99 versus 1.86 for non-operative treatment. Increasing the probability of surgical complications (sensitivity analysis) decreased the expected value of operative treatment but not below the expected value of non-operative treatment.

Conclusion: In contrast to the null hypothesis, decision analysis demonstrates that surgery is the optimal treatment of ACL rupture in patients over 40 years of age. A limitation is that by convention, decision analysis does not investigate actual patients with the condition. It is clinically relevant that individuals over 40 are extremely averse to accepting potential knee instability during pivoting and thus prefer ACL surgery despite risk of surgical complications.
ACL Reconstruction in Patients Over 50 Years

Purpose
There is currently a paucity of data in the literature on anterior cruciate ligament (ACL) reconstruction in patients aged 50 years and older. The purpose of this study is to evaluate the results of ACL reconstruction in patients over fifty years of age at the time of surgery.

Methods
The records of all patients at our institution at least 50 years of age who underwent ACL reconstruction between 1990 and 2002 were reviewed. Inclusion criteria were age > 50, primary ACL reconstruction, and at least 24 months of follow-up. Patients with a history of multi-ligamentous injury were excluded. Pre-operative and post-operative clinical records were reviewed. Pre- and post-operative range of motion was recorded. IKDC, Lysholm, UCLA, and Tegner scores were calculated.

Results
There were 35 knees in 34 patients that met the inclusion criteria. The mean age of the patients was 57 years (50 to 66) and the mean clinical follow-up was for 72 months (25 to 173). A total of 23 knees were reconstructed with patellar tendon allograft, and 12 with patellar tendon autograft. The mean pre-operative knee extension was 1° (−5° to 10°) and flexion was 129° (125° to 150°) and at follow-up these values were 0° (−5° to 5°) and 135° (120° to 150°), respectively. Pre-operatively there were 31 knees (89%) with a Lachman grade 2+ or 3+. Post-operatively, 33 knees (94%) were Lachman grade 0 or 1+. The mean pre-and post-operative IKDC scores were 39 (range 23-72) and 90 (range 33-100) respectively. UCLA activity scores averaged 8.5 pre-injury, 4.3 post-injury and 8.3 post-operatively. Four knees required additional surgery following ACL reconstruction. There were three graft failures (8.6%) requiring revision. No patient was treated for post-operative arthrofibrosis, infection, or deep-vein thrombosis.

Conclusions
This study demonstrates satisfactory clinical and functional results in patients over 50 years of age undergoing anterior cruciate ligament reconstruction. Advanced chronologic age alone should not be considered a contraindication to reconstruction.
Objectives: The goal of this prospective, randomized study is the long-term evaluation of functional and radiological results after implant free press-fit ACL reconstruction performed using the bone-patella-tendon (PT) vs. hamstrings (HT) graft.

Methods: 62 ACL insufficient patients without any concomitant sports injuries took part in a prospective, randomized study. In the PT group 31 patients (18 male, 13 female) underwent ACL reconstruction using BPT graft. The HT group included 31 patients (15 male, 16 female) who underwent ACL reconstruction using a quadrupled hamstrings graft (semitendinosus and gracilis tendon). The time from injury to surgery was 1.51 years in group PT and 1.49 in group HT (NS). All patients were operated between 10’98 and 09’99 by the senior author. The average age in the group PT was 29.9 years (range 16-46 years) and 34.2 years (range 16-55) in group HT at the time of the operation. Both surgical procedures were performed without any implants in a press-fit technique. The same rehabilitation protocol was applied to both patient groups (accelerated rehabilitation, early weight bearing). At a mean follow-up time of 8.48 years (101.7 months) we examined 49 patients, 23 (14 male, 9 female) in group PT and 26 (14 male, 12 female) in group HT. All patients were examined 1 day pre-op, 3, 6, and 12 months and 8 years post-op with Tegner, Lysholm and the IKDC, KT-1000, one leg hop test, kneeling and knee walking test and isokinetic testing. We also performed bilateral MRI to determine the cartilage defects of both injured and uninjured knee according to the ICRS protocol and compared this with the pre-operative status. For statistical analysis we used the Student’s t-test. The level of significance was p<0.05.

Results: At a mean of 8.48 years after surgery we found 6 ruptured grafts (12.2%), 3 in each group. 4 of these ruptures, 2 in the PT (8.6%) and 2 in the HT group (7.7%), were connected with new sport injuries. These patients were excluded for final examination. The Tegner Score of the other 43 patients was 4.86 in group PT vs. 5.29 in group HT (NS) compared to the pre-operative results of 4.0 vs. 4.1 (NS). The Lysholm Score was 87.2 vs. 92.47 (NS/p=0.32) compared to pre-op values of 65.4 vs. 65.7 (NS). 16 patients in the patellar tendon group and 23 patients in the hamstring group had normal or nearly normal scores in the IKDC Score (A or B) throughout the review (69.23%/88.89%). The KT-1000 stability test showed a side-to-side difference of <3mm in 92.86% of the PT group and in 88.24% of the HT group (NS). A pivot shift glide had 28.6% of the cases in group PT and 17.6% in group HT. There was no gross pivot shift in either group. Concerning ROM, there were no significant side-to-side difference in flexion deficit (2.5°/1.6°) and extension deficit (0.7°/0.5°). Isokinetic testing showed nearly normal quadriceps function in both groups (91.2% /92.4%). However, there was a significant lower hamstrings strength in the HT group (99.0%/91.4%; p=0.029), unchanged since the 12 months follow-up. The significant difference of kneeling and knee walking test between both groups at the 12 months FU persisted at the 8 year follow-up. Kneeling: 1.36/1.06 (p=0.038); knee walking: 1.64/1.06 (p=0.028). The single leg hop test was significantly better in group HT (97.0%) than in group PT (92.4%; p<0.05). MRI measurements of tunnel size did not show any tunnel widening of the femoral tunnel 8 years post-op (2.11%/0.4%). However, the tibial tunnels were significantly widened in both groups (+25.38% in group PT and +20.5% in group HT). Concerning the cartilage status, 61.6% in the PT group and 88.3% in the HT group had normal or nearly normal MRI results (p<0.05). The Caton Index for patellar height in the PT group was +0.002 compared with the uninjured knee and -0.011 in the HT group (NS).

Conclusion: The implant free press-fit technique of ACL reconstruction using PT and HT graft is an excellent procedure to restore stability and function of the knee. Using hamstring as graft, a significant lower morbidity was noted except for a persistent hamstring deficit.
Arthroscopic ACL Reconstruction: Results of 8 to 10 Years Follow-up

Anterior cruciate ligament rupture is a common lesion, particularly in sport activities. Various surgical procedures and graft selections have been proposed for ACL reconstruction. In past years, the BPTB and hamstring tendons have been the most common type of graft used. More recent studies have pointed out that a patellar tendon graft can cause an increased incidence of anterior knee pain, flexion contracture of the knee and delayed recovery of the strength. The purpose of this study was to evaluate the functional results after ACL reconstruction using the hamstring graft via 8-10 years follow-up.

Between 1998 and 2000, 140 consecutive patients with a primary diagnosis of anterior cruciate deficiency underwent arthroscopically assisted ACL reconstruction using autogenous quadrupled semitendinosus + gracilis tendons. The graft fixation was used the Endobutton on the femoral site and screw + washer on the tibial site. On follow-up, the study included 90 patients, 65 male and 25 female, with a mean age 22.7 years (range, 18 to 29) at the time of surgery. Postoperatively, patients were assessed for clinical instability and laxity after mean follow-up of 6.7 years (range, 5 to 8). Clinical evaluation was performed by using the modified Lysholm scoring scale and the International Knee Documentation Committee (IKDC) rating system. To assess muscle force evaluation, quadriceps strength was measured with a Tricone Isokinetic Dynanometer (Lumex Inc., Ronkonkoma, NY). One-way analysis of variance was used to determine pre-and post-operative differences for all variables. The significance level was set at $P < 0.05$.

The clinical results for the Lysholm rating system were 91% good to excellent, while for the IKDC rating system was rated 85%. The results of the Lachman and pivot shift tests between pre-and post-operative were revealed statistically significant ($P < 0.05$). Eighty two of the 90 knees surveyed achieved full range of motion postoperatively. Meanwhile two patients displayed a 10° loss of full extension, three patients had a 5° to 10° loss of flexion and three patients displayed a 5° loss of full extension as compared to uninvolved knee. The anterior tibial displacement was measured with a K-T 1000 and the results were compared with the uninvolved knee, revealing nearly 90% cases less than 3 mm. The roentgenographic studies performed at follow-up exhibited degenerative change less than 15% (12 of 90 knees). Moreover, postoperative isokinetic quadriceps strength testing results comparing the two legs showed no significant difference ($P < 0.05$). Additionally, peak torque did not differ significantly at either 60 deg/sec or 240 deg/sec between the involved and uninvolved group. Finally, the quadriceps index indicated no significant difference in both legs. This investigation proposes that ACL reconstruction using the autogenous hamstring graft and fixation by Endobutton devices achieve good clinical outcome on 8-10 years follow-up.
Outcome of Arthroscopic Anterior Cruciate Ligament Reconstruction Using Fresh-Frozen Bone-Patellar-Tendon-Bone Allografts: 15-year Follow-up

Purpose: To evaluate the long-term outcomes following arthroscopic assisted anterior cruciate ligament (ACL) reconstruction using fresh-frozen bone-patellar-tendon-bone (BPTB) allografts.

Methods: Between 1991 and 1992 38 patients underwent ACL reconstruction using a BPTB allograft by a single surgeon. The same technique was used in all operations, which consisted of the 1-incision endoscopic approach. Of these patients 31 were available for full evaluation. Evaluation included: history, the Knee injury and Osteoarthritis Outcome Score (KOOS), Tegner score, physical examination, functional knee ligament testing and the International Knee Documentation Committee standard evaluation form (IKDC). Degenerative joint disease on radiographs was scored as prescribed in the x-ray section of the IKDC evaluation form.

Results: The average age of the 38 patients at the time of operation was 29.2 (range 13-46) and the mean duration to follow-up was 14.5 years (range 13-16). Three patients were lost to follow-up. 29 reoperations were performed in 17 patients. Reoperations consisted of removal of the fixation material (11 patients), meniscectomy (5 patients), cyclops (2 patients), high tibial osteotomy (2 patients) or revision of the ACL (4 patients, of whom one had a total knee prosthesis afterwards), total knee prosthesis (1 patient and one was expecting one in the near future) and a diagnostic arthroscopy (4 patients). 31 of the 38 patients were available for full examination (3 patients lost to follow-up, 3 patients with a revision surgery and one with a total knee prosthesis). The mean scores for the KOOS subscales were 88.7 for Pain (±20.7), 79.3 for Symptom (±20.0), 90.5 for ADL (±18.5), 72.3 for Sport/Rec (±32.3) and 75.2 for QOL (±26.2). The mean Tegner score was 4.2 (±2.2). Using the IKDC evaluation score 3 patients were classified as normal (group A), 11 as nearly normal (group B), 12 as abnormal (group C) and 5 as severely abnormal (group D). 24 patients showed none or mild degenerative joint disease (group A and B). 2 patients showed moderate (group C) and 5 patients severe (group D) degenerative joint disease.

Conclusion: Only 14 patients (45.2%) were classified as normal or nearly normal using the IKDC evaluation score. More than half of the patients (54.8%) required one or more re-operations and 7 patients (22.6%) showed moderate or severe degenerative joint disease.
Osteoarthritis Incidence Ten Years After Arthroscopic ACL Reconstruction

Introduction: During the past several decades, many changes in the management of an anterior cruciate ligament (ACL) tear have occurred, regarding the preservation of the meniscal tissue, arthroscopic techniques, and rehabilitation. Limitations of previous studies, in addition to ongoing modifications in ACL deficiency management, emphasize the need for studies with long-term follow-up to evaluate contemporary practices. The purpose of this study was to evaluate the long-term outcomes specifically regarding OA incidence following a modern management of ACL tear, including arthroscopic procedure using a bone-tendon patellar-bone auto-graft (BTPB) along with early rehabilitation.

Material and Methods: An institutional prospective computerized database of ACL reconstruction was established in 1992. A case series of 101 ACL reconstructed between January 1993 and December 1994 was performed. Inclusion criteria were: reconstruction with BTPB graft, a minimum of ten years of follow-up, a standardized operative procedure and no previous ACL repair or associated ligament lesions. The meniscus status and cartilage lesions were recorded. The graft was fixed on both sides with interference metal screws. Before surgery, the mean age of patients was 28.8 year +/- 8.3 (mean + SD). Follow-up assessment was established with the IKDC 2000 form. Instrument testing was performed using a KT-1000 arthrometer to assess the laxity. Joint space narrowing assessment used the IKDC score with a 30° posterior anterior weight bearing view. Mean follow-up was 11.6 +/- 0.8 years.

Results: Nine Knees (8.9%) suffered a graft rupture during the 11-year assessment period. Further meniscus surgery was performed in less than 9 % of subjects. At follow-up, the satisfaction rate was excellent (90%). Before injury, 3 patients were not involved in sport activities. Two years following ACL reconstruction, that number rose to 10 patients (10.2%). And at final follow-up, 25 patients (26.3%) either stopped or never returned to sport participation. The mean subjective IKDC 2000 score was 90.5 + 8.8 points. Kneeling was painful in 48% of patients. The subjective IKDC score was statically correlated to laxity, time from injury, and osteoarthritis. Using the full IKDC assessment for follow-up, 91 knees (90.1%) had a normal or nearly normal overall IKDC grade (graded as A or B) and ten knees (9.9%) had an abnormal grade (graded as C). The radiological assessment reported 17.8% of osteoarthritis and 39% of radiological changes. Osteoarthritis was associated with a higher pre-operative body mass index (BMI) (p = 0.01) and a higher age at follow-up (p=0.006). In a selected population without meniscus or cartilage tear, an osteoarthritis rate of only 8% was found.

Conclusions: ACL reconstruction with BPTB graft and early rehabilitation offers excellent outcomes after eleven years. Moreover, a high percentage of patients remained involved in sports activities. However, knee osteoarthritis developed in 17, 8 % of subjects.
The Prevention of Post-Operative Arthrosis Following ACL Reconstruction Is Possible if Osseous Homeostasis is Restored and Maintained

Background: Recent reports from the USA, Europe, and Asia have documented the disconcerting phenomenon of early knee arthrosis following even biomechanically well done ACL reconstructive surgery. In prior work, we have suggested that the achievement of a normal Tc 99-MDP bone scan - representing an objective marker of the restoration of osseous/joint homeostasis – following ACL reconstructive (and other) knee surgery is predictive of the absence of DJD out to 7 years. In this work, we report on 19 patients with 20 ACL reconstructed knees followed to between 10 to 15 years postoperatively both radiographically and scintigraphically.

Materials and methods: 19 patients (14 males and 5 females with a mean age of 28 - range 18 to 43 -at the time of single bundle BTB autograft reconstruction by SFD) with 20 reconstructed knees are included in this report. In addition to a history and physical examination, all patients had a Rosenberg X-ray and a standard 3 hr delayed static Tc 99MDP bone scan of the knees between 10 and 15 (mean 12.8) years post reconstruction.

Results: 18/20 knees demonstrated a normal or nearly normal Rosenberg X-ray and bone scan of the involved knee. Two of the 20 knees demonstrated a positive bone scan associated with radiographic signs of degenerative arthrosis (joint space narrowing and osteophyte formation). The degree of post-operative laxity did not correlate with the absence of degenerative changes.

Discussion: In prior work, we have shown that persistent loss of osseous homeostasis (manifested by positive bone scans) identifies knees “at risk” of developing early arthritis. In this work we have demonstrated in a population of ACL reconstructed knees using a single-bundle BTB autograft technique - the principle that if osseous/joint homeostasis can be restored and maintained (currently best documented by normal bone scans) such knees can remain free of degenerative changes out to a mean of 12.8 years post-operatively. For those who may wish to avoid irreversible degenerative arthrosis in ACL reconstructed knees, it is recommended that the achievement of osseous/joint homeostasis become a clinical priority.
Tibial Rotation is Restored After ACL Reconstruction with a Single Bundle Hamstring Graft

BACKGROUND:
It has been suggested that excessive tibial rotation during pivoting tasks is not controlled by single bundle anterior cruciate ligament (ACL) reconstruction using both patellar tendon and hamstring grafts. This may in part be explained by the angle of the graft in the coronal plane, with a more vertically placed graft being less able to control rotation. The purpose of this study was to assess tibial rotation after ACL reconstruction with an obliquely placed graft and to compare reconstructions with semitendinosus alone (ST) or with semitendinosus and gracilis (STGR).

METHODS:
20 patients were evaluated. All patients had undergone a primary ACL reconstruction using a quadrupled hamstring tendon graft (9 ST and 9 STGR) for an isolated ACL injury within 6 months of injury. There were 2 females and 7 males in each group. All patients were at least 2 years from surgery (ST: mean 35 months, STGR mean 37 months) and all had made a good functional recovery and returned to their pre-injury sporting activities. Evaluation consisted of IKDC 2000, instrumented laxity testing with KT 1000, and 3D motion analysis to record tibial rotation when the subjects descended stairs and pivoted 90 degrees on landing using a similar protocol to that which has previously been reported in the literature.

RESULTS:
All patients had made a good recovery (mean IKDC score >90 for both groups) and there were no significant differences between the ST and STGR subjects for any of the background variables including anterior knee laxity. There were no differences in tibial rotation between the operated (mean: 20.2°) and non operated limb (mean: 19.4°). There was no significant difference between the graft types (ST: 18.7°, STGR: 20.0°).

DISCUSSION:
Contrary to previous reports, we found restoration of normal tibial rotation during the pivoting task after a single bundle ACL reconstruction technique. The lack of difference between the ST and STGR groups suggests that this restoration of normal tibial rotation is due to static rather than dynamic restraints. We suggest that it probably reflects the more horizontal graft orientation in the coronal plane for patients in the current study compared to that reported in previous studies.
Contributions of the Posterolateral Bundle of the Anterior Cruciate Ligament to Anterior-Posterior Knee Laxity and Ligament Forces

Purpose: The purpose of this study was to measure changes in anterior-posterior laxity and graft forces after cutting the posterolateral (PL) bundle of the anterior cruciate ligament (ACL).

Methods: Twelve fresh frozen cadaveric knees underwent anterior-posterior (AP) laxity testing at +100N of applied tibial force. Resultant forces in the ACL were recorded during passive extension from 120° to 0° with no tibial force, 100N anterior tibial force, 100N quadriceps force, and 5 N-m internal tibial torque. The femoral origin of the PL bundle was identified, the ligament fibers were dissected from bone, and tests were repeated.

Results: Cutting the PL bundle significantly increased mean laxity +1.3 mm (at 0°), +1.1 mm (at 10°), and +0.5 mm (at 30°). For the passive knee extension tests, cutting the PL bundle significantly decreased mean ACL force at 0° for all loading modes; mean decreases were 31N (no tibial force), 50N (100N anterior force), 33N (100N quadriceps force), and 40N (5 N-m internal torque).

Conclusions: The decreases in ACL force at 0° from cutting the PL bundle are consistent with the commonly accepted view that the PL bundle tightens with knee extension. Cutting the taut PL bundle did significantly increase AP laxity between 0° and 30°, but the increases were relatively small. Therefore we conclude that the PL bundle plays a relative minor role in controlling anterior tibial translation.

Clinical Relevance: In view of our findings, the need to reconstruct the PL bundle for better restoration of a normal AP laxity profile is questioned.
Potential Risk of Damage to the Nerve and Cartilage Making a Femoral Tunnel Through the Far Anteromedial Portal in Double-Bundle Anterior Cruciate Ligament Reconstruction – Cadaveric Knee Evaluation

(Introduction)
Recently, double-bundle Anterior cruciate ligament (ACL) reconstruction has been developed through biomechanical and clinical studies. In double-bundle ACL reconstruction, making a femoral tunnel through the far anteromedial portal provides more flexibility for drilling the anatomical femoral attachments of the anteromedial bundle (AMB) and the posterolateral bundle (PLB) of ACL. However, if the direction of drilling for femoral tunnel construction is inappropriate, there are potential risks for damage to the common peroneal nerve and the articular cartilage of the lateral femoral condyle.

The purpose of this study was to estimate the potential risks associated with making the femoral tunnel through the far anteromedial portal in double-bundle ACL reconstruction using cadaveric knees.

(Materials and Methods)
In this study, 10 cadaveric knees (5 cadavers: 2 males and 3 females), excluding malalignment of legs and severe osteoarthritis, were used. The average age of the subjects at the time of death, was 72.6 years. We opened the knee joint and identified the anatomical femoral attachments of AMB and PLB. The common peroneal nerve and the articular cartilage of the lateral femoral condyle were exposed on the lateral side of the knee. We drilled the passing pin to the center of the anatomical femoral attachments of AMB and PLB through the far anteromedial portal at three different knee flexion angles: 70°, 90°, 110° of knee flexion. We identified the femoral passing point as the femoral tunnel making point, and measured the length of the femoral tunnel, the shortest distance to the common peroneal nerve and the articular cartilage of the lateral femoral condyle, to evaluate the potential risks of damage to the nerve and the cartilage.

(Results)
The lengths of the femoral tunnel were no more than 25 mm in one knee when drilling the AMB and in four when drilling the PMB at a knee flexion angle of 70°. The shortest distances at a flexion angle of 70° to the common peroneal nerve were no more than 10 mm in seven AMB cases and in nine PLB cases, and at 90° in one AMB and five PLBs. On the other hand, the distances were no less than 10 mm in all the AMBs and PLBs at a knee flexion angle of 110°. In all AMB and PLB knees at 70°, the shortest distances to the articular cartilage were no more than 10 mm. In particular, the pin directly passed the articular cartilage in all PMBs. The distances were no more than 10 mm in two AMBs and all PMBs at 90°, but in only two PLBs at 110°.

(Discussion)
In our measurements, the shortest distances from the femoral tunnel making point to the common peroneal nerve and the articular cartilage of the lateral femoral condyle were no more than 10 mm in a high proportion of the subjects at shallow knee flexion angles. In this study, we proposed that making a femoral tunnel through the far anteromedial portal at shallow knee flexion angles in double-bundle ACL reconstructions may have the potential risk of damage to the nerve and the cartilage.
Analysis of the Graft Bending Angle at the Femoral Tunnel Aperture in Anatomic Double Bundle Anterior Cruciate Ligament Reconstruction: A Comparison of the Transtibial and the Far Anteromedial Portal Technique

Introduction: The partial graft tear at femoral tunnel aperture was often reported in the arthroscopic evaluations of anatomic double-bundle ACL reconstruction. One of the factors responsible for the graft damage could be the repetitive bending stress on the graft at femoral tunnel aperture, because the grafts are exposed to abrasive force at the contact area on the sharp edge of the bone tunnel aperture when the graft is acutely bent and stretched. Furthermore, it was reported that the graft damage was correlated with the postoperative knee stability. Therefore, it is important to adopt a technique which minimizes the bending stress on the graft at the femoral tunnel aperture. There are two major reported techniques for creating the femoral tunnel, drilling through the tibial tunnel (transtibial technique) and drilling through the far anteromedial portal (far anteromedial portal technique). No studies have examined the three dimensional bending angles of the graft at the femoral tunnel aperture in two techniques. The purpose of this study is to investigate and compare the three dimensional bending angle of the graft at the femoral tunnel aperture in two techniques by in-vitro cadaveric measurement using a computer simulation.

Materials and Methods: Seven fresh frozen human cadaveric knees were used in this study. Six degrees-of-freedom (DOF) of knee kinematics and knee position data were measured using an electromagnetic device (FASTRAK, Polhemus, Vermont). The system consists of a transmitter which produces an electromagnetic field, and three electromagnetic receivers. Two of the receivers are rigidly fixed to the femur and the tibia. The third receiver is attached to the end of a stylus of our own design, which is used for indicating three dimensional positions. First, the 6 DOF of the intact knee kinematics before transecting the ACL was measured through the passive knee motion.

Second, the three dimensional images of the anatomical AM and PL bundle were entered into the computer and defined as the virtual AM and PL graft. To digitize the position data of the AM and PL bundle, the ACL was resected in its midsubstance arthroscopically, and the anatomical centers of the femoral and tibial attachment sites of the AM and PL bundle were indicated using the stylus with the receiver. The acquired positions of the femoral and tibial attachment sites of the AM and PL bundle were connected and regarded as the virtual AM and PL graft.

Third, the far anteromedial portal was created at 2 cm posteromedial to the standard anteromedial portal. The location of the far anteromedial portal was indicated by the stylus and its position data was recorded. In order to assess the stress on the graft, the length between the femoral and tibial attachment sites of the AM and PL bundle were calculated. The acquired positions of the femoral and tibial attachment sites of the AM and PL bundle were connected and the length of each bundles were calculated at every 10 degrees of knee flexion throughout the recorded intact knee motion.

To measure the graft bending angle using the transtibial technique, the extended lines of the virtual AM and PL graft to the femoral side at 90 degrees of knee flexion were acquired as a virtual femoral tunnel. As the graft bending angle at the aperture of the femoral bone tunnel was defined as the angle between virtual femoral tunnels and virtual grafts, calculations were made at every 10 degrees of knee flexion throughout the recorded intact knee motion.

Moreover, the graft bending angle using the far anteromedial portal technique was calculated as follows. The acquired position of the femoral attachment site of each bundles and that of the far anteromedial portal were connected and the virtual femoral tunnel were created along the connecting line to the femoral side at 110 degrees of knee flexion, which
was the common angle for drilling the femoral tunnel in the far anteromedial portal technique. The each graft bending angle was defined as the angle between this virtual femoral tunnels and the virtual grafts, and the graft bending angles were calculated at every 10 degrees of knee flexion in the same way.

Results: The length of AM and the PL bundle increased from 90 degrees to 0 degree of knee flexion and remained stationary from 90 degrees to 130 degrees of knee flexion. The length change of the AM and PL bundle from 90 degrees to 0 degree of knee flexion were 6.2 ± 3.7 mm and 10.3 ± 4.0 mm. The length change of the PL bundle from 90 degrees to 0 degree was significantly larger than that of the AM bundle. (paired t-test, P <0.01)
The AM and PL graft bending angles in all knees reached their maximum at full extension of the knee in both techniques. At full extension of the knee, the AM and PL graft bending angles were 66.1 ± 3.7 degrees and 72.0 ± 6.1 degrees in the transtibial technique and were 59.0 ± 3.6 degrees and 55.9 ± 4.0 degrees in the far anteromedial portal technique. The AM and PL graft bending angles in the transtibial technique were significantly larger than that in the far anteromedial portal technique at low flexion angles (AM : 0~10 degrees ,PL : 0~50 degrees) . (paired t-test, P < 0.01)

Discussion: The length change of the PL bundle was larger than that of AM bundle at low flexion angle (0 ~ 90 degrees). Therefore, the PL graft could be subject to an excessive stress at near extension and such biomechanical environment might be responsible for the PL graft damage. Accordingly, it is necessary to avoid the stress exerted onto the PL graft at extension of the knee. In this study, the far anteromedial portal technique can contribute to make the bending angle more obtuse in the PL graft at the femoral tunnel aperture than the transtibial technique, which may reduce the abrasive stress at the site in anatomic double-bundle ACL reconstruction.
ACL to PCL Impingement: MRI and Arthroscopic Evaluation
Before and After ACL Double Bundle Reconstruction

Introduction: The purpose of this study was to evaluate anatomic findings in human cadaver knees concerning ACL to PCL Impingement in various settings of range of motions (ROM) and dynamic changes and interaction between the ACL and PCL in the human knee joint before and after anatomical double bundle reconstruction.

Methods: Six human cadaver knees, with no previous knee injury were examined to perform this study. These six human cadaver knees were examined using a standardized MRI imaging protocol for ACL und PCL prae.- and postoperatively. The imaging was performed in a high resolution 1.5T MRI using a special designated wrist coil at 0°, 45° and 90° of extension/flexion of the knee in continuous sagital TSE - weighted as well as two continuous TSE – weighted oblique coronal views, One oblique coronal view was perpendicular to the longitudinal axis of the ACL, and the other perpendicular to the longitudinal axis of the PCL. All relevant picture files were measured concerning ACL and PCL length and width, distances in between the ligaments in correlation to notch width and areas above and in between the ligamentous structures, as well as shapes and angles of the ligaments. All the images were analyzed with special interest concerning any signs of Impingement.

After prae op scanning an arthroscopy of the knee joint was performed using a 6 portal standard approach in various settings of ROM to evaluate the anatomic relation between the two big ligamentous structures in the knee in these various angles of knee motion. This was followed by an anatomical double bundle reconstruction.

Results: No signs of Impingement could be found in any of the cadaver knees between 0° and 90° of knee motion. MRI imaging as well as the arthroscopic and microscopic evaluation showed that the ACL and PCL showed an alteration of various shapes and sizes in different positions of ROM of the human knee, without ever touching in these static (MRI) and dynamic evaluations (ASK/microscopic high imaging).

Discussion: The authors of this study believe that ACL to PCL Impingement does not occur in normal functioning human knees and after anatomically exact reconstructed ACL double bundle surgery during movements between 0° and 90° but that events, for example trauma (hyperextension/rotational) or ACL surgery with misplaced tunnels may cause Impingement and following structural damage to the cruciate ligaments in the knee.
Postoperative Evaluation of Tunnel Position by Radiography in Anatomic Double-Bundle ACL Reconstruction: Correlation with Clinical Results

Background:
Double-bundle ACL reconstruction has been proposed to restore normal anatomy and kinematics of the knee, however non-anatomic tunnel placement may lead to less than optimal clinical outcomes. The purpose of this study was to determine the relationship between tunnel placement and clinical outcomes following double-bundle ACL reconstruction.

Hypothesis: Anatomic tunnel placement will be related to better clinical outcomes.

Methods:
The tunnel positions for 67 subjects that underwent double-bundle ACL reconstruction were measured on post-operative radiographs. Forty males and 27 females were included in this study. Their average age was 27.39 ± 11.04 years and the average length of follow-up was 2.07 ± 0.52 years. Femoral length was measured as the distance from the most posterior contour of the lateral femoral condyle parallel to Blumensaat’s line and femoral height was measured as the perpendicular distance from Blumensaat’s line. Tibial depth was measured as the distance from the most anterior aspect of the tibia on the sagittal view and tibial width was measured as the distance from the medial tibial plateau on the AP view. All measurements of tunnel position were normalized to express the position as the percentage of medial-lateral and anterior-posterior distance on the tibial plateau and the proximal-distal and anterior-posterior position on the femoral condyle. The relationships between tunnel position and clinical outcomes including range of motion, manual and instrumented laxity and patient-reported outcome were analyzed.

Results:
On average, the center of the femoral AM insertion of the ACL was located at 26.3% of the femoral length and at 17.6% of the femoral height. The center of the femoral PL insertion was located at 40.2% of the femoral length and 40.8% of the femoral height. The center of the tibial AM and PL insertions were located at 34.8% and 52.6% of the AP tibial length and at 43.2% and 47.2% of the tibial width, respectively. A higher and more anterior position of the AM femoral tunnel was associated with a greater perception of instability. Lower position of the PL femoral tunnel was associated with higher Activities of Daily Living Scores. More posterior placement of the AM tibial tunnels was associated with a greater KT-1000 side to side difference.

Conclusion:
Our results indicate that placing the AM and PL femoral tunnels closer to their anatomic insertion sites leads to improved clinical outcomes. The results also suggest that more anatomic placement of the AM tibial tunnel better restores normal AP knee laxity.

Key words: Anterior cruciate ligament, double bundle, reconstruction, tunnel placement, radiography
The Use of 3-D CT Scan to Validate the Position of the Femoral Tunnels in Anatomic Double-bundle ACL Reconstruction

Purpose: The success of anatomic double-bundle ACL reconstruction is strongly related to tunnel positioning. Quantification and validation of tunnel location is still subject to debate. We performed a clinical study for evaluating the positioning of femoral anteromedial (AM) and posterolateral (PL) tunnels following anatomic double-bundle ACL reconstruction using high-speed 3-D computed tomography (3-D CT). We hypothesize that the position of the tunnels drilled with a specifically designed aimer will be located within the native ACL femoral footprint limits.

Type of study: case controlled series

Methods: anatomic double-bundle ACL reconstruction with hamstrings tendons was performed with the Anatomic Director instruments set. During surgery the centre of each bundle was marked with a thermal probe. After drilling the AM tunnel through the AM portal, the PL tunnel was drilled with a specific PL aimer inserted through a far medial portal in the previously drilled AM tunnel. Thirty five continuous patients were enrolled in the study and prospectively evaluated with high speed 3-D CT scan performed within 1–3 days following surgery. Three-D reconstructions of both intact and involved knees were performed using the volume rendering technique, with the contralateral knee as control. In the control group, we measured the angle formed between the resident's ridge -which is parallel to the longitudinal axis of the ACL footprint- and the axis of the femoral diaphysis, named the “footprint angle” (FA) and the angle formed between the ridge and the Blumensaat’s line (FB). On the involved side, using the axis passing through the centres of both tunnels as a reference line, FA and FB angles were also measured. The AP- and proximo-distal diameters of the ACL attachment area were measured. Also, in the involved side, the distances of ACL from the anterior, posterior and distal cartilage borders were measured and compared with the results of anatomical studies available in the literature. Finally, the distance from the centres and the bone bridge between the tunnels were also measured.

Results: the morphometric data for the involved group were the following: FA 31.4° ± 15.2°, FB 67.0° ± 16.9°, AP footprint diameter (mm) 17.2 ± 2.1, proximo distal diameter 8.1 ± 0.9, distances to cartilage (mm), posterior 2.2 ± 1.6, anterior 1.1 ± 0.7, distal 2.7 ± 1.2, distance between AM and PL bundle centres (mm) 9.4 ± 1.2. For the control group, FA 26.5° ± 4.7°, FB 61.6° ± 6.8°, AP footprint diameter (mm) 17.3 ± 1.7, proximo distal diameter 8.8 ± 1, distances to cartilage (mm), posterior 2.5 ± 1.1, anterior 1.8 ± 1.3, distal 2.8 ± 1.5, distance between AM and PL bundle centres (mm) 8.2 ± 1.2. There was no significant difference between the different values of the two groups. The native and reconstructed footprints were always entirely located distal to the resident’s ridge. A highly significant correlation was found between FA and FB in both control (r = 0.71) and involved (r = 0.9) groups. The bone bridge thickness between the tunnels was 2.9mm ± 1.1mm.

Discussion and conclusions: the morphometry of the femoral footprint of the ACL can be quantified using both its orientation and distances with regard to the local anatomical bony ridges, and cartilage borders landmarks. Locating the tunnels within the ACL footprint limits with appropriate restoration of the angle between the long axis of the femur and the long axis of the ACL femoral footprint are appropriate criteria to validate the proper positioning of the femoral tunnels when an anatomic double-bundle ACL reconstruction is performed. The use of a specifically-designed posterolateral femoral aimer allows duplicating the true morphometry of the native ACL footprint. Finally, as FA and FB are highly correlated, it is possible to use FB only to validate the footprint orientation on regular X-ray lateral view.
Effects of Initial Graft Tension on Clinical Outcome After Anatomic Double-bundle Anterior Cruciate Ligament Reconstruction: Comparisons Among Three Tensioning Techniques

INTRODUCTION:
Graft tensioning is one of the important factors that influence the clinical outcome of anterior cruciate ligament (ACL) reconstruction. The effect of initial graft tension on the clinical results of single-bundle ACL reconstruction has been studied by several studies. However, no studies have clarified the effect of initial graft tension on the clinical outcome after anatomic double-bundle ACL reconstruction. We have developed the first procedure for anatomic double-bundle ACL reconstruction (Arthroscopy 2004), and evaluated the clinical results (Arthroscopy 2006, AJSM 2008). We also clarified the effect of initial tension on the tension-knee flexion angle curves of the anteromedial (AM) and the posterolateral (PL) grafts transplanted with our clinical procedure (Arthroscopy 2007). Based on these fundamental studies, we have conducted a prospective clinical study to clarify the effect of initial graft tension on clinical outcome after anatomic double-bundle anterior cruciate ligament reconstruction. The specific aim of this study is to compare clinical outcome after anatomic double-bundle ACL reconstruction among three tensioning techniques with different combinations of initial tension applied to the AM and PL grafts.

MATERIALS AND METHODS:
A prospective comparative cohort study was carried out with 125 consecutive patients who underwent anatomic double-bundle ACL reconstruction using the hamstring tendon hybrid grafts (Arthroscopy 2004) in the unilateral knee. The patients were divided into three groups. In Group I (44 patients), a 40-N tension was applied to both the AM and PL grafts at 30 degrees of knee flexion. In Group II (28 patients), 50-N and 30-N tensions were applied to the AM and PL grafts, respectively, at 30 degrees of knee flexion. In Group III (53 patients), a 30-N tension was applied to both the AM and PL grafts at 10 degrees of knee flexion. All operations were performed by one surgeon using the same procedure. Two tunnels that passed through the anatomical attachment of the AM and PL bundles, respectively, were drilled in the tibia. Then, two femoral tunnels that passed through the center of the anatomical femoral attachment of each bundle were drilled through each tibial tunnel. After the femoral side of each graft was secured with an Endobutton, the above-described initial tension was simultaneously applied to the two grafts for 2 minutes at a selected angle of knee flexion using tensiometers. Then, two tibial tape portions of the hybrid grafts were simultaneously fixed with two spiked staples in the turn-buckle stapling technique. Postoperatively, the same rehabilitation protocol was used for each patient. All the 125 patients were evaluated at the time of one year after surgery. Objective evaluations involved a range of knee motion, the side-to-side anterior laxity measured at 30 degrees of flexion (KT-2000 Arthrometer), and quadriceps and hamstring strength (Cybex II). As to the overall evaluation, the Lysholm knee score and the IKDC form were used. Statistical comparison was made among the three groups using the analysis of variance (ANOVA) with the Fisher’s PLSD test for post hoc multiple comparisons. Significance level was set at p=0.05. For non-parametric comparisons, the chi-square test was used.
RESULTS:
There were no significant differences in the background factors among the three groups. No intra-operative and postoperative complications were experienced in this study. The postoperative side-to-side anterior laxity averaged 1.1 (SD: 1.7), 0.9 (SD: 1.5), and 0.9 (SD: 2.1) mm in Groups I, II, and III, respectively. The ANOVA demonstrated no significant difference among the three groups. Concerning the range of knee motion, the muscle strength, the Lysholm knee score, and the IKDC evaluation, there were no significant differences among the three groups. Concerning the postoperative range of knee motion, although no statistical significance was calculated among the three groups, loss of knee extension by 5 degrees or more was found in 3 patients out of Group I, in 1 patient out of Group II, and in no patients out of Group III.

CONCLUSIONS:
This study demonstrated that there were no significant differences in the clinical results among the three tensioning methods used in this study. According to our intra-operative measurement study on the effect of initial tension on the tension-knee flexion angle curves of the anteromedial (AM) and the posterolateral (PL) grafts (Arthroscopy 2007), it is considered that the PLB graft tension immediately after tensioning was the highest (approximately 60 N or more) at the full extension position in Group I and the lowest (approximately 30 N) in Group III, while the AMB graft tension was the highest (approximately 60 N or more) at the full extension position in Group II and the lowest (approximately 30 N) in Group III. This study suggested that the clinical results of anatomic double-bundle ACL reconstruction are not sensitive to the differences in the tensioning procedures used in this study. The reasons may include that the initial tension applied to each bundle was acutely relaxed immediately after surgery (Yamanaka, AJSM 1999), and that we did not perform aggressive rehabilitation after surgery. However, we should note that 3 patients showed loss of knee extension by 5 degrees or more in Group I. This result is considered to be caused by the high tension in the PLB graft at the extension position. Therefore, we do not recommend to apply a 40-N tension to both the AM and PL grafts at 30 degrees of knee flexion. We recommend to simultaneously apply a 30-N tension to each graft at 10 degrees of knee flexion, and to simultaneously fix the two grafts at this position.
Tunnel Enlargement after Double-Bundle Anterior Cruciate Ligament Reconstruction

Purpose: The aim of this study was to compare tunnel enlargement in patients with the double-bundle and the single-bundle anterior cruciate ligament (ACL) reconstruction. Our hypothesis was that double-bundle ACL reconstruction results in less tunnel enlargement than single-bundle technique.

Methods: Sixty patients were randomized with closed envelopes into two different groups of anterior cruciate ligament reconstruction with hamstring tendons: double-bundle technique with bioabsorbable screw fixation (n = 35), and single-bundle technique with bioabsorbable screw fixation (n=25). Magnetic resonance imaging (MRI) evaluation was performed in 53 patients (88%) (32 in the double-bundle group, and 21 in the single-bundle group) for an average of 27 months follow-up (range, 24 to 36 months). Tunnel enlargement was determined by digitally measuring the widths perpendicular to the long axis of the tunnels on an oblique coronal and sagittal plane. The MRI measurements were compared to the intraoperative drill diameter.

Results: No significant differences were found between the double-bundle group and the single-bundle group in tunnel enlargement on femoral side. However, on tibial side, tunnel enlargement was greater in the single-bundle group than in the double-bundle group (p=0.051). With the double-bundle group, no tunnel communication between the anteromedial and the posterolateral tunnels was seen in any of the patients either on tibial or on femoral side. Three graft failures were observed in the single-bundle group comparing one graft failure in the double-bundle group.

Conclusions: This prospective, randomized study showed that our double-bundle ACL reconstruction technique results in less tunnel enlargement on tibial side, and less graft failures than the single-bundle technique with similar fixation methods, graft material, and rehabilitation. In addition, no tunnel communication was observed in the patients with the double-bundle ACL reconstruction. The clinical results were good in both groups, and were not influenced by tunnel enlargement.
Prospective Randomized Clinical Comparison Between Double Bundle and Single Bundle Anterior Cruciate Ligament (ACL) Reconstruction: Four Tunnel Hamstring vs. Patellar Tendon

Double bundle (DB) ACL reconstruction has gained popularity in the last few years. Biomechanical and intra-operative studies have showed better antero–posterior and rotational stability after DB vs. single bundle (SB) reconstruction. However, only few studies are found in the literature that have evaluated and compared clinical results between SB and DB ACL reconstruction. All reported studies used hamstrings in both DB and SB techniques. We found no studies that used patellar tendon autograft for the SB. The purpose of the present study was therefore to evaluate and compare the clinical results of DB hamstring and SB patellar tendon ACL reconstruction techniques.

METHODS:
A total of 40 patients (29 male and 11 female, average (SD) age 36 (11)) were randomized during routine surgery into either double bundle (DB) or single bundle (SB) group. Patients with combined (medial, lateral or posterior) ligamentous injuries were not included in the study. ACL reconstruction in DB group was done by four tunnel hamstring technique with EndoButton femoral and cancellous screw tibial fixation. In the SB group, patellar tendon autograft was fixed with titanium interference screws. The same postoperative rehabilitation protocols were used for both groups. The average (SD) follow up was 21.5 (6) in the SB group and 22 (5) in the DB group. Subjective evaluation comprised IKDC 2000 subjective score, Tegner activity and Lysholm scores. Objective evaluation followed the IKDC 2000 knee examination protocol. Antero–posterior instability was measured by Rollimeter. Pivot shift test was used to evaluate rotational instability and one leg hop test was performed to assess the functional results.

RESULTS:
At the follow up, 95% of all subjects were tested. There were no significant differences in accompanying meniscal or chondral lesions between both groups. Subjective results showed no difference between both groups. The median (range) IKDC 2000 subjective score was 68 (16) in the DB group and 71 (10) in the SB group. Median (range) Tegner score was 6 (2) in DB and 6.5 (1) in the SB group and Lysholm score was 88 (19) in DB and 86 (10) in the SB group. The average (SD) antero–posterior translation was greater in group DB (3.5 (1)) than in group SB (2.3 (1.5)) (p<0.05). No differences were found in pivot shift tests or in one leg hop test between the groups. 50% of SB patients were grouped A and B according to the IKDC 2000 examination protocol, whereas only 32% of patients scored A and 68% scored B in the DB group.

CONCLUSIONS:
The results of the present study indicate better outcome of ACL reconstruction using single bundle patellar tendon than double bundle hamstring autograft after 2 years follow up according to objective AP translation and IKDC 2000 examination tests. However, no differences between the two techniques were found in subjective scores, pivot shift test and functional one leg hop test. Our results are not in agreement with other studies that showed superior results using the DB technique when hamstrings were used for single bundle reconstruction.
Comparison Between Anatomic Single and Double Bundle ACL Reconstruction Using a Two-incision Technique: Two-year Minimum Results of a Randomized Clinical Trial

INTRODUCTION: The aim of this study was to compare the clinical outcome results of single and double bundle ACL reconstruction using a two-incision technique.

MATERIALS AND METHODS: Seventy patients with a chronic unilateral ACL lesion who underwent arthroscopic assisted ACL reconstruction using a hamstring graft were randomized to receive a single (SB) or double (DB) reconstruction. Both groups were comparable with regard to demographic data, preoperative activity level, injury mechanism, injury to surgery interval, and the amount of knee laxity preoperatively. The incidence of meniscal lesions was comparable between the two groups. A conventional double incision surgical technique was adopted to perform the SB reconstruction. To insert tibial and femoral guide wires, a 65° Howell Tibial Guide and a Shino Femoral Guide were employed. In the femur we aimed to an anatomic position in between AM and PL insertion sites. In the DB technique the AM tunnel was drilled using the same tibial and femoral guides. On the tibial side the PL guide wire was inserted using a prototype rod guide inserted in the AM tunnel which allow the wire to exit posterior and lateral at a fixed distance (9mm). On the femoral side, with the knee at 90° of flexion we chose the insertion points starting from the AM which was placed near the posterior cartilage below the OTT. The PL insertion point was automatically defined by the prototype rod guide based on the AM tunnel. The distance to the first pin was fixed (9mm). With the knee at 90° of flexion the exits of the two tunnel were almost parallel to the tibial plateau. In both groups the pretensed graft was fixed, after looping the hamstrings around a bony (DB) or a metallic (SB) bridge on the tibial side and with RCI screws reinforced with one staple on the femur. In the DB group the PL bundle was fixed first with the knee in extension with manual tension. The AM bundle was fixed second at about 30° of flexion with the same tension. In the SB group the graft was manually tensioned and fixed in extension. The same rehabilitation protocol was adopted in both group. Outcome assessment was performed by an independent observer, blinded with regard to the involved leg and the type of reconstruction employed, using the new International Knee Documentation Committee form, the Knee injury and Osteoarthritis Outcome Score, and an arthrometric KT-1000 evaluation.

RESULTS: All the patients reached a minimum follow-up of two years. No differences between the two groups were observed in terms of overall KOOS, IKDC subjective score (82 DB and 78 SB; n.s.). A statistically significant difference in favour to DB group was found in the VAS (8.3 DB vs 7.4 SB; p<0.03). A significant increased number of patients in DB group was able to return to level 1 or 2 sports activities (57% DB vs 34% SB; p=.05). The objective IKDC final scores showed more “Normal knees” in BD group (80% DB and 60% SB; trend toward significance p=.06). There were one failure in DB and two in SB group. The KT data showed a statistically significant decrease in the average anterior translation (ATT) in the DB (1.2 mm DB vs 2.1 mm SB; p<.03). A “normal” side to side anterior tibial translation (0-2 mm) was found in 83% in DB and in 66% in SB knees. The incidence of a residual pivot shift “glide” was 14% in DB and 20% in SB (n.s.).

CONCLUSIONS: At two-year follow-up the DB ACL reconstructions shows better VAS, sports activity recovery, and average ATT than the SB.
Single-Bundle versus Double-Bundle Anterior Cruciate Reconstruction: A Matched Pairs Case-Control Study

Background:
The goals of double-bundle (DB) ACL surgery are to better restore native anatomy and biomechanical function of the knee compared to single-bundle (SB) ACL surgery, which is hypothesized to result in more optimal clinical outcomes. The purpose of this matched pairs case-control study is to compare the clinical outcome of patients undergoing DB ACL reconstruction to that of patients that underwent SB ACL reconstruction.

Methods:
Thirty-five patients that underwent DB ACL reconstruction were matched based on sex, age, length of follow-up and pre-injury activity level with 35 patients that had undergone SB ACL reconstruction by the same senior surgeon. Patient-reported clinical outcomes included the IKDC Subjective Knee Form (IKDC), Activities of Daily Living (ADLS) and Sports Activity Scales (SAS) of the Knee Outcome Survey and the SF-36. Clinician-measured outcomes included the side to side difference in range of motion, and the Lachman, pivot shift and KT-1000 tests.

Results:
There were no differences between the groups in terms of sex, age, body mass index, and graft type. The length of follow-up was slightly shorter for patients undergoing DB ACL reconstruction (2.1 vs. 2.5 yrs., p=0.03). There were no differences between the groups in IKDC, ADLS or SAS scores. Patients undergoing SB ACL reconstruction had slightly higher standardized role physical scores (0.3 vs. -0.2, p=.03), otherwise there were no differences in the SF-36 scores. There were no significant side to side differences in range of motion. Patients undergoing DB ACL reconstruction had a smaller KT-1000 side to side difference (0.7 mm vs. 2.2 mm). Seven (20%) patients undergoing SB ACL reconstruction and 3 (8.6%) patients undergoing DB ACL reconstruction had a glide pivot shift; however this difference did not reach significance.

Conclusions:
Double-bundle ACL reconstruction showed improved antero-posterior stability and a trend towards improved rotational stability compared to single-bundle ACL reconstruction. This improvement in objective measures however did not translate to improved patient-reported outcomes for patients undergoing DB ACL reconstruction.
The Comparison of the Two-year Outcome of Three ACL Reconstruction Techniques

Introduction

Conventional anterior cruciate ligament (ACL) reconstruction procedures have grafted only a single bundle that mimics either anteromedial or posterolateral bundle. Currently, to improve the results of ACL reconstruction, double-bundle reconstruction procedures have been developed. However, it remains unclear as to whether double-bundle reconstruction procedure leads to substantial improvement in the postoperative function, there are some reports which indicate the advantage of double-bundle ACL reconstruction recently. In this study, we performed middle term follow-up examinations and compared the clinical outcome among double-bundle group (DB), anteromedial single-bundle group (AM) and posterolateral single bundle group (PL).

Materials and methods

58 patients with ACL rupture were randomly separated into three groups: DB group 19 (9 male, 10 female; average age 27±9 years), AM group 19 (8 male, 11 female; average age 26.9±9 years) and PL group 20 (5 male, 15 female; average age 22±5 years) ACL reconstructions. Average follow-up period is; DB: 24.7 months, AM: 21.3 months and PL: 23.1 months. We evaluated Lysholm score, the anterior laxity with KT-1000 arthrometer (MEDmetric Corp, San Diego, CA), the lack of extension with heel-height distance (HHD), and the muscle strength with knee extensor and flexor isokinetic peak torques with a Cybex 2 (Lumex Inc, Ronkonkoma, NY) at 60°/sec.

Results

Lysholm scores were equally good at the last follow-up in three groups: DB 93.7±6.9?AM 94.4±6.5?PL 96.7±3.9. In anterior stability of the knee, as measured by the KT-1000 arthrometer, it was significantly better in DB group than PL group (p<0.05): DB 0.79±2.0mm?AM 1.37±2.5mm?PL 2.5±2.5mm. HHD was significantly smaller in PL group (p<0.05): DB 16.8±15.8?AM 19.5±18.2?PL 6.94±9.05. Knee extensors strength of DB group was significantly higher than AM group (p<0.05). Two patients in PL group were experienced re-rupture of ACL ligament (the rate of re-rupture was 10%), however there was no graft failure in the other groups.

Discussion

We compared the clinical results of three reconstructive procedures (DB group, AM group, and PL group). This study demonstrated that the patients with double-bundle reconstruction had better results with respect to post-operative anterior stability and isokinetic knee extensors strength comparing with the other groups. As to the complication of re-rupture, there were two patients of re-rupture in PL group. This may indicate that stressful loading was applied to the PL single-bundle graft. The time of re-rupture was after 1.2 or 1.6 years post-operatively. The lack of extension with HHD of DB group was significantly larger than that of PL group.

In conclusion, our results seem to indicate that double-bundle reconstruction can provide better post-operative recovery from ACL injury in middle term follow-up. However, considering the additional surgical time and cost, and the increased technical complexity, it remains to be seen whether performing double-bundle anatomic reconstruction in clinical practice is worthwhile.
An Oxidized Zirconium Femoral Component for Total Knee Arthroplasty

Oxidized Zirconium is a new material available for the femoral component of total knee arthroplasty. Laboratory studies have demonstrated a decrease in adhesive and abrasive wear using this new material, as compared with CoCrMo and a reduced friction against cartilage due to its increased lubricity. However it has been previously noted that preclinical laboratory testing of materials may not be entirely reliable, and the purpose of the present study was to assess the medium term clinical results of total knee arthroplasty with a femoral component made of oxidized zirconium.

We prospectively studied 94 consecutive patients (98 knees) undergoing total knee arthroplasty (June 2001 to June 2004) using the Genesis II® total knee arthroplasty (Smith & Nephew, Memphis, TN) with the femoral component made of Oxidized Zirconium (Oxinium); three knees were lost to follow-up, so 95 knees were available for inclusion in the present report with a minimum duration of follow-up of four years, average 5.1 years (range, 4 to 7 years). The average age of the patients was 58.3 years (range, 22 to 65 years). In 37 (38.9%) cases we resurfaced the patella, in 58 (61.1%) knees we left the patella unresurfaced.

No knees was revised; the mean Knee Society score improved from 42.7 to 87.7 points postoperatively and functional score improved from 47.5 to 82.5 points postoperatively. In the non resurfaced group, knee anterior knee pain was reported only in 1 knees (1.7%) and the patellar score was higher than the resurfaced group (p<0.5).

This study demonstrates that, unlike other new bearing materials, with a minimum follow-up of four years, no adverse effects had been observed clinically or radiologically with oxidized zirconium. Furthermore we could demonstrate a new distinct positive effect of oxidized zirconium femoral component when articulating with the native patella, since the lower coefficient of friction against cartilage and the greater lubricity allowed a better coupling of the unresurfaced patella with the Oxinium femoral component.
Rotation of the Tibial Component in TKA: Influence of the Design

INTRODUCTION: Correct positioning of the tibial component in TKA requires optimized coverage of the resected tibia and correct rotational alignment. The design of tibial component is fundamental to satisfy the two criteria. It is usually based on morphometric measurements of the tibial plateau: mediolateral width (ML), anteroposterior depth (AP), and aspect ratio (ML/AP). The landmarks for rotational alignment are not clearly defined: Posterior Tibial Margin (PTM), TransEpicondylar Axis (TEA) (Akagi technique or self adjustment with femur) or Anterior Tibial Tuberosity (ATT).

HYPOTHESIS: ML/AP is influenced by the choice of reference axis (PTM, TEA or ATT). The operative technique of a TKA must therefore be in accordance with the reference axis used to design the prosthesis.

AIM OF THE STUDY: (1) analyze and compare the morphology of the proximal tibia using the three reference axes and (2) deduce optimal aspect ratio for the tibial component design in TKA.

MATERIALS AND METHODS
100 preop CT scans before TKA were studied: It was stages II and III OA, 50 females (age 75.3 ± 7.1) and 50 males (age 74.2 ± 8.7), 52 right and 48 left knees, with mean mechanical femoro-tibial angle 176.4° ± 5.6°. We used the software OsiriX, dedicated to DICOM images. AP, ML and ML/AP were measured using the 3 reference axes. The TEA was deduced from femur slices and was defined as the line joining the lateral epicondyle to the sulcus of the medial epicondyle. The ATT axis (aATT) was defined as the perpendicular to the line joining the geometric center of the tibia and center of ATT. APlat and APmed were measured at 30% of the width of each plateau.

RESULTS
The TEA is on average externally rotated by 1.6°±5.1° relative to the PTM (females 1.1°±5.5, males 2.1°±4.7, p = 0.3289). The aATT is externally rotated by 14.8°±7.2 relative to the TEA (females 15.6°±6.3, males 13.9°±8.1, p = 0.2440). The AP and ML dimensions, as well as the aspect ratio are almost identical when the reference axes are PTM or TEA (p = 0.6504): AP = 46.4±4 and 46.2±4; ML=73.7±6 and 73.7±6; ML/AP =1.59±0.12 and 1.6 ± 0.11. Measurements differ significantly when the reference axis is the ATT (p < 0.0001): AP= 51±8; ML=71.9±5 and ML/AP=1.44±0.18. The AP and ML dimensions differ significantly according to gender but the aspect ratio remains unchanged, except when the reference axis is the ATT. This could be due to a slightly higher external rotation of the ATT in females than in males. The AP dimension of the lateral plateau is greater than or equal to that of the medial plateau in 15% of knees (PTM), or 17% (TEA) or 3% (ATT).

CONCLUSION
The dimensions that define the shape and asymmetry of the tibial plateaus are variable depending on reference axis used for measurement. The majority of prosthetic tibial components available are designed for alignment with the PTM. A different design would be necessary if we wish to align the implant with the ATT and to avoid prosthetic overhang or insufficient coverage.
**Posterior Stabilized TKA's are Less Sensitive to Implantation Tightness than PCL-Retaining Designs: A Biomechanical Study**

**Introduction:**
Restricted range of motion or excessive laxity are potential complications of total knee arthroplasty (TKA). In contrast patients demand more function for daily activities. To achieve a good function after TKA is important but the aim for all patients should be a better flexion to kneel, work and live without restrictions. Hence the present study was to investigate the effects of implantation tightness on soft tissue strain during passive range of motion.

**Method and Material:**
Fourteen fresh frozen cadaver knee joints mounted in a passive flexion rig. Passive flexion was applied to the tibia in 15 deg increments from 0 to 150 deg of flexion. Tibiofemoral force and ligament strain of the medial and lateral collateral ligaments were measured using a custom-built force platform inserted beneath the polyethylene inlay. The standard implantation technique and two variations (2 mm tighter, 2 mm looser) were tested for four prosthesis types: fixed-bearing PCL-retaining (with and without PCL) (PFC), mobile-bearing PCL-sacrificing (LCS), posterior-stabilised (PS), posterior-stabilised with HiFlex femoral component (HF).

**Results:**
As expected all prostheses showed a significant increase in tibiofemoral force at full extension when implantation tightness was increased. By comparison in the midrange between 15-90 deg the tibiofemoral force dropped down and was independent of variation in implantation tightness in all designs. Beyond 90 deg the fixed bearing design (PFC) and in the LCS knee were sensitive on implantation tightness. In contrast the two posterior stabilised prosthesis types (PS and HF) showed a different pattern of tibiofemoral force during flexion, with low force throughout the range of motion.

**Conclusion:**
As a result in full extension and deep flexion both the PFC prosthesis and the LCS knee represent sensitive designs when considering implantation tightness. Whereas posterior stabilised knee implants are associated with lower tibiofemoral force during the range of motion and more forgiving designs in relation to implantation tightness. The data also suggest that soft tissue structures other than the collaterals tighten as the knee flexes and cause an increase in tibiofemoral compressive force.
Comparison of Mobile-bearing versus Fixed bearing in High - Flex Total Knee Arthroplasty

Purpose:
The purpose of this study was to compare the clinical and radiological results of a PFC flex mobile bearing design with those of a LPS flex fixed bearing design in high-flex total knee arthroplasty.

Materials and Methods:
From January 2005 to November 2006, Forty-six patients who received PFC flex mobile bearing prosthesis in one knee and LPS flex fixed bearing prosthesis in the contralateral knee followed up for a minimum 2 years were evaluated. Clinical results were assessed using the ROM, the Hospital for Special Surgery, the Knee rating systems of the knee society, WOMAC score and SF-36. Radiological results were evaluated tibio-femoral angle and loosening or osteolysis of components. We subdivided preoperative less 90 degree and more 90 degree in each group.

Results:
Mean ROM range of last follow up was increased to 131.1 degree in LPS group and 130.1 degree in PFC group. But there was no significant difference between the two groups. HSS score, knee pain and function score, WOMAC score, SF-36 score didn’t differ significantly between two groups. But descending stairs, rising from sitting, bending to the floor more improved significantly in LPS group. Tibio-femoral angle was changed from preoperative 8.2 degree varus to a postoperative 4.8 valgus. No knee had aseptic loosening or osteolysis.

Conclusion:
Postoperative ROM was increase significantly in PFC flex mobile bearing groups and LPS flex fixed bearing groups. But we found no significant differences between the two groups with regard to clinical and radiological parameters excepts descending stairs, rising from sitting, bending to the floor in WOMAC score. There was no aseptic loosening or osteolysis but needed long term observation about these concerns.

Key Words: Total knee arthroplasty, High-flex total knee arthroplasty
Reproducibility and the Importance of Isokinetic Tibial Rotatory Strength Findings in Healthy Individuals

BACKGROUND. The importance of knee rotatory strength following the ACL injury and surgical reconstruction was highlighted in the past years. Several studies reported the significant decrease in internal tibial rotation strength, following the reconstruction using the semitendinosus–gracillis graft. Strength deficits were identified using the isokinetic testing of the knee rotatory strength. No data regarding the reproducibility of such testing exists in the literature. The aim of our study was to evaluate the reproducibility of those testing procedure.

STUDY DESIGN: Descriptive Laboratory Study (validation study).

METHODS: Twenty three healthy physical education students without previous knee injury were tested twice over a period of one week using an isokinetic dynamometer. The main outcome measure was isokinetic peak torque of tibial internal and external rotation. For the evaluation of the reproducibility we have used absolute reproducibility indices and repeated measures analysis using factors muscle, contraction type, velocity and set.

RESULTS. Test-retest agreements were relatively low (0.20-0.72) with systematic difference between two consecutive sets of testing. The SEM%, representing the smallest change that indicates a real improvement for a group of subjects, was relatively small (10-18%). On the other hand, SRD%, that represents the smallest change that indicates a real improvement for single subject ranged from 38-50% for internal tibial rotators and from 23-42% for external tibial rotators.

CONCLUSION. Isokinetic testing of the tibial rotatory strength shows a strong learning effect that contributes to the test-retest differences and indicates the need for extremely good familiarization with the device and testing procedure prior to any clinical decisions based on single testing.
Hamstring Antagonist Moments in Females Compared to Males: Further Investigation of the ACL Gender-bias

INTRODUCTION
Given their role in reducing anterior tibial translation (ATT), the recruitment patterns and viscoelastic properties of the hamstring muscles have been implicated as neuromuscular factors contributing to the anterior cruciate ligament (ACL) gender bias. Nevertheless, it is uncertain whether patterns of aberration displayed by the female neuromuscular system significantly alters the antagonist moments generated by the hamstrings during maximal effort knee extension. Therefore, the purpose of the current study was to examine the effect of gender on hamstring antagonist moments in order to explain the higher ACL injury rates in females.

METHODS
Eleven females (age 30.6 ± 10.1 yr, mass 62.1 ± 6.9 kg, height 165.9 ± 4.6) and 11 males (age 29.0 ± 8.2 yr, mass 78.6 ± 14.4 kg, height 178.5 ± 6.2) with no history of trauma or disease in either knee and no evidence of abnormality on clinical examination were recruited as subjects. Surface electrodes were placed over the semitendinosus (ST) and biceps femoris (BF) muscles of the dominant and non-dominant limbs. Each subject performed two sets of five maximal extension and flexion repetitions at 180°·s⁻¹ on a Cybex© isokinetic dynamometer. Test order for the non-dominant and dominant limbs was randomised. EMG, isokinetic torque and knee displacement data were sampled at 1000Hz using an AMLAB® data acquisition system.

RESULTS
Average hamstring antagonist torque data across the range of knee flexion for female subjects was significantly higher (%Diff=24%) than for the male control subject. Statistical analyses revealed a significant main effect of gender (F = 4.802; p = 0.036).

DISCUSSION
Given that females possess a more compliant ACL and hamstring musculature compared with their male counterparts, an augmented hamstring antagonist may represent a compensatory neuromuscular strategy to increase knee stiffness to control ATT and ACL strain. Such a strategy may also increase the opposition to a rapidly applied external deforming force and decrease the proportion of the external force that must be resisted by the ACL and other passive structures of the knee. An increase in antagonist torque may, conversely, decrease joint efficiency and have implications for skill acquisition and refinement. Nevertheless, it is unlikely that gender-related differences in hamstring antagonist torque is one of the predisposing factors contributing to the higher ACL injury rates in females.
Neuromuscular Response of the Reconstructed Leg is Diminished During a Heavy Intensity Running Bout

Introduction: Efficient neuromuscular response provides shock-absorption and protection of the graft and cartilage following anterior cruciate ligament reconstruction. The purpose of the present study was to investigate if accumulation of metabolic fatigue may impair the neuromuscular response of the reconstructed leg during high intensity treadmill running.

Methods: Telemetric electromyographic recordings from vastus lateralis and biceps femoris muscles were performed bilaterally in 9 bone-patella tendon-bone ACL reconstructed soccer players during two 10-min treadmill runs, one at a moderate intensity (with no metabolic fatigue) and one at a heavy intensity (under substantial metabolic fatigue).

Results: During the heavy run [end-exercise lactate 7.2 (1.8) mM], electromyographic activity increased significantly [294.2(120.6) μV to 317.1(140.5) μV, p= 0.03] for the vastus lateralis of the intact leg, while remained unchanged [267.8(142.8) μV to 263.8(128.9) μV, p>0.05] for the vastus lateralis of the reconstructed leg. For BF, EMG amplitude did not increase for neither leg [208.7 (110.4) mV to 217.1 (106.0) mV, p= 0.325 for the intact leg and 222.4 (92.4) mV to 233.9 (94.2) mV, p= 0.107 for the reconstructed leg. During the moderate bout [end-exercise lactate 2.4 (0.6) mM] electromyographic activity remained unchanged for both legs for both VL and BF muscles.

Conclusions: Metabolic fatigue decreases neuromuscular response for the vastus lateralis muscle of the reconstructed leg. Anterior cruciate ligament reconstructed athletes engaging heavy intensity aerobic exercise such as in game sports may exhibit reduced shock-absorbing capacity due to accumulating metabolic fatigue and impaired neuromuscular response. This may result in increased chances for re-injury especially during the later parts of the game where fatigue is rapidly accumulating and diminished protection of the graft and cartilage from repetitive high impact forces during running. Rehabilitation following ACL reconstruction involves strength and neuromuscular training but aerobic endurance training is not formally introduced. It is suggested that aerobic endurance training aiming at improving muscle adaptations should be undertaken prior returning to strenuous aerobic activities.
A Randomized Controlled Study on a Rehabilitation Model for Strengthening Self-efficacy of Knee Function in Patients with an ACL Injury

Background: The Knee Self-Efficacy Scale (K-SES) has been shown to have good reliability, validity and responsiveness for patients’ perceived self-efficacy of knee function during rehabilitation of an Anterior Cruciate Ligament (ACL) injury. Determinants of self-efficacy of knee function one year after ACL injury have been found to be the patients’ internal locus of control and knee symptoms in sports and recreation. Perceived self-efficacy of knee function measured by the K-SES has also been shown to have a predictive ability for patients’ outcome after an ACL reconstruction.

Purpose: To evaluate the effectiveness of a rehabilitation model containing strategies to reinforce or to maintain high self-efficacy of knee function compared with a standard rehabilitation protocol.

Material and method: Forty patients with a recently ACL injured knee were randomly allocated to an experimental group (n=20) for the rehabilitation model or a control group (n=20). Data were collected from patients recently injured and at 4, 6 and 12 months after the injury. The self-administrated instruments K-SES, Tegner activity score, Physical Activity Score (PAS), Knee Injury and Osteoarthritis Outcome Score (KOOS) Lysholm and Multidimensional Health Locus of Control (MHL) were used as outcome measures. Twenty-four patients, 12 in each group, completed the 12 month follow-up.

Results: There was a significant increase in both the experimental and control group for K-SES (p=0.005 and p=0.003), KOOSport (p=0.005 and p=0.044), and KOOSqol (p=0.014 and p=0.041) at the 12 month follow-up. Both groups revealed a significantly lower physical activity level (Tegner) (p=0.009 and p=0.036) at the 12 month follow up. The control group had also a significantly lower score for physical intensity and frequency (PAS) (p=0.020) and internal locus of control (MHL) (p=0.026) at the 12 month follow-up. No significant differences were found between the experimental group and the control group at inclusion or at the 12 month follow-up for any of the outcome measures.

Conclusion: Increased self-efficacy of knee function as well as subjective satisfaction with knee symptoms and function was achieved in both groups. The experimental group, however, did not decrease in physical intensity and frequency and internal locus of control, which may be an important aspect for future function and possible surgical intervention.

Key words: Self-efficacy; physical activity; symptoms; function; locus of control; self-administrated instruments.
Etiology of Shoulder Injuries in SA Tennis Players

Background:
Shoulder injuries are the most common upper limb injuries in first class tennis players and there is little information on the etiology. The pathology in the painful shoulder in tennis is often equated to be the same as other overhead sports like in baseball pitcher’s injuries. Studies have shown an increased external rotation and decreased internal rotation, due to posterior capsule tightness, in the dominant arm in tennis players.

Objectives:
A study was performed trying to find a relationship between difference in ranges of movement, grip position on racket on serve and average speed of service on shoulder symptoms and objective ultrasound findings in a cohort of first class tennis players in South Africa.

Subjects:
Our study consisted of 76 players that were recruited at the yearly senior interprovincial tennis tournament.

Methods:
A detailed history was taken, taking into consideration level of competitiveness, years of playing, position of grip on the racket, amount of serves in training, shoulder injuries, previous treatment and preventative measures taken. Objective ranges of movement of dominant and non-dominant shoulders were done and high definition ultrasound was performed on all dominant shoulders. The player’s speed of service was also recorded with a radar device.

Results:
20 players reported previous acute and chronic shoulder pain. Dominant shoulder on the male tennis players showed tendency for increased range of external rotation (p=.05) and a significant decrease in internal rotation in 90º abduction (p< .05).
Although there was an increased external rotation in female players (p<.01), in the dominant shoulder, there was not a resultant decreased internal rotation. There was no difference in ultrasound rotator cuff pathology and shoulder symptoms compared to average service speed, amount of serves in training, racket grip position and level of competition. No differences in range of movement in players with shoulder injuries

Conclusions
1) The dominant shoulder of tennis players showed to have an increased range of external rotation in males and females compared to non-dominant side
2) In male tennis players there was a decreased range of internal rotation on the dominant side compared to non-dominant shoulder.
3) No correlation between grip positions, speed of service, years and level of competition and shoulder injuries or ultrasound pathology could be found
4) No correlation between differences in range of movement in shoulders and shoulder injuries or ultrasound pathology could be found
Efficacy of the F-MARC 11 and the F-MARC 11+a Training Program on Collegiate Football Teams

Background: The International Federation of Football Association (FIFA) recommends F-MARC 11, an injury prevention program; however, the efficacy of this program has not yet been clarified.

Objective: To elucidate the efficacy of the F-MARC 11 program on both injury prevention and performance improvement.

Design: A prospective study and pre-post intervention study.

Setting: The first division of the collegiate football league in the Kanto area of Japan.

Participants: Ninety-two collegiate male football players participated. Players were divided into three groups: the F-MARC 11 group who participated in the program (n=30), the F-MARC +a group who participated in an adjusted program (n=32), and a control group (n=30).

Interventions: The two training programs were conducted once or twice per week for 6 months. Injury occurrence was analyzed using a specialized check sheet.

Main Outcome Measurement: The incidence of all injuries, lower-extremity injuries, and ankle sprains were measured. Incidence rate was denoted per 1000 player-hours (PH). Using several field tests (sprint, pro-agility, cutting), each subject’s performance level was evaluated prior to training as well as six months after training.

Results: The most common injury was an ankle sprain (38.1% of all players). The incidence of lower-extremity injury was 1.07 per 1000 PH (control group), 0.36 per 1000 PH (F-MARC 11 group) and 0.54 per 1000 PH (F-MARC +a group). Sprint time and cutting time were significantly shortened in the F-MARC 11 and F-MARC + a group (p<0.05).

Conclusions: The incidence of football injuries could be reduced with suitable training. The F-MARC 11 program may have the added benefit of improving performance, especially sprint time and cutting time.
Role of Prevention and Epidemiology of Shoulder Pathologies in Elite Swimmers

Introduction: Overuse pathologies occupy a dominant role in sports traumatology among professional swimmers and the shoulder is the anatomic district more often involved. The purpose of this study was to perform an epidemiological study on shoulder injuries among the Italian elite swimmers, to select two homogeneous groups, to apply a prevention protocol to one group, and to follow-up the two groups at one year evaluating the role and efficacy of prevention exercises.

Methods: A pilot study was performed on 53 athletes of the Senior and Junior National Team administrating a questionnaire developed and approved by the Medical Commission of the Italian Federation of Swimming (FIN). The form included 20 questions about the distance and discipline, type, timing and insurgence modalities of the injury, type, side and timing of symptoms, missed days of training, days of differentiate training, type and timing of treatment (if needed), problems during last year, and finally the participation to a pre-existent prevention programme. Afterwards, the questionnaire was administrated to other 142 elite swimmers (they swam at least a final at the Italian championship in 2003). At the end of the epidemiological study, all the athletes who didn’t use a prevention exercises (91/195 46.6%) were randomly split in two groups. In one group a prevention protocol of on-land exercises were administered (one session of 25 minutes for each training day). In the other group (control), the athletes didn’t follow any prevention protocol. At one year follow-up, the questionnaire was newly administrated.

Results: The epidemiological study showed that 68.7% of swimmers suffered at least once of shoulder problems and 46.1% had symptoms during last year of activity. The dominant shoulder was involved in 87.1%, especially among crawlers. The crawlers were more prone to shoulder injuries than other strokes. The average of missed days of training was 12.8±18.2 and the average of differentiated training days was 25.1±24.2. Swimmers performing prevention exercises were 53.4% and those with an history of shoulder problems were 67%. At follow-up, the control group showed an incidence of shoulder problems, missed days of training and differentiated training sessions, statistically significant higher than prevention group.

Conclusions: Shoulder injuries are very common among elite swimmers showing different grades of severity. The prevention protocol adopted by Italian Federation of Swimming and utilised in this study has demonstrated a significant efficacy to lower the incidence of shoulder problems after an year of administration.
Preparticipation Hip Evaluation of College Football Players to Identify Athletes at Increased Risk of Chondral Labral Dysfunction of the Hip

The prevalence of hip injuries in the elite football player is increasing. The purpose of this study was to identify athletes who may be at risk for chondral labral dysfunction of the hip through a Preparticipation Physical Evaluation (PPE).

Methods: Prior to the 2006 season, 81 Division one college football players underwent a series of physical examination techniques to identify injury and flexibility deficiencies of the hip. The examination included hip range of motion tests for straight leg raise, hip flexion, internal rotation, and external rotation. Athletes with an abnormal hip exam (hip pain or an asymmetrical FABER test greater than 4 cm) underwent magnetic resonance imaging (MRI). MRI’s were then read by a single musculoskeletal radiologist. The alpha angle was measured on all MRI’s. Those athletes identified to be a risk for chondral labral dysfunction were placed on a modified rehabilitation and training program and followed for signs and symptoms of hip pain and dysfunction.

Results: Thirty-three athletes (41%) had abnormal hip exams (3 bilaterals). There was no difference in hip flexion between hips with normal exams (101) and hips with abnormal exams (98). Hips with abnormal exams had significantly less external rotation (49 vs. 39; p<0.01) and significantly less internal rotation (33 vs. 28; p<0.05) than hips with normal exams. Twenty-seven hips were evaluated by MRI. The average alpha angle measurement was 67° (range 44°-83°), with 26 hips with alpha angle greater than 50°. On MRI, eleven hips had suspected pathologies of the chondral labral junction. These hips had significantly higher alpha angle than hips with no chondral labral pathologies suspected (73 vs. 62; p<0.01). No athlete with MRI missed games in the 2006 season due to hip symptoms. However, 7 athletes had continued symptoms at the beginning of the 2007 season. Six of these 7 athletes had suspected pathologies of the chondral labral junction on MRI. Of the athletes with MRI’s, athletes with suspected chondral labral pathology were 18 [CI:2 to 137] times more likely to have unresolved hip pain the following football season.

Conclusion: This study showed that athletes with abnormal hip exams have reduced range of motion. These athletes also had high alpha angles, which correlated with the suspicion of chondral labral pathologies. This PPE identified athletes at risk for chondral labral dysfunction. Players with suspected pathologies of the chondral labral junction were significantly more likely to have continued symptoms. Surgical intervention to treat these pathologies may allow for resolution of symptoms and decrease the risk of further damage to the hip.
Revision ACL Reconstruction: Reinjury Mechanism, Failure Mode and Graft Choice from the Multi-Center ACL Revision Study (MARS) Group

Background: Most orthopaedic sports medicine specialists believe that clinical outcomes after revision ACL reconstruction (RevACLR) compare unfavorably to primary reconstruction (PriACLR), however, there are no prospective cohort studies. Our hypothesis is that modifiable independent predictors of RevACLR outcomes can be identified from a large multicenter cohort to potentially improve the RevACLR outcomes in the future. Initially we focused on the mechanism of reinjury, mode of failure, and graft choices of MARS surgeons.


Results: As of Nov 1, 2007 60 surgeons have enrolled 90 patients. Median age for the cohort was 26 years with 52 (58%) males. This was the 1st revision for 72 (77%). Mechanism of reinjury was 63 (70%) traumatic and 36 (29%) atraumatic. Mode of failure as deemed by the revising surgeon was 5 (6%) biologic, 22 (24%) technical, 27 (30%) traumatic, or 27 (30%) combination. Graft choice for RevACLR was 38 (42%) autograft [53% BTB, 37% HS (st+g), 10% HS (st only)] and 52 (58%) allograft [65% BTB, 29% tibialis anterior/posterior, 4% achilles tendon, 2% HS].

Conclusions: For the majority of patients this was their first RevACLR. The cause of failure of PriACLR was believed to be most commonly trauma with technical issues a contributing factor. Allografts are a slightly more common graft choice for RevACLR with allograft BTB the single most common RevACLR graft chosen. If graft choice and technical aspects of RevACLR are subsequently proven independent predictors of patient outcome at planned longitudinal two-year follow-up, these can be modifiable in the future to improve RevACLR outcomes.
Patient Based Outcomes of Revision ACL Reconstruction: 2 year results from the MOON Cohort

Background:
Many clinicians believe that the results of revision ACL reconstruction (RACLR) compare unfavorably to primary reconstruction (PACLRR), however, few prospective studies have evaluated RACLR using validated patient based metrics. This study was performed to evaluate and compare the results of RACLR and PACLR.

Methods:
The MOON consortium is an NIH funded, hypothesis-driven, multi-center prospective cohort study of patients undergoing ACLR. All patients preoperatively complete a series of validated patient-oriented questionnaires. At scheduled 2-yr follow-up all patients are given the same series of questionnaires to complete. The study evaluated the results of two-year follow-up of RACLR performed in 2002. Parameters evaluated included Marx activity level, KOOS and IKDC scores.

Results:
487 subjects met inclusion; 2-year follow-up was obtained on 408 (84%). The cohort is 57% male, median age 23 yrs. There were 47 RACLR cases, for which follow-up was available for 39 (83%). Median baseline Marx (interquartile range) was 12 (8-16) and 10 (4.5-16) for the PACLR and RACLR groups respectively (p=0.28). At 2 yrs, median Marx was 9 (4-13) and 6 (1-10) for the PACLR and RACLR groups respectively (p=0.009). Median 2 year IKDC was 79.4 (RACLR) vs. 85.6 (PACLRR) (p=0.005). Median KOOS subscale Knee Related Quality of Life (KRQOL) at 2 years was 62.5 (RACLR) vs. 75 (PACLRR) (p<0.001).

Conclusions:
Marx activity score declined at two-year follow-up in RACLR compared to PACLR. IKDC and KRQOL were significantly decreased in RACLR compared to PACLR at 2 year follow-up. RACLR resulted in a significantly worse outcome as measured by these patient based measures at 2 years.
Biomechanical Comparison between Medial and Lateral Tibial Route in the Posterior Cruciate Ligament Reconstruction

Purpose: The purpose of this study was to compare the fixation strength and related factors (route size and angle) between the medial and lateral tibial route in the trans-tibial PCL (Posterior Cruciate Ligament) reconstruction.

Materials and Methods: For the 12 cadaveric tibias, the tip of the guide is positioned on the PCL backside of the tibia 1 cm below the articular surface and just lateral to midline. The drill guide angle of the tibia oriented 55¡. The starting point was a same level and the diameter of tunnel was 10 mm in both medial and lateral tibial route. The Achilles graft was harvested from an initial sample of 12 cadavers. The graft was fixed with 10 mm bio-interference screw. The tibia was then secured in PMMA (polymethylmethacrylate) bone cement and rigidly fixed to the testing system. Biomechanical testing was done on a testing machine (Instron 8511, MTS, Minneapolis, MN). The proximal graft was secured by around a custom-made round bar. The constructs were then cycled 10 times with a force of approximately 30 N for pre-tensioning and load was then applied at 30 mm/min to failure. For the evaluation of route size and angle, 2D- computed tomogram was performed. The longitudinal and transverse diameter of tibial entrance was measured and RCA (Route Cortex Angle) was also measured. Paired t-test was used for the analysis of maximal load of failure, route size and tunnel angle. Pearson’s correlation coefficient was calculated to evaluate the correlation between the route size and angle.

Results: For the medial tibial route, maximal load of failure, route size and RCA were 419.80 ± 154 N, 10.41±0.32 mm x 10.61±0.88 mm and 47.46±8.42¡, respectively. For the lateral tibial route, maximal load of failure, route size and RCA were 196.26 ± 146.78 N, 11.16±0.95 mm x 13.89±1.46 mm and 28.29±6.8¡, respectively. The difference of maximal load between the medial and lateral tibial route was significant (p=0.003). The difference of route size between the medial and lateral tibial route was significant (p<0.001). The difference of RCA between the medial and lateral tibial route was significant (p<0.001). However, they did not show the definite correlation between the route size and angle (Pearson’s correlation coefficient= 0.2067~0.3652).

Conclusions: Lateral tibial route showed low maximal load of failure, large size of route entrance and acute RCA versus medial tibial route for the trans-tibial PCL reconstruction. This may be due to the anatomic configuration of the proximal tibia. These negative aspects of lateral tibial route must be considered although the lateral route is favored to prevent killer turn effect.
Morphology of the Tibial Insertion of the Posterior Cruciate Ligament

INTRODUCTION
The posterior cruciate ligament (PCL) has been described as the primary restraint to posterior tibial translation and consists of two functional bundles; the anterolateral (AL) and posteromedial (PM) bundles. Double-bundle PCL reconstruction showed to better restore normal knee kinematics and function; however, it is usually performed using either the tibial inlay or single tibial technique. To perform an anatomical double-bundle, a two tibial tunnel PCL reconstruction, it is necessary to define the tibial insertions of the PCL and its bundles. The aim of this study is to correctly identify the PCL tibial insertion and related bony landmarks.

MATERIAL AND METHODS
Eighteen fresh frozen cadaver knees were used in this study. The AL and PM insertions were outlined using fine pins and all soft tissue was removed using a sodium hydroxide solution. The knees were scanned by a laser three-dimensional (3-D) scanner (FARO Laser ScanArm V2, FARO Technologies Inc., Lake Mary, Florida), and then the pictures were analyzed using specific software (Rapidform XOR, INUS Technology Inc., South Korea). The all 3-D measurements were analyzed on the tibial plane basis. The tibial plane was created on the surfaces of the tibia plateau and rectangle was fitted to the plateau edges along the posterior condylar axis. The surface area, slope angle, length and width of each insertion were calculated and their insertion centers were also defined automatically as the centroids. To obtain geometric data, their centers were projected onto the tibial plane vertically and located by anteroposterior, mediolateral and vertical dimensions.

RESULTS AND DISCUSSION
The average surface area of the AL and PM insertion were 97.3mm² and 165.0mm². The average length and width of the AL insertion were 8.9mm and 10.6mm, PM insertion were 9.8mm and 16.9mm. The average distances from the anterior and medial margin of the tibial plane to the AL center were 85.7% and 47.5%, PM center were 94.5% and 44.1%. The AL bundle was attached to the superolateral aspect of the fossa, which was termed “AL slope”. The PM bundle was attached to inferomedial aspect, which was termed “PM slope” and also extended below the posterior rim. A clear change of slope was observed between the AL and PM slopes in all knees. The average angle between the AL and PM slopes was 13.6 degree.

CONCLUSION
This study details the 3-D anatomical measurements and visualization of the tibial insertion PCL and its bundles. Our findings may assist in finding the bony landmarks that facilitate the accurate two tibial tunnel placements in anatomical double-bundle PCL reconstruction.
A Study of Functional Disability, Lower Limb Electromyography and Gait in Recreational Sportsmen with Posterior Cruciate and Posterolateral Corneer Deficiency of the Knee

Introduction:
Injury to the posterolateral corner (PLC) of the knee combined with posterior cruciate ligament (PCL) injury cause a significant disturbance of the knee. Treatment of these injuries is challenging. Although the static clinical features are well described little is known about its dynamic features which is important when considering the treatment of the functional disability.

The aim of this study:
To investigate the functional disability, clinical examination, gait analysis and muscle electromyographic changes in patients with chronic functional disability from combined PLC and PCL injury.

Patients and Methods:
Twelve patients with clinically diagnosed combined posterior cruciate ligament and postero-lateral corner injuries to the knee were included. Average age was 32 years. The mean time from injury to presentation was eight years. These patients underwent a functional assessment using the Lysholm and Gillquist scale, clinical examination, kinetic and kinematic gait analysis and electromyographic recording of the musculature of the lower limbs through gait. All data was also recorded for the normal contralateral limb to allow meaningful comparison.

Results:
None of the patients were able to play their chosen sport. Despite significant disability most of the patients remained in fulltime employment.
The mean Lysholm score obtained in all patients was 55/100 (range thirty-one to ninety). Gait analysis showed that Most of the patients had normal temporal parameters although one of the patients exhibited reduced stride length and speed and two patients demonstrated the increased single stance time on the affected limb.
Kinematic analysis did reveal two patients with dynamic varus alignment of the knee. Three patients demonstrated dynamic hyperextension through stance and two patients demonstrated increased hip abduction. Abnormalities of the kinetic parameters through gait were more numerous. Six patients demonstrated increased internal valgus knee moments (varus external moments). Two patients demonstrated increased flexion moments through stance.
Electromyographic analysis of the quadriceps (rectus femoris) revealed no abnormalities in any patients. Electromyography of the medial hamstring muscle showed premature activity in late stance and the early part of the swing phase of gait in eight patients (sixty-six percent).
Examination of the lateral head of gastrocnemius revealed premature gastrocnemius activity in five patients in early stance (fifty percent).
Conclusion:
- Combined injuries of the posterior cruciate ligament and posterolateral corner cause significant functional disability both in the ability to play sport and in the activities of daily living. Pain and instability are the main symptoms experienced by such patients.
- Gait analysis exhibited dynamic varus deformity or hyperextension of the knee through the gait cycle with corresponding increased internal knee valgus moments.
- Electromyographic data demonstrated early contraction of both the medial hamstrings and the lateral head of the gastrocnemius muscle through the gait cycle.

The findings from this study demonstrated biomechanical abnormalities in such patients causing functional deficit and the possible compensatory mechanisms developed by such patients. This provides baseline data and aids the direction of rehabilitation programs.
Prospective Diagnostic Evaluation of the Posterolateral Rotatory Instability According to the Tibial Positioning in the Posterior Cruciate Ligament: Posterolateral Corner Deficient Knee

Background: Dial test is commonly used to evaluate the PCL (Posterior Cruciate Ligament)–PLC (PosteroLateral Corner) injury with the setting of 30° and 90° of knee flexion. However, it is difficult to apply accurately in the clinical situation although it has been shown to reliably access PLC injuries in the laboratory.

Hypothesis: In the clinical situation, the reduction or subluxion of AP (Anterior-Posterior) direction would influence on the degree of tibial external rotation in the combined PCL-PLC injuries.

Study design: Cohort Study

Methods: Between April 2007 and October 2007, sixteen patients of PCL-PLC injury were assessed with dial test. TFA (Thigh-Foot Angle) was measured with external rotation stress applied to the tibia at both 30° and 90° of knee flexion in different 2 positions (reduced and posterior subluxed). The test was performed with the patient in the supine position to give the AP force to the tibia by an assistant. To reduce the intra- and inter-observer bias, the measurements were made each twice by two orthopedic surgeons for all patients.

Results: Inter-rater and intra-rater reliability ranged from 0.7865 to 0.8762. In the subluxed position, the mean side-to-side difference of TFA at the 30° and 90° of knee flexion were 11.56° and 11.88°, respectively. In the reduced position, the mean side-to-side difference of TFA at the 30° and 90° of knee flexion were 15.94° and 16.88°, respectively. For the injured knee, the difference of TFA between subluxed and reduced position at the 30° and 90° of knee flexion were 5.31° (p<0.001) and 6.87° (p=0.001), respectively.

Conclusions: The reduction of posteriorly subluxed knee increased the tibial external rotation during the dial test in the combined PCL-PLC injuries. The reduction and subluxation of tibia is easily performed with the patient in the supine position by the help of an assistant.

Key Words: Knee, Posterior Cruciate Ligament, PosteroLateral Corner, Dial test, Thigh-Foot Angle
Isolation and Characterization of Human Meniscus-Derived Vascular Stem Cells

Introduction:
The sources of various adult-derived stem cells, including muscle-derived stem cells, have been recently reported to be associated with vascular-derived cells. Since meniscus tears in the peripheral vascularized region can be successfully repaired, we believe that the repair is mediated by similar vascular-derived cells. Given the advantages for self-repair inherent in the vascularized region of the meniscus, we hypothesized that this region might possess a richer supply of vascular-derived stem cells when compared to the avascular region.

Materials and Methods:
Sample: Complete, visually intact human lateral adult menisci were harvested from subjects undergoing total knee arthroplasty, and fetal menisci were harvested from spontaneously or therapeutically aborted fetuses under 24 weeks of gestational age following IRB approved protocols.

Immunohistochemical staining:
Menisci were snap-frozen and were immunostained for CD34 (stem cell marker) and CD146 (pericyte marker), coupled with smooth muscle actin (SMA) to detect various cells around the arterioles.

Cell isolation:
Menisci were separated into 2 regions, the peripheral one third, vascularized region, and the inner two thirds, avascularized region. Each tissue was minced and then digested with type I collagenase in DMEM. Adult meniscus-derived cells from each region were cultured in 2 ways: 1) Cultured in DMEM supplemented with 10% fetal bovine serum (FBS) and 1% penicillin/streptomycin for 3 days; and 2) cultured in DMEM, supplemented with 10% FBS, 1% horse serum, 1% penicillin/streptomycin, and 0.5% chick embryo extract for 21 days. Fetal meniscus-derived cells were cultured in DMEM supplemented with 10% FBS serum and 1% penicillin/streptomycin for 3 days. After the appropriate cultivating the cells were sorted by flow cytometry.

Characterization of meniscus-derived cells:
Meniscus-derived cells were characterized by flow cytometry for CD34 and CD146 expression. The meniscus cells cultured for 3 days were sorted for expression of CD34 and CD146 after gating out hematopoietic (CD45+) cells (4 populations were derived from adult tissue, and 4 populations derived from fetal tissue). CD146 positive cells isolated from the adult peripheral and inner meniscus did not expand well, leaving 6 populations to be tested for their multilineage potential.

Chondrogenic assay:
Cells (n=2.5×10^5) were placed in a 15ml conical tube, centrifuged at 600g, and cultured in chondrogenic medium (Lonza) supplemented with BMP-4 (100ng/ml) and TGF-β3 (10ng/ml). Pellets were assessed macroscopically at day 21, and stained with Alcian blue and nuclear fast red.

Osteogenic assay:
Cells (n=1.0×10^5) were cultured in 6-well-plates in osteogenic medium supplemented with BMP4 (100ng/ml) and stained for alkaline phosphatase (ALP) at day 6. Cells were also cultured as pellets for 21 days in osteogenic medium and evaluated with a micro-CT (Visio) and stained with von Kossa for assessment of mineralization.

Adipogenic assay:
Cells (n=1.0×10^5) were cultured in 6-well-plates for 14 days in adipogenic medium and stained for Oil Red O.

Characterization of sorted cells: Cells positive for CD34 and CD146 were cultured, and then characterized by flow cytometry for CD34 and CD146 expression, once again.
Results:

Immunohistochemical staining:
Adult and fetal tissues showed more positive staining for CD34 and CD146 in the periphery than in the inner meniscus.

FACS analysis:
Adult meniscus cells: The percentage of cells positive for CD34 and CD146 were, respectively, 11.87 and 0.27% in the adult peripheral cells cultured for 3 days, 6.2 and 0.57% in the inner cells cultured for 3 days, 0 and 44.8% in the peripheral cells cultured for 21 days, 0 and 34.7% in the inner cells cultured for 21 days.
Fetal cells: The percentage of cells positive for CD34 and CD146 were, respectively, 14.5 and 15.6% for the fetal peripheral cells, and 11.18 and 21.48% for the fetal inner cells.

Chondrogenesis:
Among the adult-derived CD34+ cells the largest pellets were generated by cells that were isolated from the peripheral (P34), vascularized, region of the meniscus. Fetal pellets made of peripherally-derived CD146+ (P146) cells generated the largest sized pellets among all the fetal-derived cell populations. All the pellets stained positively with Alcian blue indicating good cartilage formation because of the presence of proteoglycan.

Osteogenesis:
Adult-ALP staining - P34 cells (peripheral CD34+ cells) displayed significantly more ALP staining compared to I34 cells (inner CD34+ cells) (P <0.05). Adult-MicroCT - Bone volume from P34 pellets were significantly larger than I34 pellets (P <0.05). Adult-von Kossa staining - P34 cells displayed more positive staining compared to I34 cells (P <0.05). Fetal-ALP staining - P34 and P146 displayed more positive staining compared to the inner cells. Fetal-MicroCT- Bone volume from P34 pellets was the largest among fetal populations. Fetal-von Kossa staining - Pellets made with peripheral cells displayed more positive staining compared to pellets from inner-derived cells.

Adipogenesis (adult and fetal):
Oil red O staining demonstrated that peripheral cells showed more characteristic lipid droplets compared to inner cells (P <0.01).

Characterization of sorted cells:
P34, P146, I34, and I146 cells were cultured for over one month and then characterized by flow cytometry for their expression of CD34 and CD146. Adult cells: The percentage of positive cells for CD34 and CD146 were, respectively, 0.00 and 90.7% in the P34 cells, and 0.00 and 85.0% in the I34 cells. Fetal cells: The percentage of positive cells for CD34 and CD146 were, respectively, 0.0 and 90.4% in the P34 cells, 0.0 and 89.8% in the P146 cells, 0.0 and 73.3% in the I34 cells, 0.0 and 73.0% in the I146 cells.

Discussion:
Our study showed that CD34 positive and CD146 positive cells, which are found more prevalent in the peripheral vascular region than in the inner avascular region, exhibited potential for multilineage differentiation suggesting that these populations exhibit stem cell characteristics and may contribute to meniscal regeneration. Culturing the meniscus-derived cells decreased the percentage of CD34 cells and increased the percentage of CD146 cells observed by flow cytometry. Moreover, our results showed that cells which were originally positive for CD34 lost this surface marker and began expressing CD146. Meniscus-derived cells have the potential for multilineage differentiation. The cells isolated from the peripheral vascular region have a greater multilineage differentiation potential than cells isolated from the inner region. The present findings may provide important clinical insight for cell-based therapy aimed at enhancing meniscal repair and regeneration following injury.
Implantation of Comminuted Autogenous Meniscus Tissue into a Large Meniscal Defect Enhances Spontaneous in Situ Regeneration of the Meniscus: An Experimental Study

INTRODUCTION:
Poor healing capacity of the meniscus tissue often dictates removal of the damaged tissue, making meniscectomy the most common treatment for meniscal injury. Although meniscectomy provides pain relief and a return to function, the loss of meniscal tissue results in long-term dysfunction and secondary osteoarthritis. Thus, the meniscus-deficient knee is a common problem facing orthopaedic surgeons. When significant portions of the meniscus are surgically removed due to a complex injury, replacement or regeneration with a tissue of normal size, shape, and composition would appear to be the optimal object when considering the long-term function of the knee. Currently, there are multiple strategies for addressing this objective, including meniscal allografts, biologic scaffolds to replace the meniscus, and meniscal tissue regeneration. Concerning meniscal allografts and biologic scaffolds, although short-term clinical or experimental results seem to be favorable, the clinical utility has not been established as of yet because of many unsolved problems. Concerning meniscal tissue regeneration, many investigators have studied a tissue-engineered meniscus, while its utility remains unknown. On the other hand, few investigators have studied biologic stimuli for spontaneous meniscal tissue regeneration. Based on our preliminary experiments, we have proposed a therapeutic hypothesis that, when meniscectomy has been performed, implantation of autogenous fragments created from the resected meniscus into the large defect may induce spontaneous in situ regeneration of the meniscus after surgery. Therefore, we have conducted an in vivo experimental study with rabbits. A specific hypothesis to test in this study is that implantation of autogenous meniscal fragments into a large defect created in the medial meniscus using an autogenous fascia sheath may significantly enhance the spontaneous in situ regeneration of fibro-cartilage tissues in morphological, histological, and biomechanical evaluations. The purpose of this study is to test this hypothesis.

STUDY DESIGN: Controlled laboratory study

MATERIALS AND METHODS:
A total of 75 female Japanese White rabbits were randomly divided into 3 groups of 25 animals each. In each animal, the right knee underwent arthroscopy, and a half of the medial meniscus was resected in the anterior portion using the standardized method. Then, in Group I, no treatment was applied to the meniscal defect. In Group II (Sham group), the defect was covered with only a rectangular fascia membrane (10x12mm) harvested from the left thigh. In Group III, the resected portion of the meniscus was fragmented into a number of small pieces (approximately 0.5x0.5x0.5mm) using a sharp blade. Then, after the defect was covered with a rectangular fascia membrane in the same manner as used in Group II, the autogenous meniscus fragments were grafted into the fascia sheath. No immobilization was applied in each animal after surgery. In each group, 15 rabbits were randomly selected from the 25 rabbits for histological examinations, and 5 rabbits were sacrificed at 3, 6, and 12 weeks, respectively. Five of the remaining 10 animals were sacrificed at 6 and 12 weeks, respectively, for biomechanical evaluations. In each period, morphological observations were performed in the animals immediately after sacrifice. Tissue dimensions of the regenerated tissue in the defect were determined in both the morphological and histological observations. Histological findings of the regenerated tissue observed with the hematoxylin and eosin, Safranin-O, and Toluidine-blue staining were quantified with an original scoring system. For biomechanical evaluations, we fashioned the tibia (anterior attachment)-medial meniscus-tibia (posterior attachment) complex specimen from each harvested knee, and mounted on an Instron-type tensile tester with special grips. Tensile
tests were performed at a cross-head speed of 50 mm/min. We determined the structural properties of the regenerated portion under quasi-hoop stress, because all meniscus specimens failed at the regenerated portion. Statistical analyses were made using the two-way ANOVA with the Fisher’s PLSD tests for multiple comparisons. The significance level was set at p=0.05.

RESULTS:
In Groups I and II, each defect was incompletely filled with thin fibrous tissues even at 12 weeks, while a cartilage tissue rarely regenerated in the tissue. In Group III, all defects except for one were completely filled with thick fibro-cartilage tissues, which were richly stained with the Safranin-O and Toluidine-blue staining methods, by 12 weeks. The width and the cross-sectional area of the regenerated tissue were significantly greater (p<0.001) in Group III than in Groups I and II at 12 weeks. The histological score of the cartilage regeneration of Group III (6.2+/−3.2points) was significantly greater (p<0.0001) than that of Groups I (1.0+/−0.6 points) and II (0.3+/−0.8 points) at 12 weeks.

In the biomechanical evaluation, the maximal load and the linear stiffness of the regenerated tissues were significantly greater (p<0.01) in Group III (29.9+/−1.8 N, 11.2+/−4.5 N/mm) than in Groups I (15.3+/−5.8N, 6.2+/−2.1N/mm) and II (17.5+/−6.1N, 5.4+/−2.1N/mm). However, the maximal load and the linear stiffness of the regenerated tissues in Group III were significantly less than those of the normal meniscus (47.6+/−8.8N, 17.0+/−4.6N/mm) harvested from the left knee (p<0.01). Articular cartilage damage was significantly (p<0.01) less in Group III than in Groups I and II.

DISCUSSION:
This study demonstrated implantation of autogenous meniscal fragments into a large defect created in the anterior portion of the medial meniscus using an autogenous fascia sheath enhanced the spontaneous in situ regeneration of the fibro-cartilage tissues to a significantly greater degree than the sham treatment in morphological, histological, and biomechanical evaluations. We speculate on a few mechanisms which may play a role in this phenomenon. It is well known that a thin meniscus-like tissue incompletely regenerates in situ after total meniscectomy at the peripheral margin with vascularity. Implantation of the autogenous meniscal fragments may provide multiple sources of chondrocyte migration and/or sufficient amount of extracellular matrix for cell migration from multi origins, resulting in a greater amount of fibro-cartilage regeneration. This study proposed a novel strategy to treat a large defect after meniscectomy. Namely, there is a strong possibility that, when meniscectomy has been performed, spontaneous in situ regeneration of the meniscus can be induced after surgery by implantation of autogenous fragments created from the resected meniscus into the large defect.

Key Words:
Meniscus, In situ regeneration, Meniscal fragment implantation, Meniscectomy, Experimental study
Effect of the Addition of Mesenchimal Stem Cells in the Healing of Acute and Chronic Meniscal Lesions in the Avascular Zone: An Experimental Study in Rabbits

INTRODUCTION AND OBJECTIVES: the treatment of meniscal lesions is a challenge because, although lesions in the vascular region often heal with traditional techniques, lesions in the avascular area rarely heal. Different experimental studies have explored the effect of a variety of substances in the healing of lesions in the avascular area, but poor results are the norm. Adult Mesenchimal Stem Cells (MSC) obtained from fat have shown an ability to regenerate cutaneous and osseous defects. The objective of this study is to determine if the addition of MSC to a sutured meniscal lesion in the avascular zone of rabbit menisci improves the outcome of acute and delayed repairs.

METHODS: twenty four New Zealand rabbits were used in the study. MSC were obtained from fat extracted from the rabbits inguinal zone that was processed and cultured sequentially (two to three times) so as to obtain an adequate number of MSC; in the last culture the cells were incubated in a solution containing deoxibromouridine (DBU) so as to mark their DNA. The medial meniscus of both knees was approached, and a 0,5 cm longitudinal tear in the avascular area of the anterior horn was performed. In twelve rabbits the lesions were repaired immediately and in another twelve rabbits the lesions were repaired three weeks later. All the tears were sutured with one simple vertical stitch of nonabsorbable suture. A Matrigel® solution with 100,000-1,000,000 MSC was placed prior to suture tightening inside the sutured area of one of the knees; in the contralateral knee the Matrigel® solution was placed without cells to be used as controls. The rabbits were sacrificed after 12 weeks, menisci were evaluated macro-microscopically and an immunohistochemical analysis with antibodies for DBU was performed to evaluate the presence of siblings of the stem cells.

RESULTS: In the group repaired acutely three total and three partial healings were observed in the MSC group and none in the control group. In the group repaired after three weeks one total and one partial healing were observed in the MSC group and none in the control group. The immunohistochemical evaluation showed positive results in menisci with partial or complete healing.

CONCLUSIONS: MSC have a strong positive effect in the healing of meniscal lesions in the avascular zone in rabbits repaired acutely. This effect is lees marked if at all present when the lesion is repaired in a delayed fashion.
Long Term Clinical Outcome of Meniscal Allograft Transplantation

Purpose: Meniscal allograft transplantation for the symptomatic post-menisectomized knee in younger patients has become an accepted treatment. However, long-term data on the clinical outcome of this procedure are scarce. We describe the results of cryopreserved meniscal allograft transplantations with a follow-up of nine to eighteen years.

Methods: From 1989 to 1999, 63 meniscal allografts were transplantated in 57 patients. The clinical outcome and failure rate of 40 lateral and 23 medial meniscal allografts were evaluated at a mean follow-up of 165 months (SD 105-221) using KOOS, Lysholm and the IKDC scoring systems.

Results: Combined failure rate was 29%, 35% of medial allografts and 25% of lateral allografts failed. A significant difference between preoperative and long-term Lysholm scores were found for almost all types of allograft transplantation, except medial transplanted allografts, female patients and left treated knees. Lysholm scores were poor (<65) for both medial and lateral allografts. No significant differences in pain, symptoms and function scores were seen between these groups. In addition, there was no significant difference in clinical outcome between post-transplanted survivors and post-transplanted non-survivors who received a total knee arthroplasty.

Conclusions: The results of pain and function scores of the knee after meniscal allograft transplantation at the long-term are poor. However, earlier results from this population confirmed an improvement in clinical function and pain relief at the short- and intermediate-term, leaving meniscal allograft transplantation as a good option for the treatment of degenerative arthritis of the symptomatic, post-meniscectomized knee. Meniscal allograft transplantation is a good postponement till total knee arthroplasty.
An Allograft Based Tissue Engineered Meniscus Scaffold

Intro: Treatment options for irreparable meniscus injuries in the USA remain limited to partial or total meniscectomy and meniscus transplant. Current allograft meniscus transplants have been shown to lack complete cellular ingrowth. This may contribute to impaired long term incorporation and function. Increased porosity and interconnected pores may be able to improve the potential for cellular ingrowth. The objective of this study was to develop an allograft based 3-dimensional scaffold for use as a meniscus transplant.

Methods: Twelve ovine medial menisci were harvested and frozen in isotonic saline. Six menisci were left intact while n=6 menisci were decellularized and oxidatively etched using a series of hypotonic washes, tritonX100, and peracetic acid washes. The menisci (now scaffolds) were normalized in phosphate buffered saline. To look for remaining nuclei, menisci (intact and scaffold) were analyzed histologically using H&E, Masson's Trichrome, and nuclear fluorescent staining. DNA content was quantified for both the intact and scaffold menisci. To evaluate changes in porosity, 2-dimensional SEM analysis and a novel microCT based 3-dimensional porosity analysis were performed.

Results: H&E and nuclear staining illustrated an obvious absence of nuclear material in the scaffold compared to the intact meniscus. Trichrome staining clearly showed the remaining collagen fibers in the scaffold after processing. DNA content analysis demonstrated >60% decreased DNA (p<0.05) in scaffold constructs compared with intact meniscus. SEM and microCT showed a significant increase in porosity from 3% to 69% in the scaffold after processing (p<0.05). Pore connectivity also increased significantly over 200% (p<0.05).

Discussion: We have developed a porous meniscus scaffold that is decellularized and oxidatively etched. This scaffold shows increased porosity while preserving the collagen extracellular matrix of the native meniscus. This scaffold has the potential for improved cellular ingrowth compared with fresh frozen allografts and may help to improve current treatment options for meniscus transplant.
Modification of the Human Meniscus Vascular Supply During Foetal Development: About 16 Cases

Introduction: The description of the vascularisation of the menisci, with 3 zones as described by Arnoczky, allows a better understanding of the mechanisms for meniscus healing. It was performed on adult meniscus. The purpose of this anatomical study was to describe the gradual changes in the vascular supply of the menisci during foetal development.

Material and methods: We studied 16 menisci (8 lateral menisci and 8 medial menisci) in 8 human fetus subjects, with ages ranging from 24 to 41 weeks of gestation. One case was used for the study of feasibility. The other 15 specimens were injected with India ink and dissected. They were then cleared using the Spalteholtz method, and then embedded in paraffin. Sections were cut and specific endothelial immunologic markers (CD 31, CD34, Factor VIII) were searched. We then studied the arterial part of the perimeniscal capillary plexus.

Results: The blood supply to the menisci comes from the superior and inferior branches of the medial and lateral geniculate arteries. These vessels were disposed predominantly in a circumferential pattern, with radial branches directed toward the central portion of the menisci. In the 24 weeks of gestation old fetus, in most cases, these vessels stop at the third external part of the meniscus. After 41 weeks of gestation, the vascular supply reaches the inner part of the meniscus. The vascular supply distribution and modification was the same in every menisci studied.

Conclusion: contrary to other publication, this study describes the vascular supply of the human meniscus only during foetal development. The vascularisation of the meniscus changes during the foetal development. Only localized in the lateral third during the foetal period, vascular supply reaches the inner part of the meniscus at the time of the birth. This may be clinically important for the comprehension of the development of degenerative changes and for the healing of meniscal lesion.
Wireless Video Arthroscopy

INTRODUCTION:
Utilizing newly invented wireless technology, video arthroscopy is now performed without the need for the cumbersome and expensive conventional arthroscopic tower, video cables and fiberoptic light cords. Images are projected onto any standard PC or laptop computer. The complete system is ultra lightweight (3.5 kg) compared to the traditional, costly, and cumbersome "arthroscopic tower" (50 kg) and is completely portable. The need for the traditional "arthroscopic tower" has been eliminated.

METHODS:
A miniature wireless video camera (225 grams) send signals to a video receiver (220 grams). This is projected wirelessly to any PC, laptop, or computer monitor. A removable and reusable high intensity light source (LED) (150 grams) is directly attached to the arthroscopic cannula eliminating the need for fiberoptic cables. Picture and video files can be captured and "dragged and dropped" to any presentation format in seconds.

RESULTS:
Since January, 2007, more than 200 wireless video arthroscopies of the knee and shoulder have been performed with no infection or adverse effects. The use of all cumbersome wires running from the arthroscopic surgical field have been eliminated. This eliminates a potential source of contamination and infection. This new technology avoids the conventional light source, fiberoptic cables, video cables, and arthroscopic tower set.

DISCUSSION AND CONCLUSION:
Wireless video arthroscopy utilizing a wireless video camera and self containe high intensity light source is a new technology that allows arthroscopic procedures to be performed "without wires." Images can be viewed and captured on any standard PC or laptop computer. The technology is perfect for surgical arthroscopy, practicing procedures in a dry lab setting, training of physicians (eg. third world locations with little or no arthroscopic equipment), and office arthroscopy. The technology is extremely cost efficient (one tenth the cost of a conventional arthroscopic tower), ultra-lightweight, completely portable, and has excellent resolution.
Treatment of Unstable Distal Clavicle Fractures Using Suture Anchors and Suture Tension Band Wiring

Introduction: Distal clavicle fracture associated with coracoclavicular ligament ruptures are unstable and result in high rate of nonunion. This study presented clinical results of a combined surgical technique for the fracture fixation and ligament reconstruction using two suture anchors and two nonabsorbable suture tension band wiring.

Materials and Methods: Twelve patients with distal clavicle fractures associated with coracoclavicular ligament ruptures were included with a mean follow-up of 22 months. Average age was 37 years old. Bicycle accident was the most common cause of injuries. Eleven patients were treated within 10 days after injury and 1 patient underwent surgery in two months. Two 3.7mm bio suture anchors were placed on the anterolateral and posteromedial portion of the base of the coracoid process separately, where supposed to be the coracoid insertion of the trapezoid and the conoid ligament. Two strands of #2 Fiberwires attached to the suture anchor in the posteromedial portion were passed through the drill holes in the distal site of proximal clavicular fragment to pull it down. 2 strands of #2 Fiberwires attached to the suture anchor in the anterolateral portion were passed through the drill holes in the proximal clavicle and distal fracture fragment, crossing the fracture site, for reduction. Then two #5 Fiberwires were passed through holes in the proximal clavicle and distal fragment in figure-of-eight fashion. The coracoclavicular space and fracture held reduced as each of the suture were tied over the clavicle.

Results: An average fracture fragment length was 2.4cm. Eleven patients obtained bony union at 3 months postoperatively. One patient with extended interval to operation showed union at 6 months. The coracoclavicular distance widened up to 300% compared with the contralateral side preoperatively and 10 patients reduced to normal range. Average Constant score improved to 96 points and 11 patients had good and excellent results according to UCLA score. One patient showed superior angulation of the distal fragment and the other patient showed osteolysis in fracture site.

Discussion: A satisfactory outcome can be achieved by reconstruction coracoclavicular ligament using suture anchors in addition to fracture reduction with the suture tension band wiring.
Postoperative Outcomes of Partial Humeral Head Resurfacing for Avascular Necrosis

This is a prospective series of nine patients diagnosed with avascular necrosis (AVN) who underwent partial humeral head resurfacing. Their mean age was 43 years. Preoperative and postoperative standardized evaluations included history, physical examination (PE), radiographs, and clinical scoring systems- including the Western Ontario Osteoarthritis of the Shoulder index (WOOS), Constant and Visual Analog Pain (VAS) scores. All patients had failed conservative treatment and were experiencing worsening pain and progressive loss of motion prior to surgery. Postoperative assessments were conducted at 4 - 7 days, 6 weeks, 3, 6, 12, 18 and 24 months. Statistical analysis of the data was performed in order to determine significant differences between preoperative and postoperative scores. No significant complications were experienced. Postoperatively, all patients reported significant pain relief. VAS scores improved from 4.36 preoperatively to 1.00 three months postoperatively. PE revealed significant improvements in functional outcomes as well. Forward flexion improved from a mean of 107.2 degrees preoperatively to 155 degrees postoperatively. Abduction improved from a mean of 38.8 degrees preoperatively to 48.1 degrees postoperatively. Good to excellent results were also observed in the WOOS and Constant scoring systems. Partial humeral head resurfacing in patients diagnosed with AVN yields a successful outcome, with patients experiencing excellent pain relief and improved range of motion. Furthermore, satisfactory results may be obtained without the use of excessively large humeral heads; rather, preservation of bone stock is maintained.
Arthroscopic Repair of Isolated Partial Subscapularis Tendon Tears

Rotator cuff tears involving complete subscapularis tendon tears are relatively uncommon. In contrast to that, partial intraarticular tears in the upper third of subscapularis tendon insertion appear to be much more frequent. According to different theories, these tears could be related either to degenerative tendon weakening or subcoracoid impingement. We describe an arthroscopic intraarticular approach for repair of partial intraarticular subscapularis tendon lesions and present short-term results of this technique.

We prospectively followed 38 patients diagnosed with partial isolated subscapularis tendon tear and treated by arthroscopic intraarticular tendon repair. In all patients a coracoplasty through rotator interval was performed and tendon was repaired with one or two absorbable suture anchors. There were 23 men and 15 women with a mean age of 52 years in our study group. Functional results were assessed by Constant and UCLA score, pain was evaluated by VAS. All measurements were performed preoperatively and at the time of final examination by an independent observer. Statistical significance was calculated using T-test for paired variables. Average time of follow-up was 18 months. Average preoperative Constant score was 43 (±9) and improved afterwards to 84 (±7). Average preoperative UCLA score was 11 (±4) and improved to 31 (±2) at the final examination. Average preoperative VAS score was 8 (±1) and postoperatively 2 (±1). The measured improvements in shoulder function and pain were all statistically significant.

Arthroscopic intraarticular repair of partial articular-sided subscapularis tendon tears is an effective procedure that preserves the residual intact attachment of the subscapularis tendon and according to our short-term results helps to significantly improve shoulder function.
Arthroscopic Repair of Combined SLAP and Bankart Lesions

Overview: Superior labral anterior posterior (SLAP) lesions arise from different injury mechanisms. Their association with an anteroinferior labrum detachment is a challenging situation for athletes. Arthroscopic techniques over the open procedures are suitable for an accurate reconstruction of the involved structures.

Purpose: The aim of this study was to retrospectively evaluate patients who underwent arthroscopic treatment for SLAP lesions combined with anteroinferior labral reconstruction (Maffet SLAP V). Type of Study: Case Series. Level IV.

Methods: Out of 123 arthroscopic shoulder stabilization procedures performed in our institutions, 21 (17%) patients presented a superior labrum detachment which deserved suture anchor fixation. Eighteen patients (15 males and 3 females) with a mean age of 27 years (range 17 to 43 years) were available for a mean follow up of 35.5 months (range 24 to 56 months). In all the patients the symptoms started after trauma. The main preoperative complain was instability with dislocations and subluxations in 15 shoulders. Three patients suffered pain alone without important signs of instability. Only in 5 cases the preoperative MRI demonstrated the superior labrum injury. As a first step of the procedure the anterior-inferior labrum was fixed with moderate capsular placation. The SLAP lesion was stabilized later through a posterolateral portal. An average of 4.3 anchors were used to fix the anteroinferior labrum and one of these devices was used to stabilize the superior labrum posterior to the LHB insertion area. The included cases were fully preoperatively and postoperatively evaluated with extensive physical exam, UCLA, Constant & Murley and Rowe Scores.

Results: At the follow up evaluations two patients were considered clinical failures (11%). One due to dislocations and one for pain and disability without instability symptoms. Functional results were excellent-good in 16 patients (89%). The mean UCLA Score increased from 17,1 preoperatively to a 28,8 postoperatively (P = 0,00002) with a corresponding increase in the mean Rowe Score from 34,1 to 85 points (P =0,00003). The Constant and Murley Score improve from 63,7 preoperatively to 84,4 postoperatively (P =0,0002).

Conclusions: The combined injury of the superior and anterior-inferior labrum is not infrequently seen. Arthroscopic fixation of the avulsed labrum seems to be the mainstay of treatment of these complex injuries.

Key Words: Shoulder - SLAP - Instability – Bankart.

Introduction: The treatment of recurrent involuntary posterior instability of the shoulder, remains discussed, and open procedures are described as the gold standard. Arthroscopic procedures allow a better description and understanding of lesions. We evaluated the outcome of arthroscopic posterior capsular shift in 18 patients with involuntary unidirectional recurrent posterior instability of the shoulder that failed to respond to conservative treatment.

Patients and methods: Between 2000 and 2006, 18 patients, suffering of traumatic posterior involuntary instability were treated. The average age of the patients was 26 years. Within them, 16 had sports activities. All patients had sustained a definite injury that had initiated the instability. The 18 shoulders were treated with a posterior capsular shift and a reattachment of the posterior labrum to bone. With a mean follow-up of 3 years, outcomes were assessed by means of a clinical examination, with calculation of the Duplay score, and by means standardized radiographs and arthro-CT Scan or arthro-MRI.

Results: With a mean score of 89.4 points out 100 at the last follow-up, based on the Duplay score, the results were rated good or excellent for 83.4% of the patients, fair for 11.1% and poor for 5.5% (1 patient). All patients were satisfied with the results, although the patients estimated that the function of the shoulder was an average of 82.5% of that of a normal shoulder because some experienced some residual pain or in 2 cases of algoneurodystrophies, none suffered of instability. 68.8% return to sports activities at the same level and only 1 stopped his sports activities.

Discussion: Unidirectional, posterior involuntary instability can be treated by an arthroscopic reattachment of the posterior labrum and capsule to bone is by way of suture anchors. But injury to the capsulolabral structures must not be underestimated, and a capsule plication has to be performed, associated to a closure of the rotator interval if needed.

Conclusion: Clinical results of this study confirm results published recently. Arthroscopic repair followed by a well-monitored rehabilitation protocol yields promising short-term to medium-term results that allows patient to return most individuals back to professional activities and sport.
Revision Bankart Repair: Is Arthroscopic Reconstruction the Right Path to Follow?

Overview: The mainstay of revision surgery for recurrent shoulder instability is controversial. Accurate patient selection may be the key to success.

Purpose: The objective of this study was to report the results of a selected group of patients with recurrent shoulder instability that were revised arthroscopically with a suture anchors technique. Type of Study: Prospective nonrandomized outcome study. Level III.

Methods: Sixteen patients (13 males and 3 females) with failed traumatic instability repairs were prospectively selected for arthroscopic revision surgery. The mean age was 26.8 years (range 16-42 years). Inclusion criteria included unilateral traumatic injury, subluxations or less than five dislocations after the first reconstruction and moderate bone loss. Exclusion criteria included patients with bone loss more than 25% of the glenoid surface, Hill Sachs more than one third of the articular surface, MDI or the will to return to contact or collision sports. An engaging Hill Sachs lesion or poor tissue quality were not considered a contraindication for an arthroscopic procedure. The patients had a mean of 1,25 surgeries before the revision. Four shoulders had two previous surgeries. The primary procedures were 14 arthroscopic (6 transglenoid, 2 staples and 6 suture anchors techniques) and 6 open. Thermal shrinkage of the capsule was performed in 4 of the previous surgeries. During the revision surgical procedure an arthroscopic capsular shift, an extensive Bankart repair with anterior capsular placation and a rotator interval closure were performed in all cases. A mean of 4,5 anchors were used in each patient. With a mean follow up of 30,9 months (range, 24 to 46 months), the patients were evaluated with a thorough physical exam, UCLA, Constant & Murley and Rowe Scores.

Results: At the follow up evaluation three patients were considered clinical failures (18,75%). Two patients presented dislocations and one subluxation. There was clinically significant improvement in UCLA Score from 22.1 preoperatively to 30.9 postoperatively ($P = 0.0006$), Constant & Murley 68.7 preoperatively to 80.5 postoperatively ($P = 0.0005$) and Rowe Score 33.1 preoperatively to 80.3 postoperatively ($P = 0.00024$).

Conclusions: Arthroscopic revision surgery is technically challenging. However, with a conservative patient selection and an accurate surgical technique, good results can be expected achieving satisfactory functional outcomes.

Key Words: Shoulder-Instability-Revision-Arthroscopic.
A Biomechanical Comparison of Three Double-Row Rotator Cuff Repair Techniques

PURPOSE
We hypothesize that the arthroscopic mason-allen and the open mason-allen technique will fail at a higher load than the standard double row technique.

SIGNIFICANCE
Recent advances in arthroscopic shoulder surgery has expanded the options available to surgeons repairing rotator cuff tears. However, limited data exists on comparing the various double row techniques. The objective of this study was to compare the load to failure properties of two arthroscopic and one open double row fixation techniques. Our hypothesis was that the open mason-allen and arthroscopic mason-allen suture techniques would result in a higher load to failure than the standard technique. This is based on the assumption that stitching methods that strengthen the tendon-suture interface can improve the strength of double row rotator cuff repairs.

METHODOLOGY
Thirty sheep shoulders were harvested and the infraspinatus tendons dissected free from all surrounding muscles and osseous attachments. Three double row stitch configurations (9 arthroscopic standard, 11 arthroscopic mason-allen, 10 open mason-allen) were performed and tested. The shoulders were then secured in a material testings machine and pretensioned for 10 cycles between 5 and 50N at 0.20 Hz. The specimens were then loaded to failure under displacement control at 1 mm/sec. Stiffness, yield load and ultimate load were measured and compared. The failure type, either through suture or anchor pull out, was also recorded.

RESULTS
The load to failure for the open mason-allen technique was 421 N +/- 116N. The load to failure for the arthroscopic mason-allen technique was 387 N +/- 74N. The load to failure for the standard double row was 409 N +/- 132 N. The yield load was 312 +/- 82 N, 299 +/- 71 N and 318 +/- 110N respectively. The stiffness was 25.6 +/- 5, 28.4 +/- 9.4 and 27.6 +/- 3.9 respectively. No significant differences were found between the suture techniques in the ultimate load to failure, yield load or stiffness.

CONCLUSION
In this in vitro cadaver sheep study, we found no significant differences between the three double row suture techniques in the ultimate load to failure. Different suturing methods to improve the strength of the suture tendon interface does not seem to have a significant impact on the ultimate load to failure of double row rotator cuff repair constructs.
Musculoskeletal Injury in Middle Age Runners

Objective:
To determine if injury patterns and risk factors for injury differ between middle age and younger runners.

Design: Prospective survey.

Material & Method:
Santiago Runners, Chile. A total of 150 runners consented to participate and completed the survey. Eighty percent (120/150) completed the survey electronically and 20% (30/150) manually. Middle age runners (>or=40 years) made up 40% of the population (60/150) The survey was distributed to all participants in march of 2007 and 2008. Runners reported on training patterns, injury location, and diagnosis over the previous year.

Statistics Study:
Descriptive statistics and chi analysis were used to detect differences in injury rate and location between middle age and younger runners. Multivariate logistic regression models were used to identify risk factors for injury for each group.

Results:
The injury rate for the entire population was 42% (63/150). Significantly middle age runners were injured than younger runners (P<0.05). More middle age suffered multiple injuries than younger runners (P<0.001). Significantly more middle age runners were male, had 5 or more years of running experience, run more than 50 km/wk, 6 or more times/week than younger runners (P<0.001). The knee and foot were the most common locations of injury for both groups. The prevalence of soft-tissue-type injuries to the calf, achilles, and hamstrings was greater in middle age runners than their younger counterparts (P<0.001). Younger runners suffered more knee and leg injuries than masters runners (P<0.005). Running more times/wk increased the risk of injury for both groups.

CONCLUSIONS:
There were subtle differences in injury rate and location between middle age runners and younger runners, which may reflect differences in training intensity.
Chronic Exertional Compartment Syndrome: Accurate Diagnosis and Effective Surgical Management

Chronic exertional compartment syndrome (CECS) is a common injury affecting athletes of all levels of participation. Various methods of diagnosing and managing this condition have been described.

PURPOSE: To assess the results of subcutaneous fasciotomy for CECS following clinical assessment and a needle manometer “quick stick” method as diagnostic criteria.

METHODS: 50 patients with CECS in 112 compartments (93 anterior lower leg, 10 lateral lower leg, 7 deep posterior lower leg, 1 volar forearm and 1 dorsal forearm) were included in this retrospective cohort study. All the subjects underwent clinical assessment, and the diagnosis of CECS was confirmed using the needle manometer “quick stick” method (peak pressures > 30mmHg within 60 sec post exercise). All the subjects then underwent surgical subcutaneous fasciotomy, and were followed up via a telephonic questionnaire. Measures of outcome were the extent of symptom resolution (no change, partial relief, almost asymptomatic, asymptomatic), return-to-sport time frame, levels of pre and post-surgical activity (as measured by the Tegner Activity Level Scale) and complications.

RESULTS: At follow-up, 88% of the subjects achieved an excellent result (almost or totally asymptomatic), 10% fair (mild relief) and 1 patient (2%) had no change in symptoms. Return to sport time frame was a mean of 8.4 weeks (range 4-24 weeks). There was a 0% complication rate from the “quick stick” measuring technique used and a 9% rate of minor complication post surgery (4 wound infections, 2 wound breakdown, 1 recurrence and 3 cases of superficial numbness.)

CONCLUSIONS: The combination of clinical assessment and needle manometer measurement of all potentially involved muscle compartments results in an acceptably accurate diagnosis of chronic exertional compartment syndrome. Surgical fascial release of CECS provides relief of symptoms and return to sport in most cases (>85%). There is a low complication rate associated with the diagnostic needle manometer “quick stick’ method, as well as with subcutaneous fasciotomy in CECS.
A Prospective, Randomized Comparison of Functional Bracing Versus Rigid Immobilization After Modified Percutaneous Achilles Tendon Repair Under Local Anesthesia

OBJECTIVE: General complication rates were reported to be the highest in patients treated with percutaneous repair and early mobilization (15.6%). Modified percutaneous suture techniques have shown promise in biomechanical studies.

PURPOSE: To analyze the results of two ways of immobilization after treatment with the modified and biomechanically significantly stronger percutaneous Achilles tendon repair under local anesthesia.

MATERIALS AND METHODS: In prospective, randomized study from the year 2001 to 2004 with 3 years follow-up there were 31 patients (32 ruptures) in the functional bracing group (Group 1) and 30 patients in rigid immobilization (Group 2), both for the period of 6 weeks and operated on using the same method.

RESULTS: There were similar data in Group 1 and 2 regarding gender (3 vs. 2 women), average age (41.9 vs. 42.2), side (16 vs. 13 right sided ruptures) and sports activity during injury (18 vs. 19). There was no re-rupture in Group 1 vs. one (3,3%) in Group 2 (1,6% altogether), two (6,2%) transient sural nerve disturbances in Group 1 and one (3,3%) in Group 2 (4,8% altogether), one suture extrusion problem in Group 2 (3,3%) with no other major or minor complications (6,2% of altogether complications in Group 1 vs. 10% in Group 2). Patients in Group 1 had slightly thicker but less rigid healed tendons, were (subjectively) more satisfied with the comfort (treatment), reached sooner final range of motion without limping and had higher average AOFAS score (96.9 vs. 95.7) with no statistical significant difference (p=0.38).

CONCLUSIONS: The results of study support the choice of modified percutaneous Achilles tendon repair under local anesthesia with functional bracing and early mobilization.
Platelets Can Cure Lateral Epicondylitis

OBJECTIVE: The purpose of this study is to examine the effect of a single percutaneous injection of platelet-rich-plasma compared to an injection of corticosteroids in patients with chronic lateral epicondylitis.

BACKGROUND: Lateral epicondylitis is a common problem that usually resolves with nonoperative treatments. When these modalities fail, however, patients are interested in an alternative to surgical intervention. Platelet Rich Plasma (PRP) is a component of whole blood that contains concentrated amounts of powerful growth factors. PRP has been used for a variety of orthopedic applications including tendinopathy, wound healing and spinal fusion with varying degrees of success. Buffered PRP has also been used to enhance cell proliferation in-vitro. Human fibroblast and mesenchymal stem proliferation is increased in buffered PRP compared to control media. This in-vitro data may help explain the positive clinical results.

HYPOTHESIS: Treatment of chronic severe lateral epicondylitis with buffered platelet-rich plasma will reduce pain and increase function in patients considering surgery for their problem.

STUDY DESIGN: Prospective double-blind randomized-control trial.

METHODS: One hundred patients with persistent lateral epicondylar pain were evaluated in this study. All these patients were initially given a variety of nonoperative treatments. These patients had significant persistent pain for at least 6 months despite these interventions. All patients were considering surgery. This cohort of patients who had failed nonoperative treatment was then given either a single percutaneous injection of platelet-rich plasma (experimental group, n = 50) or corticosteroids (control group, n = 50). This amount of patients creates a power of 80% with a beta error of 0.05.

RESULTS: Significant better results were measured in the patients receiving PRP after 3 months, 6 months and 12 months, but not after 6 weeks. We used an improvement of more than 25% of the baseline VAS for pain and DASH scores. None of the patients receiving corticosteroids had a successful outcome over 6 months.

DISCUSSION: Although PRP is a more expensive method than corticosteroids, its use in patients who are opting for surgery is an option.
Wavelet-EMG Analysis of the Leg Muscles in Fencing During a Flèche Attack

INTRODUCTION - Fencing is highly demanding on the coordinative skills of athletes. The timing of the muscular activation during a flèche attack is one factor of a successful touch during an attack in a fencing bout. The goal of this study was to analyze the muscular activation sequences of the main leg muscles during flèche attacks and to help to improve training methods in fencing.

METHODS - Kinematics of the whole body [Romkes, 2007] (VICON MX, 240 Hz), ground reaction force during the push-off phase (Kistler, 6000 Hz) and EMG data (Biovision, 6000 Hz, SENIAM-Standard) of the M. Tibialis anterior, (TA), M. Gastrocnemius Medialis (GM), M. Vastus Medialis (VM), M. Rectus Femoris (RM), M. Semitendinosus (HAM) of both legs and of the M. Vastus lateralis (VL) of the front leg was recorded of 7 volunteer male expert fencers. The data of 10 trials/subject were averaged using EMG Wavelet-Transformation (WT-EMG) [von Tscharner, 2000].

The test setup simulates a competition situation. The subject was doing small vertical bouncing jumps on the 2 force plates. The start for flèche attack was given by a visual signal at the target. The distance between the force plate and the target was 2.5 m. The beginning of the forward movement of the center of mass was set as movement start (t = 0 sec).

RESULTS AND DISCUSSION - The movement was initialized by lowering the center of mass and shifting it slightly in direction of the target. The actual push-off movement started with an activation of the RF, VM and GM of the rear leg. After taking off the rear foot a short co-contraction of the RF and HAM occur to stabilize the position of the hip joint. [Nene 2004]. The push-off movement of the front leg started before the muscular activation of the rear leg was finished. It started with the RF, VL, VM, GM and slight co-contraction of the RF and HAM after the foot left the ground. Prior to landing all measured muscles of the rear leg were activated, a co-contraction was seen for the ankle joint by the GM and TA and for the hip and knee-joint by the RF, VM and HAM.

The co-contraction of the RF and HAM after take-off of the rear leg is needed to keep the leg in the desired position. While the co-contraction of the RF, VM and HAM and the TA and GM prior to landing is a muscular pre-activation which is needed to control angular position of the joint and to absorb the impact force of the landing of the rear foot after hitting the target. The main landing impact was first absorbed by TA and slight later by GM and VM, with a clear higher muscular activation.

SUMMARY/CONCLUSIONS - The result of this study shows that the flèche attack is a highly demanding movement for the muscular coordination.

The pre-activation which is known form running [von Tscharner, 2003], can be seen also in the landing after flèche attack. In parallel the co-contraction is part of strategy of positing and stiffening up the joint.

The pre-activation and co-contraction are essential for optimizing the joint loading and preventing injuries.

REFERENCES

ACKNOWLEDGEMENTS
This study was supported by Robert Mathys Stiftung, Bettlach (Switzerland)
The Effects of Hyperbaric Oxygen Therapy on Patients with Muscle Injury

INTRODUCTION: Muscle injury is a major injury associated with sports activity. Hyperbaric oxygen therapy (HBO) application for soft tissue injuries, including muscle injury, was reported by several authors. As compartment syndrome is indicated for HBO, HBO would reduce edema after injury. Rapid improvement of muscle strength by HBO application in rat model was reported. Thus, HBO would be effective for the patients with muscle injury. The purposes of this study were to evaluate the effect of HBO on patients with muscle injury.

MATERIALS AND METHODS: Twenty-six patients, who involved muscle injury in sports activity and admitted to our hospital within 7 days after injury, were included in this study. The patients were administrated to HBO of 2.8 ATA for 1 hour from once to 7 times. At the time of pre-treatment and post-treatment, visual analog scales (VASs) regarding with rest pain, motion pain, and patients’ subjective evaluation of edema were measured 34 times in 12 patients. Muscle stiffness was measured with muscle tonometer 18 times in 14 patients. Leg volume was measured with the water-filled volumetric gauge in patients with Gastrocnemius muscle injury, and MRI investigation was performed.

RESULTS: The VAS values at pre-treatment and post-treatment were respectively 27.5 points and 22.5 (p<0.001) in rest pain, 44.6 points and 36.3 (p<0.001) in motion pain, and 31.8 points and 27.6 points (p<0.005) in patients’ subjective evaluation of edema. Muscle stiffness averaged 61.5 points at pre-treatment, and 59.9 points at post-treatment (p<0.01).

DISCUSSION: In this study, in patients with muscle injury, HBO was effective on the VAS values, muscle stiffness, and leg volume. HBO would be effective on patients with muscle injury. Further study should be necessary for assessment of healing acceleration and intermediate term results in patients with muscle injury.
The Application of Myoblasts Transfected with pEGFP-C2- h?IFN Gene for Skeletal Muscle Injury

Objective: To observe the effects of constructed myoblasts C2C12 with human interferon ? (h?IFN) gene on mouse acute muscle contusion, after transplantation by local injection into injured site.

Methods: With the technology of gene rearrangement, h?IFN gene was cloned into pEGFP-C2 plasmid; then its correctness was evaluated by the means of restriction enzyme analysis and sequencing. pEGFP-C2- h?IFN was transfected into myoblasts C2C12 with liposome mediated transfection, and the h?IFN gene expression of transfected C2C12 cells were tested by RT-PCR and Western Blot analysis; acute skeletal muscle contusion models were produced on right gastrocnemius in 64 male mice of 7-12 weeks. The 64 mice were divided into 4 groups randomly as group A (injection with h?IFN), group B (injection with C2C12 cells transfected h?IFN gene), group C (injection with blank C2C12 cells), group D (without intervention). The intervention was introduced on the 10th day following injury by different injection into the injured muscle, whereas the group D without any intervention for natural healing as control. The injured right gastrocnemius were harvested from 4 mice in every group on day 7, 14, 28, and 42 following injury, which were tested of expression of MHC-?b and vimentin by RT-PCR and immunohistochemistry technology.

Results:
(1) Correct construction of pEGFP-C2-h?IFN was identified by methods of restriction enzyme analysis and nucleotide, and the h?IFN expression in myoblasts C2C12 transfected with pEGFP-C2-h?IFN was detected by RT-PCR and western blot analysis; (2) After intervention, the expression of vimentin in the group A and group B was significantly lower that in the group C and group D; the expression of vimentin of group transfected cell was similar to group IFN, except that it was lower than group IFN on day 42. (3) No significant difference of the expression of MHC-?b among 4 groups.

Conclusion:
(1) The pEGFP-C2-h?IFN, an eukaryotic expression plasmid of h?IFN gene, has been constructed. And the h?IFN could be expressed effectively in mouse myoblasts C2C12 transfected with the recombinant plasmid; (2) Local injection of C2C12 myoblasts with h?IFN gene into injured muscle could inhibit the expression of vimentin, whose effect was similar to exogenous h?IFN; (3) It was indicated that the time of inhibition of vimentin expression by C2C12 myoblasts with h?IFN was longer than those injected with exogenous ?IFN directly.

Key words  human interferon ?, gene expression, myoblasts, transfection
Blocking Myostatin with Suramin Can Enhance Muscle Healing

Objectives:
Muscle injuries are very common musculoskeletal problems in sports medicine. Although current therapies such as RICE (rest, ice, compression, and elevation) are the norm for treatment, complete functional recovery is hindered by the development of scar tissue formation. Myostatin, a negative regulator of muscle growth, has been shown to stimulate fibrosis in skeletal muscle.1 Thus, we have focused the current study on the prevention of scar tissue through the down-regulation of myostatin by suramin, an anti-fibrotic agent which is already approved by Food and Drug Administration (FDA). Using an animal (murine) model of muscle contusion, we examined, 1) whether suramin can block the effect of myostatin and promote myogenic differentiation of myoblast cells in vitro and 2) whether suramin treatment enhances muscle regeneration and reduce fibrosis by down-regulating myostatin expression in vivo.

Methods & Materials:
In vitro: Myoblast cells were cultured with low-serum medium containing different concentrations of myostatin (0 and 1 ?g/ml) and suramin (0, 1, and 25 ?g/ml) to induce myogenic differentiation. In vivo: The muscle contusion was made on the tibialis anterior (TA) muscle of each mouse. Two weeks after injury, different concentrations of suramin (0 and 2.5 mg) were injected intramuscularly (n=20 mice/group). At different time points (0.5, 1, 2, 10, and 14 days after injection), mice were sacrificed and cryosections of TA muscle were analyzed histologically.

Results:
In vitro: Myostatin treatment significantly inhibited the myogenic differentiation of myoblasts. However, suramin treatment significantly blocked myostatin’s effects and moreover suramin treatment stimulated the fusion of myoblasts in a dose-dependent manner in the presence of myostatin. In vivo: Suramin (2.5 mg) injection demonstrated a significant increase in the number of regenerating myofibers and reduction of fibrotic area when compared with the control group (0 mg). Furthermore, suramin injection effectively inhibited the expression of myostatin in the injured muscle.

Conclusion:
Suramin improved skeletal muscle healing by enhancing regeneration and reducing fibrosis after contusion injury. Furthermore, a decrease the expression of myostatin in injured muscle treated with suramin may reveal a possible mechanism by which suramin improves skeletal muscle healing after injury. Our findings may contribute to the development of progressive therapies for muscle injury.

Acknowledgements:
The authors are grateful for technical assistance from Maria Branca, Jessica Tebbets, Aiping Lu. Funding support was provided by Department of Defense (W81XWH-06-1-0406 awarded to Dr. Johnny Huard, Ph.D.), the William F. and Jean W. Donaldson Chair at the Children’s Hospital of Pittsburgh, and the Henry J. Mankin Endowed Chair in Orthopaedic Surgery at the University of Pittsburgh.
The Influence of Locally Applied Platelet Derived Growth Factor on Free Tendon Graft Remodeling After Anterior Cruciate Ligament Reconstruction in Athletes

Background: No studies have dealt with the effects of growth factors on the free tendon autograft in anterior cruciate ligament reconstruction in athletes. The Platelet rich plasma gel (PRPG) contains a significant amount of growth factors deriving from activated platelets, and it has been shown that they participate in the repair process of tissue in animal models, as is the case of PDGF, IGF-1, IGF-2, TGF-b, among others, although it has not shown a specific clinical application.

Hypothesis: Application on the free tendon auto graft of Platelet Derived Growth Factor on free tendon graft remodeling after anterior cruciate ligament reconstruction in athletes, may affect the remodeling process of the graft.

Purpose: To determine the influence of platelet-derived growth factor on tendon graft remodeling in athletes.

Study Design: Controlled Randomized prospective clinical study.

Methods: The study group (25 knees from 25 patients) underwent anterior cruciate ligament reconstruction. 10 patients with the autogenous bone-patellar tendon-bone graft and 15 with hamstring tendon (semitendinosus and gracilis tendon). During the surgery the graft was prepared using a bio-scaffold with 5 cc of Platelet rich plasma gel (PRPG). The control group (25 knees from 25 patients) underwent ACL reconstruction without PRPG. 21 patients with the autogenous bone-patellar tendon-bone graft and 4 with hamstring tendon. MRI evaluation was done between 2 and 9 months post-op for the study group and 6 to 12 months post-op in the control group. Magnetic resonance imaging has been used to determine graft integrity and study the remodeling process of anterior cruciate ligament grafts morphologically with a score assigned by the same Clinical Radiologist depending on the level of signal intensity of the intraarticular segment of the graft.

Statistical Analysis: Both groups were comparable in the sex, age and case number variables, as per T-Student Test (p-value < 5%) and Test F (p-value < 5%). Statistical Package SPSS was used together with a Predictive Quadratic Model to determine the average maturing time for each group.

Results: The average maturing time of the group with GF, as per the Predictive Quadratic Model, was of 177 days, versus 369 days in those patients where AGF was not used that is half the time. This accelerated maturing with AGF is even more evident if one compares those patients that received ACL reconstruction with HTH graft, in both groups, attaining predictive maturing times of almost one third of the time maturing takes without GF. When we only compare those patients, in both groups, who had totally homogeneous grafts at the time of the evaluation, that is to say, scores of 0, homogenization of the graft in Group A (with GF) is achieved in 49.4% of the time it took for Group B (without GF). This is significant statistic difference.
Conclusions: The remodeling process of the graft during ACL reconstructive surgery, evaluated with MR, is faster in the presence GF obtained from Platelet Derived Growth Factor. The graft’s maturing time in ACL reconstruction using GF is 49.4% shorter than if not used. This means that the graft used could have its process completed in half the time required in the natural form. Great news, since a professional athlete could return to sports between months 4 and 5. We are conducting a follow-up of all our operated athletes to see what happens with the issue of re-ruptures, but we still don’t have sufficient numbers to show. The use of Pfizer’s gelite (Gelfoam) might affect the analysis of the MRI, but since it is an absorbable element it will probably be degraded at the time of the imaging assessment. For our patients, the majority of them high performance athletes, the possibility of reducing the biological maturation time of the graft has allowed them to work with more motivation and safety in their functional rehabilitation and therefore to return to their sports, on average, two months earlier than in previous periods. Certainly there is much more to be done. The actual application of the growth factors obtained from autologous platelet concentrate, does not allow us to specifically detect the ones that have to do with the process. We are surely applying a cocktail of factors where apparently not all participate nor influence the scarring of these tissues. We are not clear either on whether one application during surgery is sufficient or if it would be more effective to repeat the application of these factors during the recovery and post-op rehabilitation. What growth factors are really needed for ACL reconstruction? Are we applying the adequate amount? Is it important to keep the interaction and balance between all the growth factors present in the platelet concentrate? How long does the effect last? We still do not have the answers to these queries, but when we do, undoubtedly they will represent another important advancement in the treatment of these sports lesions in the future.

Clinical Relevance: Application of growth factors is a possible strategy to prevent graft rupture and accelerate sports return.
In Vivo Local Administration of Osteogenic Protein-1 Increases Structural Properties of the Overstretched Anterior Cruciate Ligament with Partial Midsubstance Laceration: A Biomechanical Study

INTRODUCTION:
Over-stretched ACL injury with partial midsubstance laceration and permanent elongation frequently occurs in athletic accidents. We have had no therapeutic options to repair this type of ACL injury because of the poor healing potential of the ACL. Recently, we have established a new over-stretched ACL injury model, with partial midsubstance laceration and permanent elongation.[1] Using this model, we recently reported that local application of transforming growth factor (TGF)-beta1 significantly inhibits the reduction of biomechanical properties of the partially injured ACL.[2] However, it has been well known that the intra-articular application of TGF-beta1 induces osteoarthritic changes in the knee joint.[3] Therefore, we have to seek for an alternative growth factor that can enhance the healing process of the injured ACL without any detrimental effect to the knee joint. Recently, clinical application of the osteogenic protein (OP) -1, a member of the TGF-beta superfamily, has been safely performed for non-union of the bone and cartilage regeneration.[4] In addition, Tsai et al [5] reported that OP-1 significantly enhances cell proliferation in a cultured ligament. Therefore, there is a strong possibility that local application of OP-1 can enhance healing of the injured ACL. No in vivo studies, however, have actually been conducted to clarify the effect of local application of OP-1 on healing of the injured ACL. We hypothesized that local administration of OP-1 significantly increases mechanical properties of the fascicles in the overstretched ACL in vivo, leading to a significant increase of structural properties of the whole overstretched ACL. The purpose of this biomechanical study is to test this hypothesis.

METHODS:
A total of forty-five mature Japanese White rabbits were used in this study. In each animal, the right ACL was injured using the following quantitative technique. The anteromedial and posterolateral bundles of the ACL were transected at two different levels, the proximal one-third and the distal one-third levels of the ACL, respectively. The ACL was then stretched by applying an anterior drawer force to the tibia at 90° of knee flexion. Subsequently, the ACL length was irreversibly elongated to 110% of the original length. Then, the rabbits were randomly divided into 4 groups of 15 animals each. In Group I, no treatments were applied. In Group II, 0.2-ml phosphate-buffered saline (PBS) was applied around the injured ACL. In Group III, 12.5-μg OP-1 (R&D) was applied with 0.2-ml PBS around it. In Group IV, fifteen knees randomly harvested from all the left knees were used to obtain normal control data. In each animal, no immobilization was applied after surgery. All animals were sacrificed at 12 weeks. In each group, 12 of the 15 rabbits were used for biomechanical evaluation, and the remaining 3 were used for histological observation. In biomechanical evaluation, the anterior-posterior (A-P) translation of the knee was measured using a tensile tester with a 3-DOF fixture under +/-10N forces at 30, 60, and 90° of knee flexion. The cross-sectional area was measured using a video dimension analyzer.[6] Seven were used for mechanical evaluation of the femur-whole ACL-tibia complex and the other five were used for mechanical evaluation of the fascicles harvested from the ACL. The latter evaluation was conducted to answer a question whether the OP-1 application mainly affected collagen fibrils themselves or minor collagens and proteoglycans that existed between collagen fibrils, based on previous biomechanical studies on structural properties of the tendon/ligament tissue.[6-9] Statistical analyses were made using the ANOVA with the Fisher’s PSLD test.
RESULTS:
(1) Concerning the A-P translation of the knee, Groups I (p=0.0025), II (p<0.0001), and III (p=0.0041) were significantly greater than Group IV at 30, 60, and 90° of knee flexion. Regarding the whole cross-sectional area of the ACL, there were no significant differences in the 4 groups.
(2) Structural properties of the femur-the whole ACL-tibia complex:
Concerning failure modes, all specimens failed at the midsubstance in Groups I, and II, while the ACL insertion was avulsed in 4 and 7 specimens in Groups III and IV, respectively. The ANOVA demonstrated significant differences in the maximum load (p<0.0001) and the stiffness (p<0.0001) among the groups. The post hoc test showed that the maximum load and the stiffness of Group III were significantly greater than those of Groups I (p=0.0022, p=0.0136), and II (p=0.0317, p=0.0245), respectively, but significantly lower (p=0.0003, p=0.0262) than those of Group IV.
(3) Mechanical properties of the fascicles from the ACL:
The ANOVA demonstrated significant differences in the tensile strength (p<0.0001) and the tangent modulus (p=0.0004) among the groups. The post hoc test showed that the tensile strength and the tangent modulus of Group III were significantly greater than those of Groups I (p=0.002, p=0.0171), and II (p=0.0051, p=0.0221), respectively, but significantly lower (p=0.0064, p=0.0396) than those of Group IV. There were no significant differences between Groups I and II in these parameters.
(4) Histologically, alignment of collagen fibers appeared to be irregular in the midsubstance of the ACL with numerous cells having a small round nucleus in the treated groups. Any abnormal findings were not observed in the joint cartilage.

DISCUSSION:
This study clearly demonstrated that application of 12.5-μg OP-1 significantly increased the stiffness of the injured ACL midsubstance at 12 weeks. In addition, the results of the failure modes and the maximum load of the femur-the whole ACL-tibia complex suggested that this application significantly increased the maximum load of the injured ACL midsubstance at 12 weeks. According to our measurement using the micro-tensile tester, application of 12.5-μg OP-1 significantly increased the tensile strength and the tangent modulus of the fascicles harvested from the injured ACL at 12 weeks. These results implied that local application of OP-1 significantly increases the structural properties of the injured ACL via an improvement of the mechanical properties of the collagen fascicles which regenerated in the injured portion. Therefore, administration of OP-1 is considered a valuable study in future therapeutic strategy for treating overstretched ACL injuries.

REFERENCES:
A Prospective Randomised Double Blinded Clinical Trial Comparing The Efficacy Of Hylan G-F 20 And Steroid Following Arthroscopic Debridement In The Treatment Of Osteoarthritis Of The Knee.

Aim: To compare the clinical effectiveness, functional outcome and patient satisfaction following intra articular injection with Synvisc® or steroid (Depomedrone) following arthroscopic debridement in patients with osteoarthritis (OA) of the knee.

Methods: Patients with OA of the knee and mechanical symptoms who underwent arthroscopic debridement and/or minimal trimming of the cartilage were reviewed six weeks after the surgical procedure. All such patients with a VAS pain score of 6 or more (0-10, 10 as worst pain) were identified (n=132) and randomised into two groups to receive either hylan G-F 20 (Synvisc) (n= 70) or steroid (Depomedrone) (n=62). All patients were to receive the recommended doses (i.e. 3 weekly injections 2 mls Synvisc or 80mgs of Depomedrone and 5mls of 0.5% Marcaing at week 1 and 5mls of 0.5% Marcaing at week 2 and 3) which were administered by the same physician using the default technique. All patients were prospectively reviewed by independent assessors who were blinded for the treatment at pre injection, 6 weeks, 3 and 6 months and yearly thereafter. All patients received standardised physical therapy. Weight bearing radiographs were reviewed at baseline to grade the degree of OA using the Kellgren-Lawrence system. Knee pain on a VAS (0-10,) was the primary outcome variable. The functional outcome was assessed using WOMAC, Oxford knee score and EuroQol- 5D scores. VAS was used to quantify patient satisfaction. Any decision to postpone knee arthroplasty was recorded. Any adverse events were recorded. The mean follow up was 12 months.

Results: The mean age of the randomised patients was 75.4 yrs. Patients in both groups predominantly had grade III/ IV OA. There were no significant differences in the age, sex and degree of OA between the two groups. Knee pain as measured by VAS improved from 7.8(6-9) to 3.9 by 3 months (p=0.007) and was sustained until 12 months (4.1, p=0.009) with Synvisc. In the steroid group, pain improved from 7.6 (6-9) to 4.4 at 6 weeks (p=0.02) and to 5.6 at 3 months (p>0.05). By 6 months, there was no difference from the baseline scores in the steroid group (7.1, p>0.05). Similarly, the WOMAC and Oxford knee scores were significantly better in the Synvisc group at 3 months (p=0.007) and 6 months (p=0.01) and 12 months (p=0.01) post injection. There was no significant difference in the EQ-5D scores at 6 weeks between the two groups. The EQ-5D description scores were higher in the Synvisc group from 3 months onwards (p=0.01) until 1 year (p=0.009). Two patients in the Synvisc group had severe local adverse events relating to the injection after the second dose. Both these patients recovered completely without any major sequale. Twenty nine of the 49 patients (59.1%) who were scheduled to have total knee arthroplasty deferred surgery to a minimum of 20 (15-24) months in the Synvisc group compared to one in 51 patients (1.9%) in the steroid group.

Conclusion: There is a significant improvement in the pain and function when hylan GF-20 is administered 6 weeks after an arthroscopic procedure in knee OA patients. The response is clearly amplified as compared to steroid injection (in the same patients population) or hylan GF-20 injection in virgin knees (data from our previous study). Furthermore, there appears to be a clear pharmaco-economic advantage of administering hylan GF-20 as it significantly delays knee arthroplasty.
The Efficacy Of Hylan G-F 20 And Sodium Hyaluronate In The Treatment Of Osteoarthritis Of The Knee – A Prospective Randomized Clinical Trial

Aim: To compare the clinical effectiveness, functional outcome and patient satisfaction following intra articular injection with Synvisc® and Hyalgan® in patients with osteoarthritis (OA) of the knee.

Methods: 356 consecutive patients with OA of the knee were randomized into two groups to receive Hylan G-F 20 - Synvisc (n=184) or Sodium Hyaluronate -Hyalgan (n=172). All patients were prospectively reviewed by blinded independent assessors at pre injection, 6 weeks, 3, 6, 12 months. Knee pain and patient satisfaction was measured on a VAS (0-10, 10 as worst pain). Functional outcome was assessed using WOMAC, UCLA, Tegner, Oxford knee score and EuroQol- 5D scores. Mean follow up was 12 months.

Results: Patients in both groups predominantly had grade III OA (Synvisc-61% and Hyalgan-59%). Knee pain on VAS improved from 6.7 to 3.2 by 6 weeks (p=0.02) and was sustained until 12 months (3.7, p=0.04) with Synvisc. In the Hyalgan group, pain improved from 6.6 to 5.7 at 6 weeks (p>0.05) and to 4.1 at 3 months (p=0.04) but was sustained only until 6 months (5.9, p>0.05). Improvements in the WOMAC pain and physical activity subscales were significantly superior in the Synvisc group at 3 months (p=0.02), 6 months (p=0.01) and 12 months (p=0.02). Similarly, the Tegner, UCLA and Oxford knee scores were significantly better in the Synvisc group at 6 weeks (p=0.02) and 6 months (p=0.03) and 12 months (p=0.04) post injection whilst there was no difference between the groups at 3 months. There was no significant difference in the EQ-5D scores at 6 weeks, and 3 months between the two groups. The EQ-5D description scores were higher in the Synvisc group at 6 months (p=0.03) and 1 year (p=0.04). General patient satisfaction was better in the Synvisc group at all times although statistically significant at 3 months (p=0.01) and 6 months (p=0.02). There was local increase in knee pain in one patient who received Synvisc, which settled by 4 weeks. Patient compliance was 99.2% in the Synvisc group as compared to 92.2% in the Hyalgan group due to the number of recommended injections. There was no difference in the cost of the drugs, but the total treatment cost was 23% more in the Hyalgan group due to the two additional visits to complete the course of treatment.

Conclusion: Although both treatments offered significant pain reduction, it was achieved earlier and sustained for a longer period in patients with Synvisc. Patients treated with Synvisc have demonstrated an early increase in activity levels as evidenced by the WOMAC, UCLA and Tegner scores. Both treatments were well tolerated, however, a local reaction of pseudo sepsis was observed with Synvisc in one patient. The total treatment cost, both for the patient and the hospital are higher with Hyalgan. From this study, it appears that the clinical effectiveness and general patient satisfaction are better amongst patients who received Synvisc.
The Mechanical Behavior of the Human Achilles Tendon In Vivo is Altered by Estrogen Levels

Introduction:
Whilst estrogen fluctuations have been implicated in the soft tissue injury gender-bias due to the hormones effect on the viscoelastic properties of the musculotendinous unit (Eiling et al., 2007), the isolated effect of estrogen on the mechanical behaviour of human tendon in vivo is unknown. Therefore, the purpose of this study was to elucidate the effect of circulating levels of estrogen on the strain properties of the human Achilles tendon in vivo.

Methods:
Twenty females (18-35 years) who were using the monophasic oral contraceptive pill together with 20 matched, non-pill users, participated in this study. Non-pill users were tested at the time of lowest (menstruation) and highest (ovulation) estrogen whilst pill users, who exhibited constant and attenuated estrogen levels, were tested at menstruation and 2 weeks later. At each test session, maximal isometric plantarflexion efforts were performed on a calf-raise apparatus whilst synchronous real-time ultrasonography of the triceps surae aponeurosis was recorded. Connective tissue length (Lo) of the triceps surae complex was measured and tendon strain was calculated by dividing aponeurosis displacement (\( \Delta L \), mm) during plantarflexion by Lo.

Results:
Repeated measures ANOVA revealed a significant \( (p < 0.05) \) main effect of subject group with significantly higher Achilles strain rates (16.1%) in the non-pill users compared to the pill users. Augmented Achilles tendon strain was associated with higher average estrogen levels in non-pill users.

Conclusion:
Those results suggest that higher estrogen levels diminish the joint stabilising capacity of the triceps surae musculotendinous unit and may alter the energy storage capacity of the Achilles tendon during stretch-shorten cycle activities. This may result in a higher incidence of injuries during periods of high estrogen concentration.
Electronic Beam Sterilization of Soft-tissue Grafts Maintains Significantly Improved Biomechanical Properties at High-dose Irradiation (34 kGy) than Standard Gamma Treatment

Introduction: Gamma irradiation is the most frequently used sterilization procedure for soft-tissue allografts as they are used in ACL surgery. However, biomechanical properties of gamma irradiated allografts at dosages > 20 kGy are significantly reduced. Electronic beam (Ebeam) irradiation dose and other parameters can be more accurately controlled than it is economically feasible than with gamma irradiation. Also, it has been shown that the addition of CO2 with Ebeam sterilization at low temperatures allows for a significant reduction of free radicals build-up which is mainly responsible for the loss of tissue strength.

It was the objective of this study to compare the impact of 34 kGy gamma vs. E-beam irradiation on the biomechanical properties of human bone-patellar tendon-bone grafts at the time of sterilization.

Methods: Paired 10 mm-wide human bone-patellar tendon-bone (BPTB) grafts were harvested from 10 donors and split into two groups (each n=10): A) Ebeam, B) Gamma. All grafts were irradiated with 34 kGy. 10 non-irradiated BPTB grafts of identical dimensions were used as controls.

All grafts underwent biomechanical testing: preconditioning (10 cycles, 0 – 20 N); cyclic loading (200 cycles, 20 - 200 N) and a load-to-failure (LTF) test. The strain rate was 150 mm min⁻¹. Graft motion during cyclic loading was tracked with an optical measurement system. Failure load and displacement at failure were recorded and stiffness was derived from these values. The strain difference between the first and last cycles as well as creep were used as a determinant of viscoelasticity. Student t-test was used for statistical comparison of both study groups (paired) and controls (independent). Level of significance was set at p < 0.05.

Results: Stiffness of non-irradiated controls (199.6 ± 59.1 N/mm) and ebeam sterilized grafts (192.8 ± 58.0 N/mm) did not significantly differ, while gamma-irradiated grafts had significantly lower stiffness (170.6 ± 58.2 N/mm) than controls (p<0.05). Failure loads were significantly lower in both study groups (ebeam: 1139 ± 445 N, gamma: 1073 ± 617 N) than in the controls (1741 ± 304 N) (p<0.05). Creep was significantly larger in the gamma irradiated (1,06 ± 0,58 mm) than in the ebeam (0,26 ± 0,24 mm) and control (0,20 ± 0,17 mm) group that did not differ significantly. Strain difference was not different between either control or study groups.

Discussion: This study shows that the impairment of biomechanical properties of soft-tissue allografts at high irradiation doses of 34 kGy is substantially reduced with the ebeam procedure compared to standard gamma treatment. Considering the results of this study and the improved control of irradiation application with electronic beam, this technique might be a promising alternative in soft-tissue sterilization. However, a significant reduction of failure strength has to be conceded with electronic beam irradiation, too. Therefore, in future studies it is important to gain better understanding of the underlying processes that affect soft-tissue strength and to eventually eliminate these adverse effects.
Gene Expression and Protein Analysis in Ruptured Human Achilles Tendons

Introduction: We studied the extracellular matrix (ECM) of 19 ruptured human Achilles tendons, comparing the tissue composition of specimens taken from area close to the rupture with specimens harvested from an apparently healthy area in the same tendon. Aim of this study was to analyze gene expression and ECM molecules as well as MMPs and TIMPs involved in ECM turnover, in order to assess the cellular activity and what might happen in Achilles tendon rupture. The hypothesis was that in the same tendon there are many differences in gene expression of ECM molecules and metalloproteinases activity between ruptured and macroscopically healthy areas.

Materials and Methods: We compared the gene expression and the protein localization of the main ECM molecules (collagen type I and IX, decorin and versican) including enzymes involved in their metabolism as matrix metalloproteases (MMP2 and 9) and tissue inhibitory of metalloproteases (TIMP 1 and 2) using a real time RT-PCR, zymography and Fluorophore Assisted Carbohydrate Electrophoresis analysis.

Results: We didn’t observe any collagen IX gene expression. The gene expression of collagen type I, proteoglycans GAGs, MMPs and TIMPs was more represented in the area close to the tendon rupture (p<0.05). The expression of MMPs was confirmed by zymography analysis, showing a marked increase of MMP9 activity in area close to the tendon rupture (p<0.05). The chemical composition of tendon changed showing that in the healthy area the GAGs content was higher than the ruptured area (p<0.05).

Conclusions: The lack of gene expression of collagen IX testifies that there wasn’t any fibrocartilagineous metaplasia as described in tendinopathy. In the ruptured area, the tenocytes tried to restore the normal proteoglycan pattern increasing the protein synthesis but without the normal glycosaminoglycan production. The low amount of GAGs in the ruptured area indicates that the catabolic processes prevail over the synthetic activity. Our data support the hypothesis that, in human tendons, the tissue in the area of rupture undergoes marked rearrangement at molecular levels based on the MMP’s activity, and support the role of MMPs in the tendon pathology.
Effect of Bone Morphogenetic Protein 12 Gene Transfer on Posterior Cruciate Ligament Healing in a Rabbit Model

Background: The posterior cruciate ligament (PCL) may heal to some extent after injury. However, its natural healing capacity is not enough, because the results treated nonoperatively may diminish with long-term follow-up. Bone morphogenetic protein (BMP) 12 can induce formation of ligament and tendon tissues.

Hypothesis: BMP12 gene transfer can increase the biosynthetic activity of PCL fibroblasts in vitro and improve the histological and biomechanical properties of healing PCLs.

Study Design: Controlled laboratory study.

Materials and methods: 1. The recombinant adenovirus carrying BMP12 (Adv-BMP12) and a recombinant adenoviral vector expressing GFP alone (Adv-GFP) were generated by using the AdEasy technology. 2. PCL cells were infected in vitro with Adv-BMP12 or GFP as a control at 200 pfu per cell or left uninfected. Types I, III collagen content were determined by an enzyme-linked immunosorbent assay (ELISA) from the culture medium. 3. To evaluate transgene expression, frozen sections were prepared with a freezing microtome. As described in the vector construction, the adenoviral vector Adv-BMP12 also contained a GFP expression cassette. So, the GFP reporter was co-expressed along with the transgene. This configuration allowed us to track transgene expression of infected PCLs effectively under a fluorescent microscope. 4. Six rabbits were used to test the mechanical properties of the injury model. The left or right PCL selected randomly was injured which was designated as group I (Injured PCL), and the contralateral normal side was designated as group N (Normal PCL). Then bilateral PCLs received tensile testing immediately postoperatively. 5. Bilateral PCLs of 32 rabbits were made injured. In one limb, which was selected randomly into treatment group (Group T), the cut ends received 0.1 ml injection containing 3×10+7(superscript) pfu Adv-BMP12. The lacerated PCL in the contralateral limb was injected only with Adv-GFP served as untreated control (Group C). Eight rabbits were sacrificed at each time-point of 3, 6, 12 and 26 weeks, respectively, after the operation. In addition, 6 rabbits receiving sham operation (Group S) were used to obtain normal control data at 26 weeks postoperatively. The PCL specimens were histologically and biomechanically evaluated.

Results: 1. The titer of recombinant adenovirus was 4×10+10(superscript) pfu/ml. 2. There was BMP12 protein secretion in Adv-BMP12 transfected cells (2.024±0.086ng/ml). We found approximately 46.44% and 22.61% increase of newly synthesized type I collagen and type III collagens, respectively, in Adv-BMP12 transfected PCL cells compared to control cells. 3. Expression of the GFP reporter was detected readily 1 week after surgery, indicating successful transfection of the PCLs. The expression was still detectable at 6 weeks after the injection. 4. The ultimate force, stiffness and energy absorbed at failure of injured PCLs decreased 44.69%, 28.17% and 52.45%, respectively compared with normal PCLs immediately postoperatively. 5. Histological Observations: At week 3, fibroblasts and inflammatory cells were observed to invade the repair tissue in some zones. There was no obvious reaction for type I collagen, but some for type III collagen, in the repair tissue of group C. The positive reaction for type I collagen and type III collagen were extensively localized in the repair tissue of Group T. At week 6, the arrangement of collagen fibers in both groups was in disorder. Positive reaction for type I collagen and type III collagen was detected in irregularly oriented new collagen fibers between the fibroblasts of Group T. The reaction for type I collagen was fairly weak, however, in the repair tissue of
group C. At week 12, the repair tissue was filled with oriented collagen fibers. Positive reaction for type I collagen was found as arrangement of collagen, and more in the central area of the repair tissue of Group T. The staining of type III collagen was found, but weak in the peripheral zone. In the repair tissue of group C, however, the staining of type I collagen was even weak. At week 26, in group C, the arrangement of the collagen fiber bundles was more regular than before, but slightly more compact than normal ligamentous tissue. Type I collagen was found in the repair tissue with a weak staining. Type III collagen was stained in most area. While in Group T, the arrangement of the collagen fiber and positive reaction for type I collagen were similar to normal ligament. Positive reaction for type III collagen was still found in the central area. 6. Significant differences were found in week 6, 12 and 26 samples for those three structural properties between Group T and Group C. The ultimate force, stiffness and energy absorbed at failure of repaired PCLs with Adv-BMP12 injections, at 26 weeks, achieved 96.13%, 91.39% and 91.30% of those of group S, respectively. At the same time, there were no significant differences of the three structural properties between group T and group S at week 26.

Conclusion: Adenovirus could mediated the gene transfer of BMP12 into rabbit PCL cells in vitro. Both type I collagen and type III collagen synthesis were increased in the induced cells. The PCLs could be infected successfully by Adv-BMP12, and the transgene expression was still detectable at 6 weeks after the infection. BMP12 gene transfer in a partial PCL laceration rabbit model resulted in an obvious increase of histological properties, tensile strength and stiffness of repaired ligaments, indicating improved PCL healing in vivo. So, an application of BMP12 gene transfer is a potential future strategy to improve the repair process of injured PCL.
Isolation and Characterization of Human ACL-Derived Vascular Stem Cells

Introduction:
Whereas most surgical procedures for anterior cruciate ligament (ACL) reconstruction require healing of tendon grafts in a surgically created bone tunnel, the attachment between the tendon and the bone is the weakest region in the early post transplantation period. Secure fixation of the tendon graft to the bone is a significant factor in allowing earlier and more aggressive rehabilitation and earlier return to sports and work. To this end, tissue engineering using stem cells have recently focused on their potential for early healing and regeneration of tendon bone integration [1]. Although there exist some reports showing the existence of mesenchymal stem cell-like cells in human ACL tissues [2, 3], their origin and characteristics still remain unclear. Recently, blood vessels have been reported to be a richer supply of stem/progenitor cells with a characteristic of expression of CD34 and CD146 surface maker [4-6]. Therefore, we tried to prove the hypothesis that there exist CD34 and CD146-expressing vascular cells in the ACL tissues which have a potential for multi-lineage differentiation and recruit to the ruptured site of ACL for their intrinsic healing.

Materials and Methods:
Sample Human adult ACL ruptured tissues were harvested from subjects undergoing ACL reconstruction (22.5±3.8 mean age, 5.1±1.9 post-injury, n=8). Tissue preparation and Cell isolation Specimens were harvested and quickly embedded in OCT compound, snap frozen in liquid nitrogen, and stored at -80°C for H&E and immunohistochemical staining (n=3). For cell isolation, specimens were separated into 2 regions, ruptured site and mid substance (n=5). Each tissue was minced and then digested with collagenase in DMEM. Immunohistochemical staining Specimens were immnostained for CD34 (stem cell marker) and CD146 (pericyte marker), coupled with smooth muscle actin (SMA) to detect vascular cells around the arterioles. Characterization of ACL-derived cells Cells derived from the ruptured site and mid-substance were characterized by flow cytometry for CD34 and CD146 expression. Next, Cells in each group were sorted by fluorescence-activated cell sorting (FACS) for expression of CD34 and CD146 after gating out hematopoietic (CD45+) cells (total 4 populations; CD34+CD45-cells, CD146+CD45-cells sorted from cells in the ruptured site and mid-substance) and cultured for 2 week expansion with proliferation medium. Osteogenic assay Cells (n=1.0x105) were cultured in 6-well plates in osteogenic medium suppremnted with BMP4 (100ng/ml) and stained for alkaline phosphatase (ALP) at day 7. As well, cells were also cultured as pellets for 21 days in osteogenic medium and evaluated with a micro-CT and stained with von Kossa for assessment of mineralization. Chondrogenic assay Cells (n=2.5x105) were placed in a 15ml conical tube, centrifuged at 600g, and cultured in chondrogenic medium (Lonza) supplementted with TGF-ß3 (10ng/ml). Pellets were assessed macroscopically at day 14, and stained with Alcian blue/nuclear fast red. Adipogenic assay Cells (n=1.0x105) were cultured in 6-well plates for 14 days in adipogenic medium and stained for Oil Red O. Reverse Transcription Polymerase Chain Reaction (RT-PCR) Differentiation potential of these cells were confirmed by RT-PCR using osteogenic (osteocalcin and type 1 collagen), chondrogenic (Sox9 and type 2 collegen), and adipogenic (lipoprotein lipase (LPL) and Peroxisome proliferator activated receptor (PPAR))-related markers.
Results:
Immunohistochemical staining Tissues showed more positive staining for CD34 and CD146 in the ruptured site than in the mid-substance. Flow cytometry analysis The percentage of CD34+CD45- and CD146+CD45- cells were significantly higher in the ruptured site compared to the mid-substance (CD34+CD45- cells: ruptured site, 44.3%, mid-substance, 8.3%; CD146+CD45- cells: ruptured site, 6.5%, mid-substance, 0.5%) (p<0.01). Proliferation potential CD34+ and CD146+ cells from the ruptured site showed high expansion potential, however, those from the mid-substance did not expand well. Based on these results, we used those from the ruptured site for multilineage differentiation assay. Osteogenesis Cultured CD34+ and CD146+ cells were positively stained by ALP. Micro CT using CD34+ and CD146+ pellets clearly demonstrated the bone formation. Von Kossa staining of CD34+ and CD146+ pellets also demonstrated the bone mineralization. In addition, these cells expressed gene of osteocalcin and type 1 collagen using RT-PCR. Chondrogenesis CD34+ and CD146+ cells produced pellets and stained positive with Alcian blue. In addition, these cells expressed gene of Sox9 and type 2 collagen using RT-PCR. Adipogenesis Oil red O staining of CD34+ and CD146+ cells demonstrated the characteristic lipid droplets. In addition, these cells expressed gene of LPL and PPAR using RT-PCR.

Discussion:
Our study showed CD34 and CD146+ cells, which were found around and wall of blood vessels more in the ruptured site than in the mid-substance, exhibited potential for multilineage differentiation including osteogenesis, chondrogenesis, and adipogenesis, suggesting that these populations may contribute to tendon-bone regeneration. The present findings have important clinical insight for cell-based therapy that will enhance tendon-bone integration and regeneration following ACL reconstruction.

References:
Local Administration of Synovium-derived Fibroblasts Cultured in TGF-beta1-supplemented Medium Inhibits Natural Reduction of the Structural Properties of the Tendon Autograft after ACL Reconstruction: A Sheep Model Study

INTRODUCTION:
It has been well known that structural properties of a tendon autograft become deteriorated during the remodeling phase after ACL reconstruction, and that the reduced properties are not completely restored even at 12 months after surgery.[1,2] Therefore, it is needed to study on preventing the graft deterioration after ligament reconstruction or accelerating to restore the deteriorated graft. The authors previously clarified that administration of transforming growth factor (TGF) -beta1 significantly inhibited the deterioration of the structural properties of the tendon graft in a canine ACL reconstruction model.[3] However, it has been well known that the intra-articular application of TGF-beta1 induces osteoarthritic changes in the knee joint.[4] Therefore, the intra-articular administration of TGF-beta1 cannot be applied to human ACL reconstruction. The cell-based therapy is a potential solution against this problem. Recently, the authors reported the first study in which local administration of autologous synovium-derived fibroblasts cultured in TGF-beta1-supplemented medium significantly inhibits natural reduction of the mechanical properties of the in situ frozen ACL which is an idealized tendon autograft model after ACL reconstruction.[5] We also have established a sheep ACL reconstruction model to clarify the effect of the cell-based therapy.[6] Based on these studies, we hypothesized that local application of autologous synovium-derived fibroblasts cultured in TGF-beta1-supplemented medium may inhibit the deterioration of the structural properties of the tendon autograft after ACL reconstruction. The purpose of this study is to test this hypothesis using a sheep model.

METHODS
Thirty-two mature sheep (Suffolk) were randomly divided into 4 groups of 8 animals each. In each animal, the right knee undertook ACL reconstruction using the doubled semitendinosus tendon graft. The graft was placed in bone tunnels, and fixed with an Endobutton and a post-screw. In Group I, no treatment was applied around the graft. In Group II, 1-ml fibrin sealant (Baxter) was applied around the graft. In Groups III and IV, the synovial tissue was harvested from the left knee at 14 days before ACL reconstruction. The tissue was minced and digested in 0.2% collagenase, and cultured to obtain fibroblasts for 13 days. Only in Group IV, 10 ng/ml rh-TGF-beta1 (R&D) was supplemented in the medium for the last one day. In both the groups, 3 ×10^6 cells at the 1st passage were mixed with 1-ml fibrin sealant, and incubated in DMEM for one day. At the time of ACL reconstruction in Groups III and IV, the sheet-like fibroblasts-fibrin sealant composite was applied around the graft. All animals were sacrificed at 12 weeks. In each group, 5 out of the 8 sheep were used for biomechanical evaluation, and the remaining 3 were used for histological observation. In biomechanical evaluation, the anterior-posterior (A-P) translation of the knee was measured using a 3-DOF fixture under +/-50N A-P forces at 30, 60, and 90° of knee flexion. The cross-sectional area (CSA) of the whole graft was measured with an optical method using video dimension analyzer.[7] The structural properties of the femur-graft-tibia complex were determined in tensile testing at a cross-head speed of 50 mm/min. In histological observation, the reconstructed ACL was stained with hematoxylin and eosin. Cells infiltrating in the core portion of the graft were counted in 3 longitudinal sections, and the mean cell density was determined. Statistical analyses were made using the one-way ANOVA with the Fisher’s PLSD tests for multiple comparisons.
RESULTS
Concerning the A-P translation of the knee or the CSA of the ACL graft, the ANOVA showed no significant differences in the 4 groups. In tensile testing, all specimens failed at the mid-substance in each group. The ANOVA demonstrated that there were significant differences in the maximum load (p=0.0048) and the stiffness (p=0.0275) among the 4 groups. The post-hoc test showed that the maximum load and the stiffness of Group IV were significantly greater than those of Group I (p=0.0147 and p=0.0132, respectively), II (p=0.0019 and p=0.013, respectively), and III (p=0.0014 and p=0.0114, respectively). Histologically, necrotic lesions were observed in the core portion of the mid-substance in Groups I and II. In Groups III and IV, we could not find any necrotic lesions in the mid-substance. The cell density was significantly higher in Groups III and IV than in Groups I and II. In this observation, there were no objective differences between Groups III and IV.

DISCUSSION
This study clearly demonstrated that a local application of autologous synovium-derived fibroblasts cultured in TGF-beta1-supplemented medium significantly inhibits the deterioration of the structural properties of the tendon graft after ACL reconstruction. There are some limitations in this study. The first one is that we performed only the standard histological examinations. We should conduct a molecular biological study in the near future to find objective differences in the cell function and the graft matrix among the groups, and to clarify the reason why the structural properties in Group IV were significantly higher. The second one is that there were no significant differences concerning the A-P translation. We consider that this is a common limitation in studies using animal models. As to clinical relevance, this study implied that local application of autologous synovium-derived fibroblasts cultured in TGF-beta1-supplemented medium can be a potential therapeutic strategy to shorten the remodeling period of the graft after ACL reconstruction surgery.

REFERENCES
The Intra-Articular Location of a Cartilage Defect Influences the Natural History of Cartilage Filling

Objectives:
To investigate the difference in natural history cartilage filling related to the intra-articular location of an experimental induced cartilage defect in the rabbit knee.

Methods:
A partial thickness cartilage defect (\( = 4 \) mm) was induced in both knees of 35 adult New Zealand rabbits at the age of 22 weeks. The animals were randomized to having the defect induced in the patella in either the right or left knee, whereas the other knee had the defect induced in the medial-femur-condyle (MFC). An operating microscope was used to secure the preparation of the defects. The animals were sacrificed at 12 weeks (n=8), 24 weeks (n=9), and 36 weeks (n=18) after surgery. Analysis® software was used in measuring the cartilage height at 7 determined spots in each defect. Cartilage filling was estimated relating the mean cartilage height in each defect to the mean cartilage height of the shoulders of the same defect. Statistical analyses were performed using paired T-test.

Results:
Twelve weeks after surgery the cartilage filling of patella defects were 32.3%, compared to 16.9% in MFC defects (p<0.05). Twenty-four weeks after surgery the filling of patella defects were 25.0% compared to 8.0% in MFC defects (p<0.05). Thirty-six weeks after surgery the filling of patella defects were 48.8% compared to 20.5% in MFC defects (p<0.05). There was a significant rise in cartilage filling from 24 to 36 weeks post surgery at both locations.

Conclusions:
The intra-articular location of a partial thickness cartilage defect influences the natural history of cartilage filling of the defect.
Viability Assessment of Intrarticular Osteochondral Knee Fragments

Introduction:
Viable cells are essential for cartilage remodeling. However cartilage viability might be affected once it is detached from its anatomic location as cartilage nutrition is maintain partly by the subjacent subchondral bone.

Purpose:
Our study was aimed to determinate if chondrocyte isolated from osteochondral free knee fragments are viable.

Material and Methods:
A consecutive series of 5 patients (5 knees) with unstable lesions of osteochondritis dissecans (OCD) treated with arthroscopic internal fixation were included. There were 5 males with a mean age of 21 (18-24). The mean duration of the symptoms was 5 months (2 to 9). During arthroscopy the detached osteochondral fragment was assessed and reattached with titanium Herbert screw. Cartilage biopsy was performed from the detached osteochondral fragment (Study Group). To establish a control group a biopsy from healthy native cartilage (weight bearing portion of the medial femoral condyle) was also performed.

Chondrocyte Viability:
Specimens obtained during arthroscopy procedure were taken to the laboratory in 5% medium assessing that cartilage surface was always maintained wet till the digestion was started. Digestion with Pronase (50mg/ml) for one hour followed by 12 hours of Collagenase (0.36 mg/ml) was performed. Tissue viability was assessed using live-dead assay. Percentage of live cells was established.

Statistical Analysis
T student and confidence interval was used for assessing statistical difference. A p value<0,05 was considered significant.

Results
Study group showed 88% of viable cells ± 2.1 (CI 95%50-100). Control group showed 92% viability ±0.5 (CI 95%50-100) (p=0,002).

Conclusion
These findings suggest that chondroctyes from detached osteochondral fragments are able to maintain their viability once they are detached from their anatomic location. Probably the synovial fluid might contribute as an important source of nutrition under this pathological situation.
An Unexpected Increase of Type I Collagen In Undamaged Cartilage of Anteromedial Gonarthrosis

Aim
To investigate the molecular features of progressive severities of cartilage damage, within the phenotype of Anteromedial Gonarthrosis (AMG).

Methods
Ten medial tibial plateau specimens were collected from patients undergoing unicompartmental knee replacements. The cartilage within the area of macroscopic damage was divided into equal thirds: T1 (most damaged), to T3 (least damaged). The area of macroscopically undamaged cartilage was taken as a 4th sample, N. The specimens were prepared for histological (Safranin-O and H&E staining) and immunohistochemical analysis (Type I and II Collagen, proliferation and apoptosis). Immunoassays were undertaken for Collagens I and II and GAG content. Real time PCR compared gene expression between areas T and N.

Results
There was a decrease in OARSI grade across the four areas, with progressively less fibrillation between areas T1, T2 and T3. Area N had an OARSI grade of 0 (normal). The GAG immunoassay showed decreased levels with increasing severity of cartilage damage (ANOVA P<0.0001). There was no significant difference in the Collagen II content or gene expression between areas.

The Collagen I immunohistochemistry showed increased staining within chondrocyte pericellular areas in the undamaged region (N) and immunoassays showed that the Collagen I content of this macroscopically and histologically normal cartilage, was significantly higher than the damaged areas (ANOVA P<0.0001). Furthermore, real time PCR showed that there was a significant difference in Collagen I expression between the damaged and macroscopically normal areas (p=0.04).

Conclusion
In AMG there are distinct areas, demonstrating progressive cartilage loss. We conclude that in this phenotype the Collagen I increase, in areas of macroscopically and histologically normal cartilage, may represent very early changes of the cartilage matrix within the osteoarthritic disease process. This may be able to be used as an assay of early disease and as a therapeutic target for disease modification or treatment.
Mesenchimal Stem Cells (MSC) and Dexametasone for the Treatment of Full Thickness Chondral Defects of the Knee

OBJECTIVE: To histologically and molecularly evaluate the repair tissue generated after treating full thickness cartilage defects of the knee with autologous Mesenchimal Stem Cells(MSC), with or without adding intraarticular Dexametasone, in a rabbit model.

HYPOTHESIS: Treating a full thickness chondral defect of the knee by implantation of MSC in a hialuronic acid scaffold and addition of intraarticular Dexametasone in-vivo, will generate hialine cartilage.

MATERIALS AND METHODS: Experimental study. 20mm2 full thickness chondral defects were surgically induced in the weight bearing surface of the femoral condyles of 36 rabbit`s knees. 2 weeks after the lesion, 1 million autologous MSC harvested from the iliac crest, were implanted embedded in a hialuronic acid scaffold. 0.25mg/Kg of Dexametasone were weekly injected in 5 knees. 6 knees were treated with MSC without Dexametasone. 5 knees were treated with Dexametasone without MSC. 10 control knees and 10 negative control knees were also included in the study. 6 weeks after treatment the knees were studied histologically with H-E and Toluidine Blue stains. Molecular analysis of the cartilage was performed by qRT – PCR of Collagen II vs Collagen I and agrecan vs versican. Statistical analysis was performed with ANOVA test (p<0.05).

RESULTS: None of the groups repaired with 100% hialine cartilage. The molecular analysis showed a higher expression of collagen II and agrecan in the MSC + Dexametasone group than in the other groups. Histology did not show an important difference between MSC treated groups, but they were more similar to hialine cartilage than the groups treated without MSC.

CONCLUSIONS: Although MSC + Dexametasone treated chondral lesions do not heal with hialine cartilage, the repair tissue generated has a molecular structure more similar to hialine cartilage than the other study groups. The histology, however, did not differ significantly between both MSC treated groups.
Fresh Osteochondral Allograft Transplantation for Large Sectoral Defects of the Femoral Condyles

BACKGROUND & AIMS: The treatment of large osteochondral defects of the femoral condyles can be challenging. The conventional surgical options including drilling, microfracture revascularisation, mosaicplasty, and autogenous chondrocyte implantation are often inadequate since they cannot 3-dimensionally reconstruct the structural topography of large and deep sectoral defects of the femoral condyles. Although tissue-bank procured osteochondral allografts are an attractive option, scarce availability has resulted in limited use. This prospective study aims to determine the outcomes of live donor procured fresh osteochondral transplants for large sectoral defects of the femoral condyles.

PATIENTS & METHODS: The protocol of this prospective study was validated by the ethics committee and all patients provided informed consent for participation. Between 2000 and 2005, 23 knees in 19 patients (mean age 29 years, range 20-43 years) underwent fresh osteochondral allograft transplantation for the treatment of large osteochondral defects of the femoral condyles. Inclusion criteria were solitary ICRS grade IV osteochondral defects of the femoral condyles of minimum 4 cm² surface area and a minimum depth of 1 cm following osteochondrosis dissecanse, osteonecrosis, or trauma, in patients with stable knees and normal mechanical axis. Exclusion criteria were presence of arthritis, minor or superficial cartilage defects, and bipolar defects. 16 knees had undergone other previous procedures including primary removal of osteochondral fragments (16), drilling (8), and abrasion chondroplasty (8). 11 defects involved the lateral femoral condyle, 8 defects involved the medial femoral condyle, and 4 defects involved the trochlear region. The mean defect size was 9.4 cm² (range 4-18 cm²). Grafts were obtained from young consenting donors who presented to our trauma center with either traumatic above knee amputations in whom limb reimplantation was not possible, or from femoral fractures with significant vascular injury who presented late and in whom primary above knee amputation was the procedure of choice. Grafts from open knee injuries and vascular insults beyond 18 hours were discarded. All donors underwent detailed clinical and serological evaluation as per the American Association of Tissue Banks guidelines. Donors and recipients were matched for side (left or right) and skeletal size as measured by standard radiographs and CT scans (of recipient). Harvested allografts were maintained at 4 degrees C in Ringer Lactate solution with added antibiotic and antifungal drugs. Transplantation was performed within 48 hours of harvest. The operative technique comprised recipient defect preparation and sizing, size and shape matched allograft preparation, topographical matching, transplantation, and fixation with multiple titanium Herbert screws. Prolonged non-weight bearing on the operated leg was strictly enforced. High demand knee activities and sports were withheld until at least 1 year after surgery. Each patient was evaluated both preoperatively and postoperatively using clinical criteria, radiographs, CT, and MRI. Outcomes were determined using subjective and objective IKDC scores, the ICRS patient subjective rating system, and the ICRS surgeon objective rating system. The mean follow-up was 58 months (range 26 to 97 months).

RESULTS: All patients had a minimum 2 year follow-up. Each patient improved clinically, and had relief from pain, stiffness, swelling, buckling, and locking, with improved range of motion in the operated knee. There were no general complications and no patient underwent reoperation. Radiographic union of the graft and joint congruence was noted in all patients. 1 trochlear graft demonstrated a 2 mm eccentric collapse. No graft nonunion or graft fracture was noted. There was no radiographic progression of joint space narrowing or degenerative changes of the knee on the medium-term follow-up. Postoperative union of the transplant was confirmed in all patients by means of CT. Transplant articular cartilage preservation was confirmed postoperatively in 16 patients by means of MRI. At final IKDC evaluation, 14 patients (61%) were graded level A (normal) and 9 patients (39%) were graded level B (nearly normal). The mean
preoperative subjective IKDC score was 32.3 points, whereas the mean postoperative subjective IKDC score was 84.1 points. The subjective and objective IKDC scores, and the ICRS scores were statistically significantly improved during the observation time. All 23 patients voted the treatment as excellent or good.

DISCUSSION & CONCLUSIONS: Fresh osteochondral allograft transplantation is a successful treatment option for the reconstruction of large solitary ICRS grade IV osteochondral defects of the femoral condyles caused by osteochondritis dissecans, osteonecrosis, or trauma. These transplants are capable of 3-dimensionally reconstructing the structural topography of large and deep sectoral defects of the femoral condyles, however the surgical technique is demanding and precise craftsmanship is imperative. Not only do patients demonstrate significant improvement in clinical, radiological, and functional outcome measures, but, it appears that an osteochondral graft has the potential to prevent or delay the development of degenerative changes of the knee in the medium-term follow-up.
Arthroscopic Matrix/Membranous Autologous Chondrocyte Implantation for the Treatment of Large Chondral Defects of the Knee

PURPOSE:
To examine the effectiveness of second generation Matrix/Membrane Autologous Chondrocyte Implantation (MACI) on large full thickness lesions in the knee. Matrix/Membrane Autologous Chondrocyte Implantation is a new biotechnology allowing the impregnation of autologous cultured chondrocytes onto a bilayer, bioabsorbable, purified porcine collagen I/III membrane which is applied to the chondral defect without sutures utilizing a fibrin glue. The procedure can be performed arthroscopically with the assistance of newly developed unique arthroscopic instrumentation.

METHODS:
Of 123 consecutive patients the first 42 patients (ages 16-52) with large full thickness cartilage lesions of the knee 2.5-3.0 cm2 to 20 cm2 were treated with a second generation MACI technique fixed to the chondral defect with fibrin glue were analyzed. Special unique arthroscopic instrumentation has been developed. Follow up was from 24 months to 60 months. MRI, several second look arthroscopies, Standardized Spanish knee rating scales, and VAS were obtained and analyzed. Results were compared to 152 previously performed Autologous Chondrocyte Implantation (ACI) procedures.

RESULTS:
Clinically: There was better than 86% good-to-excellent results with regards to pain relief, swelling and return to previous level of activity and satisfaction with the procedure.
Histologically: A "hyaline-like" cartilage with immature chondrocytes similar to ACI was produced.
MRI: Shows progressive loss of subchondral edema.
There was no case of delamination or tissue hypertrophy (no periosteal patch is utilized).
No infection, phlebitis, or stiffness.

CONCLUSIONS:
The MACI technique is a new surgical technique that produces a "hyaline-like" cartilage in a large full thickness chondral lesions of the knee. It reduces pain and improves activity level. MRI's show progressive resolution of the lesions.
MACI can be implanted arthroscopically or by mini-arthrotomy.
New arthroscopic instrumentation is presented.
Improvems in Function and Activity Levels After Partial Meniscectomy are Influenced by Specific Factors

Objectives: Partial meniscectomy is the current standard of care for a torn meniscus that is not suitable for repair. Arthroscopic partial meniscectomy is the most commonly performed orthopaedic surgical procedure. The purpose of this study was to determine what specific factors influence the longevity of improvements in function and activity levels following arthroscopic partial meniscectomy.

Methods: Six hundred forty (640) knees which had undergone isolated partial meniscectomy were identified from a clinical database. One hundred ninety-three (193) knees had partial lateral meniscectomy, 342 had partial medial meniscectomy, and 105 had partial medial and lateral meniscectomy. The average age was 52 years (range, 15 to 79) with 207 females and 433 males. Patients were excluded if they had concurrent ACL reconstructions or microfracture for chondral defects. Lysholm function and Tegner activity scores were collected for a minimum of 8 years after the index partial meniscectomy.

Results: For all knees, the Lysholm scores improved significantly from preoperative (54) to 1 year postoperative (76) (p<0.001). The Lysholm score did not change from year 1 to year 5. At year 6, average Lysholm score decreased to 69, and by year 8, the score decreased further to 63. When comparing the degenerative knees to the non-degenerative knees, the non-degenerative group had greater improvement and maintained it longer. The medial meniscus patients maintained their improvement at 6 and 7 years while the lateral meniscus group showed less improvement and decreased at years 6 and 7. Anatomic location of the meniscus tear (anterior, middle or posterior thirds) was not associated with changes in improvement of Lysholm or Tegner scores. Tegner activity levels improved significantly from preoperative (3.6) to 1 year postoperative (4.7) (p<0.001). This improvement was maintained at years 2, 3, and 4. There was no significant difference between preoperative Tegner and year-5 Tegner scores (4.0) (p>0.05). This same finding was also seen at years 6, 7, and 8. In the degenerative knee, there was less improvement, and the levels declined at years 6, 7, and 8.

Conclusions: Patients who undergo partial meniscectomy can expect 4 to 5 years of improved function and activity levels. Knee function continues to improve up to 5 years, but it decreases as activity levels decrease. Patients who delay treatment or have degenerative changes experience a decrease in function and activity levels sooner. Meniscectomy provides a short term improvement in function and activity levels, but long term improvement seems unlikely. Our findings confirm that specific factors such as which meniscus (medial or lateral) undergoes meniscectomy, chronicity of the tear, and preexisting degenerative changes might be expected to influence longevity of improvements after partial meniscectomy.
Hypermobile Posterior Horn Lateral Meniscus

Background: Hypermobility of the posterior horn of the lateral meniscus has been described rarely in the adult orthopaedic literature. Patients present with knee pain and locking in the absence of a discrete meniscal tear or discoid morphology. The purpose of this investigation is to increase awareness of this pathology, review MRI appearance and to present our results with arthroscopic stabilization. We present the largest series to our knowledge, reviewing the clinical presentation, MRI findings, arthroscopic findings, repair technique, post operative protocol, and outcomes.

Methods: Hypermobility was defined as translation of the entire posterior horn beyond the midpoint of the tibial articular surface with anterior stress applied by an arthroscopic probe. Patients were excluded if the meniscus had discoid morphology or if a tear was identified in the meniscus. This left 13 knees (12 patients) available for investigation. Institutional review board approval was obtained. The clinical presentation, preoperative MRI findings, arthroscopic findings, and repair technique were retrospectively reviewed. Most recent outcomes data was gathered via an IKDC-9 questionnaire.

Results: The study population consisted of 12 patients (13 knees) ages 12-48 years (mean 23 years). There were 8 males and 4 females. There were 7 right knees and 6 left knees.

Eleven of the 12 patients presented primarily with mechanical symptoms. The duration of symptoms ranged from 7 months to over 10 years. Eight of the 12 patients did not recall any history of trauma.

Each patient underwent a preoperative MRI. Twelve of the 13 preoperative MRIs did not identify lateral meniscal pathology. The remaining MRI, which was performed during a locking episode, was read as a displaced bucket-handle tear.

Stabilization was obtained by fixation of the meniscus to the posterior capsule. All-inside repairs were performed in 6 knees. Inside-out repairs were performed in 7 knees using non-absorbable vertical mattress sutures.

Ten of the 12 patients (11 of 13 knees) were able to be contacted via telephone for additional follow up information. The average follow-up was 4 years (range 6 months to 10.7 years). Subjective current knee function averaged 8.0 on a scale of 0-10 (range 5.0 to 10). Knee pain severity averaged 2.2 (range 0-4) and pain frequency averaged 3.3 (range 0-9) on a scale of 0-10.

Five of the 10 patients had no limitation of function and had been able to resume very strenuous activity without pain. This subgroup had an average age of 20.6 years at an average of 3.5 years following surgery. They were all currently participating in high impact activities on a regular basis including basketball, football, or soccer.

Five of the 10 patients had modified their activity level due to knee pain or function. They were able to perform light to moderate activities including walking, biking, or swimming without pain. The average age of this subgroup was 39 years at an average of 4.5 years following surgery. This subgroup included the 2 patients who had undergone surgical revision and the one patient who had bilateral involvement.

Seven of the 10 had no recurrence of mechanical symptoms. One patient (2 knees) had experienced two to three locking episodes over the 4 years since his surgery. He continued to have mild pain and participated in moderate activities. Post operative symptoms were less than pre operative symptoms, and he did not feel that his symptoms warranted additional treatment. Two patients were unable to be contacted. They were both doing well without recurrence of mechanical symptoms at final office follow-up.
Conclusions: We present a series of 13 cases of symptomatic hypermobile lateral menisci treated with arthroscopic repair to the posterior capsule. MRI was not found to be effective in detecting this condition. These patients can successfully be treated with arthroscopic stabilization. Our results suggest that symptomatic relief can be expected in most patients at 4 years. Better results were seen in younger patients. All-inside and inside-out techniques appeared to produce similar clinical results. Long-term, randomized studies are needed to better define optimal repair technique and long-term outcomes.
Posterior Cruciate Ligament Reconstruction with Stent Operation for Remnant augmentation.

BACKGROUND: Although, recently, it has been reported that posterior cruciate ligaments (PCLs) have spontaneous healing potential and can heal by conservative treatment, despite good early functional results, the posterior laxity of the knee is not completely eliminated after conservative treatment. The PCL can retain the normal tension only when the injured ligament is maintained anatomically.

PURPOSE: The purpose of this study was to develop and evaluate a technique of PCL reconstruction with stent operation for remnant PCL augmentation.

METHODS: Between September 2003 and March 2006, 23 patients who had a tear of the PCL underwent reconstruction with stent operation using hamstring tendon graft (20 cases) or tibialis posterior allograft (4 cases) for remnant PCL augmentation. 20 patients were evaluated after a minimum duration of follow-up 24 months. The remnant PCL and the synovium were preserved, and the augmentation was performed using transtibial technique. Femoral tunnel was created at near the foot-print of anterolateral bundle. Stability was measured on posterior stress radiographs and with a maximal manual displacement test performed with a KT-1000 arthrometer. Clinical evaluation was carried out with use of the scoring systems of the international Knee Documentation Committee (IKDC) and the Orthopadische Arbeitsgruppe Knie Score (OAK).

RESULTS: The mean side-to-side differences in displacement was reduced from 9.9 ± 4.0 mm preoperatively to 3.0 ± 2.6 mm at last follow-up on the stress radiographs, and it was reduced from 6.9 ± 2.1 mm preoperatively to 2.7 ± 1.5 mm as measured with the KT-1000. The final IKDC score was A in 7 (35%), B in 10 (50%), C in 2 (10%) and D in 1 (5%) patients. The average OAK score improved from 61.6 ± 13.1 to 88.2 ± 9.5. The group in which tibialis posterior allografts were used for augmentation showed worse results than hamstring autograft group in clinical result. In one case, posterior instability was recurred more than 10 mm compare to contralateral side, PCL revision was performed as a double bundle reconstruction using achilles allograft.

CONCLUSION: Excellent posterior stability and relatively good clinical results were achieved with the stent operation for remnant PCL augmentation. This technique is technically feasible and the PCL remnants and synovium may be beneficial to ligament healing and proprioception. However, other combined injuries seem to affect clinical results. The short-term results are encouraging , but long –term results are needed to confirm the value of this technique for alternative operative method of acute or subacute PCL injuries.
Tibial Fixation in Posterior Cruciate Ligament Reconstruction: A Biomechanical Comparison Study between Biodegradable Interference Screw and Biodegradable Cross Pin

Purpose: The purpose of this study was to compare ultimate tensile load, stiffness and slippage after cyclic loading of biodegradable interference screw and biodegradable cross pin for tibial fixation in posterior cruciate ligament reconstruction.

Methods: Biomechanical testing of 2 different fixation techniques was performed by use of human cadaver tibia and Achilles tendon. Two independent testing sessions were examined. The A session compared biodegradable interference screw and cross pin for Achilles bone block (10 x 30 mm). The B session compared hybrid fixation of soft tissue with the use of cancellous screw-washer in each group. The tibia-graft fixation complex was cyclically loaded between 50 N and 250 N at 1 Hz for 1000 cycles. After cycling, the amount of graft slippage was determined by measuring the change in grip to grip distance. The complex was then loaded to failure at 1mm/s, and ultimate tensile strength, stiffness, and mode of failure were determined.

Results: In session A, cross pin fixation group resulted in a significantly higher ultimate tensile strength (917.80 ± 102.4 vs 514.58 ± 148.4, p<0.01), significantly higher stiffness (302.3 ± 52.9 vs 193.5 ± 12.1, p < 0.05), and significantly less slippage (3.75 ± 1.0 mm vs 5.66 ± 0.6, p<0.001) than interference screw fixation group. In session B, cross pin fixation with additional screw group resulted in a significantly higher ultimate tensile strength (1023.75 ± 94.4 vs 816.81 ± 115.3, p<0.01), significantly higher stiffness (341.5 ± 64.9 vs 223.5 ± 38.1, p < 0.05), and less slippage (13.70 ± 1.3 mm vs 12.75 ± 1.0, p>0.05) than interference screw fixation with additional screw group. The failure mode of cross pin fixation group was pin breakage in all specimens. The failure mode of interference screw fixation group was pullout of the graft in all specimens.

Conclusion: Our study showed that cross pin tibial fixation both bone block and soft tissue in posterior cruciate ligament reconstruction is stronger than interference screw with respect to ultimate tensile strength, stiffness, and slippage.
Single-bundle Posterior Cruciate Ligament Reconstruction with Remnant Preservation: Lateral Versus Medial-sided Augmentation Technique

Purpose: The purpose of this study was to compare the results of lateral versus medial-sided augmentation techniques of single-bundle posterior cruciate ligament (PCL) reconstruction with remnant preservation.

Methods: 42 cases of isolated chronic PCL ruptures were reconstructed in a single-bundle manner, with 7 strand autogenous hamstring tendons and remnant preservation. The patients were randomly separated into two groups: in the medial-sided augmentation (MSA) group the graft passed through the medial side of the remnant and in the lateral-sided augmentation (LSA) group the graft passed through the lateral side of the remnant. In each group the graft was fashioned with four strand semitendinosus tendon and three strand gracilis tendon and fixed with a suspension technique by mini-plates and mini-buttons. The patients were followed up and evaluated according to the IKDC, Lysholm and Tegner rating scale.

Results: 19 patients in the MSA group and 17 patients in the LSA group were followed up for a minimum of two years. At the latest follow-up, the side-to-side differences of posterior laxity were 0 to 2 mm in 15 patients (78.9%), 3 to 5 mm in 3 patients (15.8%), 6 to 10 mm in 1 patients (5.3%) in the MSA group, with an average of 1.6 ± 1.2 mm; The side-to-side differences were 0 to 2 mm in 14 patients (82.3%), 3 to 5 mm in 2 patients (11.8%), 6 to 10 mm in 1 patients (5.9%) in the LSA group, with an average of 1.5 ± 1.3 mm (p>.05). According to the IKDC scale, 14 patients (73.7%) were graded normal, 4 patients (21.1%) nearly normal, and one patients (5.3%) abnormal in the MSA group, and 13 patients (76.5%) were graded normal, 3 patients (17.6%) nearly normal, and one patients (5.9%) abnormal in the LSA group at the last follow-up. The IKDC score were 93.1±3.8 and 92.6±4.1, the Lysholm scores were 95.0 ± 4.6 and 93.7 ± 4.2 (p>.05), the Tegner scores were 5.4 ± 0.9 and 5.6 ± 0.7 (p>.05) respectively in the MSA and LSA group.

Conclusion: Arthroscopic single-bundle posterior cruciate ligament reconstruction with remnant preservation can get 94.7% and 94.1% normal and nearly normal results respectively in the MSA and LSA group at a minimum of two years. There is no statistical significant difference between the subjective and objective results of the two groups.

Level of evidence: 1. High-quality randomized controlled trial.

Keywords: posterior cruciate ligament; reconstruction; hamstring tendon; arthroscopy
Introduction: it has been shown that chronic posterior cruciate ligament (PCL) instability is often combined with a posterolateral rotatory instability (PLRI). In this situation the necessity to combined PCL- and PLRI reconstructions to avoid stretching of the PCL graft has been stressed. However, few studies have documented the outcome of combined PCL- and PLRI reconstructions with regards to the outcome of PCL reconstruction, in case of an isolated PCL instability. The purpose of this restrospective study was to evaluate the influence of a combined PCL-PLRI (PPL) on the surgical outcome of PCL reconstruction, comparing PPL reconstruction with isolated PCL reconstruction. We hypothesized the outcome of combined PPL should be less favourable than the outcome of isolated PCL reconstruction.

Methods: PCL was always reconstructed with a 2-bundle quadriceps tendon graft routed through a tibial tunnel. PL reconstruction was performed with anatomic techniques varying according to the damages structures. Medial opening tibial valgus osteotomy (HTO) were performed in case of varus deformity. Patients were pre- and postoperatively evaluated with the IKDC scoring system. Posterior laxity measurements were performed with the Telos device at 90° and 30° of flexion.

Results: there were 12 patients with straight chronic PCL instability and 20 with PPL. The follow up was at least 12 months. Preoperatively the PPL group was significantly worst with global IKDC score grade D in 60% of the PPL case vs 36% for the straight PCL and, a posterior drawer significantly higher at 90° (9.6mm vs 6.9mm) and 30° (5.1mm vs 3.7mm) of knee flexion. However the preoperative IKDC subjective score was identical in both groups (54.5 for PPL and 52.9 for straight PCL).

Postoperatively the global IKDC score was not statistically different between both group with 50% of grade A and B. The posterior drawer was also identical in both groups at 90° (4.7mm vs 4.4mm) and 30° (1.7mm vs 1.9mm) of flexion. The posterior laxity gain was significantly higher for the PPL group at each flexion value. The subjective score increased up to 68.5 for straight PCL and 63.4 for PPL (p>0.05).

Discussion: contrary to our initial hypothesis the results at follow up were identical for both groups. However, while the preoperative IKDC score as well as the posterior laxity were worst in the PPL group, there was no more significant difference at follow up meaning the clinical and laxity gain were significantly higher for the PPL group. In conclusion, patients with chronic PPL instability benefit more from surgery than patients with chronic straight PCL instability.
Functional Outcomes of Arthroscopic Posterior Cruciate Ligament Reconstruction: Comparison of Anteromedial and Anterolateral Trans-Tibia Approach

Hypothesis: Anterolateral (A-L) trans-tibia approach is better than anteromedial (A-M) technique in posterior cruciate ligament (PCL) reconstruction.

Introduction: The purpose of this prospective clinical study was to compare the functional outcomes of A-M and A-L trans-tibia approach in arthroscopic PCL reconstruction.

Materials and Methods: Between 1999 and 2003, 55 patients (55 knees) with an average age of 30 ± 11 years (range 16 to 60 years) underwent arthroscopic single-bundle reconstruction for symptomatic isolated PCL tear. Patients were randomly divided into two groups with 28 patients (28 knees) undergoing A-M trans-tibia approach on odd-numbered days, and 27 patients (27 knees) with A-L trans-tibia approach on even-numbered days. Hamstring auto grafts were used in all cases. All patients received the same rehabilitation program postoperatively. The evaluation parameters included clinical assessment, functional outcome, ligament laxity and radiographic changes of the affected knee.

Results: Significant improvements in pain and function of the knee were observed at an average follow-up of 48 ± 15.9 months for A-M and 45.0 ± 13.7 months for A-L approach. However, no differences were noted between the two techniques. In IKDC for symptom-activity level, normal or nearly normal knees were noted in 68% of A-M and 67% of A-L approach respectively, however, the difference between the two groups was not significant. In ligament laxity, approximately one third of the knees showed normal posterior ligament laxity, however with no difference noted between the two groups. Radiographs of the knee showed no discernible differences in the overall alignment and degenerative changes as well as the sizes of bone tunnels between the two groups.

Conclusion: A-M and A-L trans-tibia arthroscopic PCL reconstructions produced comparable clinical results in short-term follow-up. The theoretical disadvantages of A-M technique including graft angulation, graft abrasion and graft failure were not observed within the follow-up period. Long-term results are needed to further confirm the adverse effects of A-M trans-tibia approach in PCL reconstruction.
Accuracy of Different Methods Indicating Femoral Insertion of Posterior Cruciate Ligament of the Knee Using Double-Bundle Reconstruction Technique: An Anatomical Study

Background: The posterior cruciate ligament (PCL) reconstruction is a fairly recent innovation, mostly performed either by two-root technique which makes two bundles of PCL, anterolateral and posteromedial bundles, or inlay technique. To perform either technique, a better understanding of the anatomical structure of the two bundles of PCL is very important, particularly the femoral insertion. This anatomical insertion has been inferred to be the anatomic point in PCL reconstruction.

Purpose: To investigate the accuracy of different methods indicating femoral insertion of PCL, to find effective and pragmatic method indicating femoral insertion of PCL for double-bundle anatomic PCL reconstruction.

Method: A total of 22 fresh health male adult’s cadaveric knees were anatomized, and the PCL was observed and measured. Among them, 11 right knees and 11 left knees. The age of the donors was from 25 to 45 years old. With the knee flexed to 90 degrees, PCL were divided into anterolateral bundles and posteromedial bundles to the insertion footprint, and the femoral insertions were measured and described. Visualization, angle equipartition, distance equipartition and intercondylar fossa measurement were performed. And compare the result of visualization with the others.

Results: On the femoral side, with the knee flexed to 90 degrees, using visualization, the related clock positions of the anterolateral bundle was 11:21±0:23 (left) or 0:39±0:23 (right), of the posteromedial bundle was 9:50±0:18 (left) or 2:10±0:18 (right), respectively. Using angle equipartition, the clock positions of the anterolateral bundle was 11:29±0:16 (left) or 0:31±0:16 (right)(p>0.05), of the posteromedial bundle was 9:42±0:24 (left) or 2:18±0:24 (right)(p>0.05), respectively. Using distance equipartition, the clock positions of the anterolateral bundle was 10:50±0:12 (left) or 1:10±0:12 (right)(p<0.05), of the posteromedial bundle was 9:45±0:20 (left) or 2:15±0:20 (right)(p>0.05), respectively. And using intercondylar fossa measurement, the clock positions of the anterolateral bundle was 11:20±0:10 (left) or 0:40±0:10 (right)(p>0.05), of the posteromedial bundle was 9:44±0:13 (left) or 2:16±0:13 (right)(p>0.05), respectively; and 6.84mm on medial intercondylar fossa correspond to per hour.

Conclusion: The intercondylar fossa measurement is an effective and pragmatic method indicating femoral insertion of PCL for anatomic PCL reconstruction. The clock positions of the anterolateral bundle was 11:20±0:10 (left) or 0:40±0:10 (right), of the posteromedial bundle was 9:44±0:13 (left) or 2:16±0:13 (right), respectively; and 6.84mm on medial intercondylar fossa correspond to per hour.

Key Words: posterior cruciate ligament (PCL), anatomy, reconstruction, insertion
Repair Versus Reconstruction of Posteromedial & Posterolateral Corners in Multiligament Knee Injury

Introduction:
The purpose of this study was to compare the clinical and functional outcomes of a consecutive series of knee dislocation patients who underwent acute repair of collateral ligaments, followed by anterior and posterior cruciate ligament reconstruction (ACL/PCL), with those who had single-stage reconstruction of all ligaments.

Methodology:
All patients with evidence/presumption of knee dislocation treated by a single surgeon, identified in our prospective database were included. Between Feb. 2004 and May 2005, patients were treated with acute repair of the posteromedial corner (PMC) and/or posterolateral corner (PLC), followed by ACL/PCL reconstructions. Between May 2005 and Feb. 2007, patients were treated with single-stage multiligament knee reconstruction. All patients followed a standard rehabilitation protocol. International Knee Documentation Committee (IKDC) subjective scores and Lysholm scores as well as clinical data were documented.

Results:
42 knees in 41 consecutive patients were identified. Group A consisted of 18 acute repairs in 14 patients of the PLC (11) and/or PMC (7), followed by ACL/PCL reconstructions. Mean follow up was 31 months (range 13 – 42). Group B consisted of 31 reconstructions in 27 patients of the PLC (23) and/or PMC (8), at the time of ACL/PCL reconstructions. Mean follow-up was 18 months (range 12 to 30). Five of the 11 PLC (45%) repairs and 1 of the 23 PLC (4%) reconstructions failed (p<0.008). Two of the 7 PMC (29%) repairs and 1 of the 8 PMC (13%) reconstructions failed (p=0.57). Following revision reconstructions in both groups, no significant differences were noted for mean IKDC subjective scores (77 vs. 70, p=0.33) and mean Lysholm scores (86 vs. 80, p=0.19).

Conclusion:
Our series demonstrated a statistically significant higher rate of failure for repair of the PLC, compared to reconstruction. No significant difference was found between PMC repair and reconstruction. We caution against the use of primary PLC repair in the setting of multiligament knee injury.
Reconstruction of the Posterior Oblique Ligament (POL) and the PCL in Knees with Posteromedial Instability

Background: Posterior Cruciate Ligament (PCL) injuries are often associated with injuries to other structures. The role of the posteromedial structures of the knee in these injuries has received little attention.

Hypothesis: Reconstruction of the posterior oblique ligament (POL) and the PCL can restore posterior tibial translation in knees with posteromedial instabilities.

Study Design: Controlled laboratory study.

Methods: Kinematic studies were carried out on ten cadaveric knees exposed to a 134-N posterior tibial load and 5 Nm internal torque at 0°, 30°, 60° and 90° of flexion. Resulting posterior tibial translation (PTT) was determined by using a robotic/universal force-moment sensor testing system for 1) intact, 2) PCL deficient, 3) deficiency of the PCL and the posteromedial structures) PCL reconstructed, 4) PCL/MCL/POL reconstructed, and 5) PCL/POL reconstructed.

Results: When both the PCL and the posteromedial structures were cut, PTT did increase significantly at any flexion grade under a posterior tibial load (p>0.05). Reconstruction of only the PCL could not restore PTT in 0°, 30°, 60 and 90° of flexion under both loading conditions in a knee with combined injury of the PCL and the posteromedial structures (p<0.05). Additional reconstruction of the POL significantly improved PTT at all flexion angles in comparison to the PCL reconstructed knee (p<0.05). Reconstruction of the MCL had no significant effect on posterior tibial translation.

Conclusions: Reconstruction of the POL has a significant role in prevention of posterior tibial translation in the knee with PCL injury and associated injuries to the posteromedial corner.

Clinical Relevance: The POL should be addressed in the patient with combined injuries to the PCL and the posteromedial structures.
Comparison of the Results of ACL Reconstruction Using Bioabsorbable versus Metal Interference Screws: Meta-Analysis

Purpose: Fixation in anterior cruciate ligament reconstruction (ACLR) can be achieved through the use of either bioabsorbable screws (BAS) or metal (MS). Although several published studies have compared the clinical results from ACLR using these two fixation types, no meta-analysis has yet been published. Fixation using BAS has similar fixation strength to MS, eliminates need for removal, allows easier revision surgery, and prevents post-operative imaging complications. Concerns remain, however, that increased inflammatory response, screw breakage, tunnel widening, or incomplete screw absorption may occur more frequently when using BAS, leading to inferior clinical results. The purpose of this study was to synthesize all relevant and available data to compare both subjective and objective clinical results from ACLR using BAS or MS.

Methods: An electronic database search was conducted to find all reports of ACLR using BAS published between January 1, 1999 and December 9, 2008. Inclusion criteria were comparative, therapeutic studies with a minimum 24-month follow-up, and available IKDC scores, laxity differences, Tegner activity level, and/or Lysholm scores. Intra-operative and post-operative complications were also considered. Seven studies matched the inclusion criteria. The studies analyzed a total of 619 cases (311 BAS and 308 MS).

Results: BAS had a slight, yet statistically insignificant advantage in IKDC scores at 24 months post-operatively. There was no significant difference in Tegner scores at 2 years between BAS and MS (6.7 vs 6.9, respectively). Lysholm tests showed similarity between fixation types at 2 years (94 for both groups). KT arthrometer measurements showed no significant difference in side-to-side anterior-posterior laxity between BAS and MS at 2 years (1.3 mm vs 1.5 mm, respectively). Rates of intra-operative and post-operative complications were higher in the BAS group (4.2% vs 0% and 9.0% vs 5.0%, respectively). There was a higher incidence of screw breakage in the BAS (13) compared to MS (0). Rates of post-operative effusion (3.7% vs 1.9%) and graft failure (3.7% vs 1.5%) were higher in the BAS group. Intra-articular infection rate was similar between the groups (1.1% BAS vs 1.2% MS).

Conclusions: A thorough review of recent published reports indicates similarity in clinical outcomes of BAS and MS across a broad range of objective and subjective measurements, although intra-operative screw breakage is a risk unique to the use of BAS. Given these results, the use of BAS is likely favored given the relative ease of revision surgery and the ability to image the knee post-operatively using magnetic resonance imaging (MRI).
Comparison of Single- and Double-Bundle Anterior Cruciate Ligament Reconstruction using Quadriceps Tendon-Bone Autografts

Introduction: Based on a biomechanical study, single-bundle reconstruction was found to be insufficient in controlling both anterior to posterior translation and rotation in extension.

Hypothesis: The outcomes of ACL reconstruction using quadriceps tendon-bone autografts will be different based on the techniques of the reconstruction.

Materials and Methods: The records of 59 patients who had ACL reconstruction from January 2005 and April 2006 were analyzed retrospectively. Twenty-eight patients had single-bundle reconstruction (Group S) and 31 received double-bundle reconstruction (Group D).

Results: The postoperative mean side-to-side difference for group S was 2.64 mm and 1.79 mm for group D, a difference that was found to be statistically significant (p = 0.020). Regarding pivot-shift test, 3 patients had grade 1+ and 1 patients had grade 2+ pivot-shift in group S, while no patients had abnormal pivot-shift in group D (p= 0.093). The patients who reported grade A or B on IKDC scores were 24 and 28 in group S and D, respectively (p=0.738).

Conclusion: Double-bundle ACL reconstruction using quadriceps tendon-bone autografts provided more satisfactory AP and rotational stability than single-bundle ACL reconstruction.

Key Words: Anterior cruciate ligament, Double-bundle reconstruction, Quadriceps tendon-bone autograft, Clinical outcomes
Double Bundle Anterior Cruciate Ligament Reconstruction Using a Polylactide Carbonate (CALAXO) Osteoconductive Interference Screw

Introduction
The purpose of this study was to describe our experience of the new Polylactide Carbonate (Calaxo) Osteoconductive interference screw (Smith & Nephew) when used for both femoral and tibial graft fixation in Double Bundle ACL reconstruction.

Methods
Since May 2006, patients with an ACL deficient knee were reconstructed using the Double Bundle technique. All were followed prospectively and outcome data collected. Evidence of fixation failure was established subjectively by clinical examination (Pivot Shift) and objectively via KT-1000 arthrometer. Following ethical approval, post-operative CT scans (immediate and 12-18 months) were performed on five (a further 5 awaited) patients allowing assessment of tunnel dimensions/fill.

Results
Twenty nine patients (26 male, 3 female) with a mean age of 30 (range 18-47) were included. At last follow-up, no evidence of graft/fixation failure was found; KT-1000 mean side-side difference 1.4mm (range -3 to +6). All patients had a positive pivot shift preoperatively which was abolished postoperatively. Subjective IKDC score was significantly improved with a mean of 76.27% (SD 17.38) at last review compared with 54.02% (SD 17.86) preoperatively (t (22) = -5.37, p<0.05) One patient had a postoperative infection with no other complications reported. Radiologically the screws did not show complete resorption in 2 cases, with significant tunnel widening found on 3 cases. Some evidence of new bone formation was noted but not found to be significant.

Discussion
We have shown satisfactory clinical results with use of the Calaxo screw when used in Double Bundle ACL Reconstruction. However, radiologically the osteoconductive properties of the screw shown in the pre-clinical animal model were not evident.
This study helps illustrate that preclinical animal data cannot necessarily be translated into human practice. Surgeons should proceed with caution when using new biological implants tested purely in animal models. Although we have not had any cases of the reported adverse local soft tissue reaction associated with Calaxo, we support Smith & Nephew’s decision to withdraw the screw from clinical use.
Does Hamstring Intra- and Extra-Articular ACL Reconstruction Increase Osteoarthritis at Long Term Follow-Up?

Background: We analyzed at a mean of 11 (10-13) years follow up the clinical and radiographic outcomes after hamstrings intra ed extra-articular ACL reconstruction.

Hypothesis: We would prove that our technique maintains good efficacy during time (11 years follow up) and that the development of osteoarthritis is strictly connected with meniscectomies and lack of range of motion.

Study Design: Case Series.

Methods: We examined 60 consecutive patients operated between 1993 and 1995, involved in sports at high level, aged more than 15 and under 50 years. The surgical technique foresees the use of hamstring tendons with tibial insertions intact plus an extra-articular plasty (augmentation) performed with their remnant part. IKDC, KT 2000, Tegner, Lysholm and subjective scores were used for clinical evaluation. Radiographic outcomes were also performed.

Results: After 11 years the IKDC showed good-excellent results (A+B) in 90,7% of patients. KT 2000 demonstrated that only two patients had more than 5 mm of laxity. Tegner mean score was 4,5, the mean Lysholm was 97,3 and the mean subjective score was 90,0%. Eleven patients underwent additional surgical procedure such as meniscectomy and hardware removal. X-Ray evaluation demonstrated progressive degenerative changes only for medial meniscectomized patients.

Conclusions: Long term results of our original technique have demonstrated highly satisfactory results with no worsening of laxity and subjective score. Statistical analysis showed that factors affecting the outcomes are strictly associated to meniscectomies and laxity. The lateral augmentation permits maintenance of laxity also at long term follow up with single bundle hamstrings graft, without increasing the risk of knee osteoarthritis on the lateral compartment.
The “V” Lesion: A Posteromedial Capsular Tear of the Knee

Purpose: To describe an arthroscopic find of the posteromedial capsule lesion of the knee that we named “V” lesion, its treatment, and to present the results of 12 cases.

Type of Study: Case Series

Methods: Twelve patients (11 males, 1 female) with “V” Lesion, combined with ACL (6) and with ACL and PCL (2). The mean age was 25 years (range, 18 to 34 years). All “V” Lesions were repaired by side to side knot with magnum wire #2 (Opus Medical) with out-inside technique. The patients were assessed before surgery and at a mean follow up of 12.1 months (range 8 months to 2 years) by a physical examination, Lysholm II scores, knee range of motion and postoperative stress radiographs obtained with Telos device (Telos, Marburg, Germany).

Results: Transoperative and postoperative physical examination revealed a reduction of the anterior and posterior drawer test and stress in valgus test: negative in all cases. In the patients with combined lesion (ACL, PCL) the stress in valgus continued positive after reconstruction and only became negative when the arthroscopic suture of the “V” Lesion was performed. On the Lysholm II knee scoring scale the score was excellent in 78% of the cases and good in 22% of the cases. The postoperative stress radiographs at six months revealed improvement of the medial, anterior and posterior instability.

Conclusion: Treatment of the instability of the knee must be completed by repairing all lesions: anterior, posterior and medial. The side to side suture of the “V” Lesion improves the medial stability and can decrease the possibility of damage to ACL or PCL reconstruction.

Level of Evidence: Level IV, therapeutic case series.
7-10 Years After ACL Reconstruction with Special Emphasis on Quality of Life and Subjective Function. Patellar Tendon Graft vs. Quadruple Semitendinosus Graft: A Prospective Randomized Controlled Trial

In a two-centre RCT 1995 – 1997, 164 patients with anterior cruciate ligament rupture were randomised to arthroscopic reconstruction with Bone-Patellar tendon-Bone (BTB) or quadruple Semitendinosus tendon graft (ST). In previously published results after two years, the groups showed equal results with no statistically significant differences except better kneeling ability in the ST group. Early reconstructed patients also tended to do better.

Materials and methods:
In this 8.4 (7-10) year follow up 153 patients were assessed by an independent observer, 75 ST and 78 P-BTB. Only 11 patients (7%) were lost to follow-up. The groups were equally distributed regarding age, height and weight. Follow up examination included IKDC, Lysholm, Tegner activity level score, Patellofemoral pain score according to Werner, instrumental laxity and one leg hop test. In addition quality of life assessment and subjective function was also evaluated with SF 36 and KOOS (Knee Osteoarthritis Outcome Score). All functional scores were self assessed.

Results:
At follow up 10 patients reported a diagnosed rupture of the contra lateral ACL (3 ST and 7 P-BTB). Five of those had been reconstructed. Four patients had been revised because of graft ruptures (2 BTB and 2 ST). Fourteen patients had meniscus surgery during the follow up period, (5 ST and 9 BTB). No significant differences were found between the groups regarding laxity, one leg hop test, Lysholm score, Tegner activity level score, IKDC or Patellofemoral pain score except better kneeling ability and knee walking ability in the ST group. Discomfort from loss of skin sensation was also greater in the BTB group. Regarding quality of life and knee function there were no significant differences in SF-36 or KOOS between the groups, however both groups were affected by their previous injury. Patients who were reconstructed within 5 months from the injury showed significantly better activity level score regardless choice of graft.

Discussion:
The ST graft choice was still at 8 years following reconstruction superior to BTB in terms of kneeling ability, knee walking and discomfort from loss of skin sensation. Conventional knee scores, laxity and hop test revealed no differences, nor did quality of life related health assessment.

Level of evidence:1
**Long term results of ACL reconstruction with bone patella bone autograph: 23 year follow-up**

**INTRO:**
Follow-up of patients with ACL using bone-patella-bone auto graft was performed after a minimum of 20 years.

**METHODS:**
105 patients underwent reconstruction using BTB autograph between 1980-87. 31 were available for follow-up after using social security searches and clinical records. Functional and radiographic evaluation was performed.

**RESULTS:**
Mean follow-up was 23.5 years. Mean KOOS symptom score = 77.4, pain = 80.3, ADL = 91.83, sports= 72.59 and quality of life = 63.42 out of 100. ARS subjective rating of running, cutting, deceleration and pivoting averaged 5.38/16. Subjective IKDC index was 29.31/100 largely because they did not participate in the kinds of activities questioned. IKDC ligament evaluation showed 27.7% type A, 55.5% type B, 16.6% type C and 0% type D. Patients had KT-1000 side-to-side differences of <3mm in 76.9%, 3-6mm in 23.1%. X-rays (Kellgren-Lawrence OA of the worst compartment) showed 10% grade 0, 30% grade 1, 25% grade 2, 30% grade 3 and 5% grade 4. The Brandt scale quantified joint space narrowing; 75% had less than 25% narrowing and 25% had >50% loss of space.

**DISCUSSION:**
Twenty-three years following ACL reconstruction patients retained good functional and radiographic outcomes. Patients were subjectively high functioning but had difficulty with sports skills. Objectively 86.6% exhibited near normal ligamentous exams by IKDC and the majority had <3mm side-to-side differences by KT-1000. Minimal joint changes were seen in 65% with nearly normal joint preservation in >75%. Location of patients was a challenge and many patients were not findable limiting the ability to interpret results widely.
Infrapatellar Branch of Saphenous Nerve Injury During Hamstring Graft Harvest: A Prospective Comparative Study of Three Different Incissons

KEY WORDS: ACL - hamstring graft harvest – infrapatellar branch of saphenous nerve

AIM OF THE STUDY:
To compare the incidence of injury to infrapatellar branch of saphenous nerve (IPBSN) between three different incisions of hamstrings graft harvesting for ACL reconstruction.

INTRODUCTION:
Anatomical studies have identified safe zones for making incisions to minimize injury to IPBSN while harvesting medial hamstrings graft. But clinical comparative studies are lacking to prove the advantage of any particular incision.

STUDY DESIGN: Prospective Cohort study.

MATERIAL, METHODS AND RESULTS:
92 patients who underwent ACL reconstruction with hamstrings graft were prospectively studied. Group 1 consisted of 30 patients with hamstrings graft harvested through standard vertical incisions. There were 27 patients in group 2, in whom the graft was harvested by a transverse incision and 35 patients in group 3, in whom the graft was harvested by anatomical oblique incision. The transverse incision was made between the anatomical landmarks for the superior and inferior trunks of IPBSN. The patients were reviewed at 6 weeks, 3 months and 6 months and the area of skin numbness around the knee was mapped. Digital photographs of the area were taken and analyzed with Adobe photoshop software. The results were analyzed with repeated measures ANOVA. There was significantly less incidence of cutaneous sensory loss in the distribution of IPBSN in patients with oblique followed by transverse incision. These group of patients also had higher subjective satisfaction scores for scar appearance.

CONCLUSION:
Oblique followed by transverse incision for hamstrings graft harvesting in ACL reconstruction minimizes the incidence of injury to IPBSN and gives better wound healing and scar.

Level of evidence: 2.
Comparison of Incidence and Cause of Osteoarthritis after ACL Reconstruction: Patellar vs Hamstring

Purpose: The incidence and the risk factors that contribute to the development of osteoarthritis after ACL reconstruction have remained controversial. We evaluated the incidence and risk factors of osteoarthritis after ACL reconstruction using patellar tendon and hamstring autograft.

Materials and Methods: Fifty-eight cases of ACL reconstruction using a patella tendon were included and the average follow-up period was 9.2 years (Group A). Forty-seven cases using a hamstring tendon were also evaluated with an average follow-up period of 7.8 years (Group B). Data on patient demographics including interval from injury to reconstruction, age at reconstruction, the history of meniscectomy, and presence of articular cartilage lesion were collected. Radiographic evaluation was done according to the Kellgren and Laurence’s classification on antero-posterior and lateral weight-bearing radiographs taken at final follow-up. Clinical functional and ligament testing (Lysholm knee score, Tegner activity score, Lachmann test, Pivot-shift test), and instrumented laxity testing were all examined in relation to the development of osteoarthritis.

Results: Osteoarthritis was detected 25 (43%) in group A and 9 (19%) in group B. Among the various factors, accompanying meniscal injury (Group A: odds ratio (OR), 9.19; p<0.001) (Group B: OR= 5.77, p=0.030), an interval from injury to reconstruction of >6 months (Group A: OR, 4.77; p=0.021), (Group B: OR, 5.03; p=0.045), and a patient age at reconstruction of >30 years (Group A: OR, 3.37; p=0.034), (Group B: OR, 5.75; p=0.026) were all found to be significant independent predictors of osteoarthritis. However, no statistically significant correlation was found between the development of osteoarthritis and clinical outcome, or radiologic stability in both groups.

Conclusion: The incidence of osteoarthritis after ACL reconstruction was 43 and 19% using patellar and hamstring autograft. It had a correlation with meniscectomy, longer interval and older age at reconstruction.
Comparison of Patellofemoral Cartilage between Primary Bone Patellar Tendon Bone Autografts versus Other Primary Grafts at the Time of ACL Revision Surgery- A Prospective MOON Cohort Study.

Background: The optimal graft choice for primary ACL reconstruction continues to remain controversial. Excellent outcomes have been documented for both HS and BPTB autograft ACLRs; however, an association between postoperative patellofemoral osteoarthritis and primary graft source has been reported in the literature. The aim of this study was to determine if there is an association between primary BPTB autograft selection for ACL reconstruction and arthroscopic evidence of patellofemoral cartilage degeneration at the time of ACL revision surgery.

Methods: Using the MOON database, patients that had ACL revision surgery during 2002 and 2003 were identified and stratified according to the graft type used for their primary ACL reconstruction (BPTB vs non-BPTB). Exclusion criteria were: previous ACL revision surgery, history of extensor mechanism injury, or prior extensor mechanism surgery. Patients with a BPTB autograft failure were compared to patients with a non-BPTB graft failure. The primary outcome measure was the Outerbridge grade of the patellofemoral joint at the time of ACL revision surgery. The Outerbridge grade was reported for 3 regions in the patellofemoral compartment: entire (any surface of the cartilaginous compartment), central (the area directly underneath the patella autograft harvest site), and peripheral (cartilaginous area surrounding the patella autograft harvest site). A Chi square analysis was used to determine if there was a difference in the Outerbridge grade of the patellofemoral compartment anatomic region in the BPTB and non-BPTB groups. Logistic regression was used to determine if there were patient variables associated with the cartilage status of the patellofemoral joint. Variables evaluated were: time elapsed from primary ACL reconstruction to ACL revision surgery, age, gender, height, weight, and patellar alignment.

Results: A total of 86 patients had undergone ACL revision surgery during 2002-2003. There were no differences in gender, age, height, or weight between the BPTB and non-BPTB groups. Average time from primary reconstruction to revision was 23.06 months (SD: 55.17). There was no difference in the percentages of patients with documented Outerbridge grade = 2 changes on the patella in the two groups: entire patella (39.2% BPTB vs 37.14% non-BPTB, p=0.846); central (33.3% BPTB vs 34.3% non-BPTB, p=0.539); peripheral (29.4% BPTB vs 31.4% non-BPTB, p=0.179). The two groups also had no difference in the percentage of patients with Outerbridge grade = 2 changes in the trochlea: entire trochlea (29.4% BPTB vs 31.4% non-BPTB, p=0.841); central trochlea (29.4% BPTB vs 31.4% non-BPTB, p=0.992); peripheral (12% BPTB vs 17.2% non-BPTB, p=0.66). Logistic regression showed that < 1% of the chondral damage in the patellofemoral compartment can be attributed to having a BPTB graft at primary ACL reconstruction (p=0.8459), and 7% of chondral damage can be attributed to patient age at the time of revision surgery (p=0.0055). The time elapsed from primary ACL reconstruction to ACL revision surgery, gender, height, weight, and patellar alignment did not show a significant contribution to the presence of chondral damage in the patellofemoral compartment for either group.

Conclusion: At the time of ACL revision surgery, there was no association between the arthroscopic appearance of the patellofemoral compartment and the graft used for primary ACL reconstruction. In the absence of early evidence patellofemoral arthrosis, this study would support either HS or BPTB autografts for primary ACL reconstruction.
In Vivo Response of Human Tenocytes to Extra-Cellular Matrix Patches used for Rotator Cuff Repair

Introduction: Several allograft and xenograft soft-tissue reinforcement devices have become commercially available to augment rotator cuff repair. There is little research about the interaction of these devices (ECM or extra-cellular matrix patches) with the human rotator cuff tendons.

Purpose: To evaluate the cell adhesion, cell proliferation, extra-cellular matrix production and extent of migration of human tenocytes to six commercially available ECM devices.

Significance: ECM devices need to incorporate into native rotator cuff tissue in order to reinforce the surgical repair. The extent of favorable or unfavorable reaction of human tenocytes to the ECM will be critical in understanding the role of these devices in rotator cuff repair.

Methods: 16 (5mmx5mm) samples from each six commercially available ECM devices (GraftJacket®, Wright Medical Technologies, Inc., Zimmer Collagen Repair Patch, Zimmer, Inc., Restore®, Johnson-Johnson-Depuy, OrthADAPT®, Pegasus Biologics, Fascia lata, Musculoskeletal Transplant Foundation, and Sports Mesh™, Biomet) were incubated in wells containing human tendon cells that had previously been collected and grown in culture from discarded surgical specimens using standard methods. Cell adhesion to each specimen was measured at 24h (n=4 each patch type) using a Coulter counter technique. Cell proliferation on each sample was measured at 48h using [3H]Thymidine incorporation measures with a scintillation counter. Extracellular matrix production by the tenocytes on each sample was measured indirectly using quantitative polymerase chain reaction (qPCR) for Type III collagen and decorin at 4 wks (n=4). Histological examination measured the depth of migration of the tenocytes into each material at 4 weeks.

Results: Cells adhered more to GraftJacket® and Restore® than the other 4 patches. Cellular proliferation was significantly greater on GraftJacket® and Zimmer patch, less on OrthADAPT and Fascia lata, and very little on SportsMesh and Restore® (p< 0.05). Tenocytes on GraftJacket and Zimmer produced more Type III collagen as measured by qPCR, with lesser amounts on fascia lata, OrthADAPT, and SportsMesh and very little on Restore® (p< 0.05). Histological examination identified tenocytes on the surface of each sample. However, the tenocytes were not seen to have migrated into the substance of any of the samples at 4 wks.

Discussion: Tenocytes proliferated and produced more extra-cellular matrix on the dermal based patches (GraftJacket and Zimmer patch) as compared to those with densely arranged collagen (OrthADAPT and human fascia lata). Tenocytes on the Restore patch (submucosal pig intestine) and the SportsMesh (biocompatible poly (urethane urea)) exhibited little proliferation and matrix production. Tenocytes were only seen on the surface of each specimen and had not migrated into any specimen at 4 weeks. In summary, in this cell culture model, tendon cells did not appear to be incorporating into any of the six ECM devices.

The results are preliminary as only tenocyte response was measured. In vivo response and signaling from other cell lines may modify tenocyte response. Further research is necessary to determine the optimal characteristics of a rotator cuff augmentation device.

Clinical Relevance: This information may play a role in a surgeon’s decision to use an ECM device for rotator cuff repair augmentation and which device is chosen.