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Paper #211  Rotator Cuff Repair in Spinal Cord Injury Patients .............................................................. John E Zvijac, Coral Gables, FL, USA
Paper #212  Glenohumeral Joint Kinematics During Anterior and Posterior Drawer Tests: Effects of Intra-Clinician Repeatability ........................................... Volker Musahl, Pittsburgh, PA, USA
Paper #213  Anterior instability Following Shoulder Replacement: Causes and Treatment ........................................... Pascal Boileau, Nice, FRANCE
Paper #214  Prospective Outcome Study of Isolated Arthroscopic Debridement for Grade IV Glenohumeral Arthritis ................................................................. Marc Raymond Safran, San Francisco, CA, USA
Paper #215  The “Hourglass Biceps” – Another Cause of Shoulder Pain ........................................................ Pascal Boileau, Nice, FRANCE
Paper #216  Arthroscopic Treatment of Painful Snapping of the Scapula .................................................................. Simon Nicholas Bell, Brighton, AUSTRALIA

• The FDA has not cleared the drug and/or medical device for the use described in this presentation (i.e., the drug or medical device is being discussed for an “off-label” use)
FULL-THICKNESS ARTICULAR CARTILAGE DEFECTS OF THE TROCHLEA: LONG-TERM PATIENT OUTCOMES AT 4-6 YEARS

INTRODUCTION: Since the introduction of ACI in the US (1995), numerous researchers have presented encouraging results on ACI for the treatment of full-thickness chondral injuries. However, data specific to outcomes for trochlea lesions are limited. This multicenter experience with autologous cultured chondrocyte implantation (ACI) for the repair of trochlear lesions now extends to more than 4-years follow-up. This paper reports long-term patient outcomes for the first 42 consecutive patients who were treated with ACI for lesions of the trochlea.

METHODS: Patients were prospectively followed and evaluated at cartilage harvest, implantation, and at a minimum of 4-years. Treatment outcomes were measured using the modified Cincinnati Knee Rating System. Information on adverse events and treatment failures came from standardized data collection forms or spontaneous report by patients or treating surgeons. Failures were included in the analysis and scored as a “2”; with all symptoms present. Patients with treated patellar or tibial lesions or spontaneous report by patients or treating surgeons. Failures were included in the analysis and scored as a “2”; with all symptoms present. Patients with treated patellar or tibial lesions were excluded. The primary endpoint of this study was the change in the overall condition score from baseline to a minimum of 4-years follow-up. These multicenter results are referred to as a “2”; with all symptoms present. Patients with treated patellar or tibial lesions were excluded. The primary endpoint of this study was the change in the overall condition score from baseline to a minimum of 4-years follow-up.

RESULTS: Thirty-six knees of 34 patients (mean age: 26 y.o) who had received transplantations of cartilage-like tissue were followed up for at least 2 years (range: 25 to 57 months). The cartilage-like tissue was made by cultivating autologous chondrocytes embedded in Atelocollagen gel (CE marked) (clinically used for the treatment of facial wrinkles for 15 years in Japan and Europe) for 3 weeks before transplantation. The causes of osteochondral defects were trauma in 25 knees, osteochondritis dissecans in 8 knees, osteoarthritis in 2 knees and chondromalacia patellae in one knee. The lesions were located on the medial femoral condyle in 17 knees, on the lateral femoral condyle in 12 knees and on the patella in 7 knees. At 6, 12 and 24 months after operation, arthroscopic, biomechanical and MRI examinations were performed. Using the Lysholm score, the clinical outcome was evaluated at the final clinical follow-up visit (range: 25 to 57 months).

Results: Transplantation eliminated knee locking and reduced pain and swelling in all patients. The mean Lysholm score improved significantly (initial: 72.4 points, final: 96.3 points). Arthroscopic assessment indicated that 32 knees (89 %) had good or excellent outcomes. No problems, including infection, were detected, except with 4 cases of graft hypertrophy, 3 cases of partial detachment of peristeum and one case of partial ossification in the graft. Biomechanical examination also revealed that the transplants had acquired hardness similar to that of the surrounding cartilage at 12 months after operation. MRI also demonstrated that the signal intensity of the grafted portion had become similar to that of the normal cartilage in 26 knees (72%) of the 36 knees at 24 months after operation.

Conclusion: Transplantation of cartilage-like tissue made by tissue engineering can promote repair of cartilage of the knee.

SEMITENDINOSUS REGROWTH: THE PHYSIOLOGIC PROPERTIES OF THE LIZARD TAIL PHENOMENON

INTRODUCTION: Several recently published articles have confirmed that the semitendinosus tendon regenerates with a “neotendon”; following harvesting for ACL reconstruction. In a preliminary study in rabbits, this regenerate tissue has been characterized as tendinous, with histological and biomechanical features compatible with normal tendon. We developed this study to further investigate this neotendon to assess whether a true, functional tendon was formed and not just scar tissue. We included a more thorough evaluation of the histology, with a...
focus on the muscle-tendon and tendon-bone interface, and an evaluation of the function of the musculotendinous regenerate tissue.

Materials and Methods: We harvested the semitendinosus tendon from one randomly assigned lower extremity of thirty-five New Zealand white rabbits using a standard tendon stripper. The rabbits returned to caged activity and were sacrificed nine to twelve months following the index procedure. The tendons were carefully analyzed by gross dissection, histology (including immunohistochemical stains and electron microscopy), and function using a force transducer and an Instron tension guage.

Results: Thirty-two rabbits were available at the time of sacrifice. One rabbit died at four months and another at six months; both were studied with gross, histological, and immunological evaluation. The remaining rabbits were sacrificed at nine to twelve months. The regenerate neotendon was highly variable in its size and function. In the majority of cases, the neotendon reattached to bone in the proximal tibia, but at a variable location. The regenerate was indistinguishable in five specimens, two of which had a history of wound dehiscence with perioperative infection. Histology and immunology confirmed that the regenerate tissue was indeed tendon with all of the characteristics of normal tendon, including cellularity, vasculature, and organization. Fatty degeneration was also evident in many of the regenerate tendons and corresponding semitendinosus muscle bellies. Electron microscopy showed the regeneration of organized collagen tissue that simulated the native tendon. A variance in cross-sectional area was noted. Functionally, the neotendon was able to transmit force across the musculotendinous junction when the muscle belly was stimulated but at a rate of 20-25% of the native side. Biomechanically, the tendons' ultimate tensile strength was dependent on the pre-harvest size of the semitendinosus tendon. A native tendon with an ultimate tensile strength of less than 21 N usually resulted in a weak, wispy regenerate while a native tendon with an ultimate strength of greater than 40 N resulted in a regenerate of nearly 75% of the original strength.

Conclusion: This study demonstrates conclusively that the semitendinosus tendon not only regenerates, but that it does so with normal, reactive tendon tissue. The insertion of the tendon, although at a variable location, resembles normal tendinous attachment. Under electrophysiologic and biomechanical testing, the tendon strength simulates the control tendon when a significantly large native tendon was present prior to the initial harvest. In summary, the tendon totally regenerates from musculotendinous junction to muscle-bone attachment, confirming that the ‘lizard tail phenomenon’, is a real entity that may have a dramatic impact on the postoperative outcome. The regenerate was indistinct in five specimens, two of which had a history of wound dehiscence with perioperative infection. Histology and immunology confirmed that the regenerate tissue was indeed tendon with all of the characteristics of normal tendon, including cellularity, vasculature, and organization. Fatty degeneration was also evident in many of the regenerate tendons and corresponding semitendinosus muscle bellies. Electron microscopy showed the regeneration of organized collagen tissue that simulated the native tendon. A variance in cross-sectional area was noted. Functionally, the neotendon was able to transmit force across the musculotendinous junction when the muscle belly was stimulated but at a rate of 20-25% of the native side. Biomechanically, the tendons' ultimate tensile strength was dependent on the pre-harvest size of the semitendinosus tendon. A native tendon with an ultimate tensile strength of less than 21 N usually resulted in a weak, wispy regenerate while a native tendon with an ultimate strength of greater than 40 N resulted in a regenerate of nearly 75% of the original strength.

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study is to evaluate the effect of the therapeutic application of TGF-beta1 and PDGF-BB on this type of ACL injury.

Materials and Methods: Thirty-six skeletally mature female 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, respectively. The ACL was then stretched by applying an anterior drawer force of 10-N to the tibia at 90 degree of knee flexion. Subsequently, the ACL length was irreversibly elongated to 110 +/- 2 % of the original length. Then, the rabbits were randomly divided into 4 groups of 9 animals each. In Group I, 4-nanogram TGF-beta1 mixed with 0.2-ml fibrin sealant was applied around the injured ACL. In Group II, 20-microgram PDGF-BB mixed with 0.2-ml fibrin sealant was applied around the injured ACL. In Group III, 0.2-ml fibrin sealant was applied as the sham treatment around the injured ACL. In Group IV, no treatment was applied around the injured ACL. No immobilization was applied after surgery in all four groups. The animals were allowed unrestricted activities in their cages. All animals were sacrificed at 12 weeks after surgery. In each group, 7 of the 9 rabbits were used for biomechanical evaluation, and the remaining 2 were used for histological observation. Nine knees randomly harvested from all left knees were used to obtain normal control data. In biomechanical evaluation, the anterior-posterior translation of the knee was measured using a tensile tester under 10-N forces at 30, 60, and 90 degree of knee flexion. The cross-sectional area of the ACL was then measured with a non-contact optical method using a video dimension analyzer. The structural properties of the femur-ACL-tibia complex were determined in tensile testing at a cross-head speed of 20 mm/min. Statistical analyses were made using the ANOVA.

Results: Concerning failure modes, the ACL insertion was avulsed in 6 of the 7 specimens in Group I and the normal control knees, while 6 of the 7 specimens failed at mid-substance in Groups II, III, and IV. The ANOVA demonstrated a significant difference in the stiffness and the maximum load among the groups (p<0.0001). The maximum load and the stiffness of Group I were significantly greater than those of Groups III (p=0.0041 and p=0.0048, respectively), and IV (p=0.0345 and p=0.0272, respectively), although these two parameters of Group I were significantly lower than those of the normal control knees. On the other hand, there were no significant differences in the maximum load and the stiffness between Groups II, III, and IV. Concerning the anterior-posterior translation of the knee, the ANOVA did not show any significant differences.

Discussion: This study clearly demonstrated that 4-nanogram TGF-beta1 significantly increases the structural properties of the injured ACL. This result indicated that TGF-beta1 significantly enhanced healing of the ACL. However, we could not find significant effects of 20-microgram PDGF-BB on the injured ACL. Our observations were different from the Hildebrand's observations on effects of PDGF-BB in the rabbit ACL. This fact implies that not only ligament healing process but also the effect of these growth factors are significantly different between intra- and extra-articular environments. In addition, this study suggested that TGF-beta1 did not sufficiently affect the anterior translation of the knee. This result suggested that TGF-beta1 does not reduce the length of the injured ACL. Therefore, an additional treatment to reduce the ACL length should be developed to apply the TGF-beta1 therapy to this type of ACL injury.
Introduction: Scaphoid is the critical lateral column link between the proximal and distal rows of the carpus. During radial deviation, the lateral column must shorten however the apparent differential rotation and relationships between the scaphoid, lunate and trapezium is not well explained by existing carpal kinetic theories. Nor is the mechanism by which the lunate remains a mobile but stable intercalated segment. By obtaining 3D CT scans of the normal and abnormal wrist in various positions of coronal and sagittal deviation, and then creating motion sequences using a step frame animation technique, the dynamic relationships between the various carpal bones can be demonstrated, ligamentous constraints inferred, and pathological and reconstructive options evaluated.

Method: Using object generation (surface rendering) software, motion sequences of serial position wrist CT scans have been obtained of a series of in vivo normal and abnormal wrists. Using a subtraction technique within the graphics environment, the motion of individual carpal bones can be studied, motion variances characterised and relationships of described ligaments demonstrated.

Results: During ulnar to radial deviation, the trapezium, which is firmly attached to the scaphoid, supinates around the fore-shortening lateral column. Further, the axial rotation of the lunate remains a mobile but stable intercalated segment. By obtaining 3D CT scans of the normal and abnormal wrist in various positions of coronal and sagittal deviation, and then creating motion sequences using a step frame animation technique, the dynamic relationships between the various carpal bones can be demonstrated, ligamentous constraints inferred, and pathological and reconstructive options evaluated.

Discussion: The motion of the carpus can be demonstrated in a clinically applicable format to aid anatomical understanding, diagnosis and reconstructive planning. The motion of individual bones of the patient’s wrist can be seen in isolation, and specific dynamic abnormalities demonstrated. An understanding of the fixed constraints within the carpus allows for the development of more logical reconstructive interventions that attempt to replicate normal kinetics.

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rate of cells after seeding, after which the matrix can be produced and organized in a highly aligned structure.

Paper #9
CHANGES IN GENE EXPRESSION OF HUMAN ARTICULAR CHONDROCYTES IN CELL CULTURE
Stefan Marlovits, Vienna, AUSTRIA
Michael Schmahl, Marburg, GERMANY
Jürgen Schlegel, Munich, GERMANY
Vilmos Vecsei, Vienna, AUSTRIA
Gabriele Striessnig, Vienna, AUSTRIA, Presenter
University of Vienna and University of Marburg, Vienna, AUSTRIA

INTRODUCTION:
The aim of the present study was the investigation of differential gene expression in primary human articular chondrocytes (HACs) and in cultivated cells derived from HACs.

EXPERIMENTAL/METHOD:
Primary human articular chondrocytes (HACs) isolated from non-arthritic human articular cartilage and monolayer cultures of HACs were investigated by immunohistochemistry, Northern analysis, RT-PCR and cDNA arrays.

RESULTS AND DISCUSSION:
By immunohistochemistry we detected expression of collagen II, protein S-100, chondroitin-4-sulphate and vimentin in freshly isolated HACs. Cultivated HACs, however, showed only collagen I and vimentin expression. These data were corroborated by the results of Northern analysis using specific cDNA probes for collagens I, II and III and chondromodulin, respectively, demonstrating collagen II and chondromodulin expression in primary HACs but not in cultivated cells. Hybridization of mRNA form primary HACs and cultivated cells to cDNA arrays revealed additional transcriptional changes associated with dedifferentiation during propagation of chondrocytes in vitro. We found a more complex hybridization pattern for primary HACs than for cultivated cells. Of the genes expressed in primary HACs the early growth response (EGR1) transcription factor showed the strongest expression whereas D-type cyclin was expressed in proliferating cells. Other factors associated with differentiated HACs were the adhesion molecules ICAM-1 and VCAM-1, VEGF, TGF[beta]2, and the monocute chemotactic protein receptor.

CONCLUSION:
Our data support the hypothesis that HACs dedifferentiate when grown in monolayer cultures. Moreover, the expression patterns also show that proliferation and differentiation are exclusive features of human chondrocytes.

Paper #10
EXISTENCE OF SLOW-CYCLING CELLS IN MENISCUS:
IMPLICATION ON PRECURSOR CELLS
Eisaku Fujimoto, Hiroshima, JAPAN, Presenter
Anders Lindahl, Gothenburg, SWEDEN
Haruyasu Kato, SWEDEN
Lars Peterson, Billdal, SWEDEN
Department of Clinical Chemistry, Sahlgrenska Univ. Goteborg, SWEDEN

Introduction
Growth and maintenance of regenerating tissues, such as skin, intestine and muscle, are mediated by the slow-cycling stem cells, which represent the proliferative reserve. The slow-cycling stem cells gives rise to the transient amplifying cells, which are responsible for cell amplification and maintenance of the tissue. The aim of this investigation was to study if the rabbit meniscus contains slow-cycling cells in vivo using long term labelling with 5-bromo-2-deoxyuridine (BrdU).

Method
Five week old New Zealand white female rabbits were injected intravenously with BrdU, 25mg/kg/day x 5 days in row. The animals were sacrificed and perfusion fixation were performed at 1, 2, 4, and 8 weeks after the administration. Both medial and lateral meniscuses were fixed in 4% paraformaldehyde and cut radially into 8 pieces per meniscus. Immunohistological analysis was carried out using a monoclonal antibody against BrdU, proliferating cell nuclear antigen (PCNA), and platelet/endothelial adhesion molecule (CD31).

Results
One week after administration, the majority of the cells were stained with both anti- BrdU and anti-PCNA antigens at almost the same region. In the longer observation period of 2, 4 and 8 weeks after injection, many cells continued to be immunostained with the anti-PCNA although the number of BrdU positive cells decreased gradually. However, BrdU positive cells were still found at the attachment of the central-posterior part of the medial meniscus and central part of the lateral meniscus at 8 weeks after the administration. The BrdU positive cells were located in the tissue and not close to the blood vessels, which were identified with anti CD 31 antigen.

Conclusion & Significance
The slow-cycling cells in the meniscus were located at the central-posterior part of the medial meniscus and central part of the lateral meniscus. This information explains the repair potential of the meniscus in this area and open new perspectives in the treatment of sever damaged meniscus where the isolation and culture of the slow cycling cells or local stimulation in situ could be future treatment options.

Paper #11
THE EFFECTS OF HYALURONIC ACID IN THE HEALING OF ACHILLES TENDON REPAIR
Münem Halici, Kayseri, TURKEY
Sinan Karaoglu, Kayseri, TURKEY, Presenter
Özlem Canoz, Kayseri, TURKEY
Sevki Kabak, Kayseri, TURKEY
Ali Baktır, Kayseri, TURKEY
Erciyes University, Kayseri, TURKEY

The aim of our study was to determine whether Hyaluronic acid (HA) treatment had a beneficial effect on the prevention of adhesion and possible role of collagen type IV synthesis of Achilles tendons in rabbits. Despite the importance of tendon healing in Orthopaedic practice, few studies have been performed to systematically examine the healing response of the Achilles tendon after repair. Thirty-two male New Zealand rabbits underwent tenotomy and repair of the left Achilles tendon and were randomized into two groups. 0.5 ml HA or equivalent of saline was injected between the tendon and sheath. The right uninjured lower limb served as an internal control. Histological studies were carried out at 6 and 12 weeks after tendon repair to evaluate the healing of tendons, extent of adhesion and collagen type IV immunostaining. The repaired tendons in the HA-treated group healed better, less peritendinous adhesion, and positive collagen type IV immunostaining than those in the group treated with saline. These findings show that exogenously applied HA may act as a modulator of Achilles tendon fibroblast proliferation, and collagen type IV production, indicating a possible mechanism for anti-adhesive effects following administration of tendon repair.
Introduction: Total ankle arthroplasty (TAA) has become a viable alternative to ankle arthrodesis. In limited clinical series, the early results of modern designs are promising. As encouraging as some results have been, TAA has been plagued with problems such as increasing patient dissatisfaction over time. The complications most commonly include joint impingement, component loosening and talar subsidence. A challenge for ankle prosthetic design is to retain the normal joint biomechanics. To date, almost all ankle prostheses have utilized a cylindrical profile for the talar component. This approach does not conform to the normal biomechanics of the ankle joint since the bony anatomy and ligaments determine the planes and ranges of motion. This study aimed to provide a method to characterize the geometry of the superior dome of the talus. Understanding the geometry of mating surfaces may help achieve desired outcomes of a stable long-term and painless joint replacement. Materials and Methods: Six-cadaveric tali were obtained from fresh-frozen ankles. Each talus was CT scanned in the sagittal plane (Toshiba X-ray CT Scanner X-series, Toshiba Corp, Japan). The image data was manipulated to obtain a surface contour of a bone. The image slices were gathered to create an image volume and develop a 3 dimensional FE model. Contours were extracted from a two dimensional image by selecting a threshold value for the gray scale using an in-house program based on a marching squares algorithm. An FE model was subsequently developed in MSC.Patran (MSC Software Corp, USA). The “images” were imported as a series of 3-D points (with x,y,z co-ordinates) that represented the bone geometry. From this, surfaces were generated and geometric values of the talus calculated. Results: The superior articular (troclear) surface of the talus and its corresponding geometry were created. The radius increases laterally and was characteristic of all specimens analyzed. The average medial/lateral radius of curvature for this study was 0.91. Discussion: From a biomechanical perspective, the relationship between the trochlear surface of the talus and the ligaments is important. The CT/FE method described in this study can be utilized to estimate a plethora of geometric properties. Indeed, an estimate for the area of the entire superior cartilage for each specimen was also investigated. It is known that the trochlear surface of the talus is constituted of two profiles. The lateral profile is an arc of a circle whereas the medial profile is compounded of the arcs of two circles of different radii. The trochlear is curved in such a manner to produce a cone-shaped articulation whose apex is directed medially.

PAPER #13

DIAGNOSIS AND ARTHROSCOPIC TREATMENT OF SUPERIOR LABRUM LESION ASSOCIATED WITH SHOULDER ANTERIOR INSTABILITY: SLAP TYPE V.

Benno Ejnisman, São Paulo, BRAZIL, Presenter
Carlos Vicente Andreoli, São Paulo, BRAZIL
Alberto Pecchini, São Paulo, BRAZIL
Gastão Monteiro, São Paulo, BRAZIL
Eduardo Da Freta Carrera, São Paulo, BRAZIL
Moises Cohen, São Paulo, BRAZIL
Federal University of São Paulo, São Paulo, BRAZIL

We reviewed 200 athletes who had undergone arthroscopic shoulder examination due to pain during sport practice. We found 17 (8.5%) type V SLAP lesions described by Maffet. This lesion is marked by the desinsertion of the superior to inferior glenoid labrum portions, jeopardizing the function of the tendon of the long head of the biceps muscle and the glenohumeral ligaments, which are strucured involved on the joint stability. Sixteen (94%) of the patients presented with anterior shoulder instability. The arthroscopic technique is used on the treatment of these lesions, giving access to the superior labrum, what is not possible with the classic open procedure. Two patients had undergone open surgery previously, and had recurrence of shoulder dislocation. They were submitted to arthroscopic examination and showed healing of the inferior portion of the labrum that was previously repaired, but presented the superior lesion that was not diagnosed on the first surgery. The superior lesion was repaired arthroscopically. The correct diagnosis and treatment of the type V SLAP lesion associated with anterior instability is best accomplished with the use of arthroscopic technique. This lesion is frequently associated with anterior instability and has to be accurately diagnosed and treated to allow the athlete to return to sport practice.

Paper #14

THE RELIABILITY OF MR-ARTHROGRAPHY IN PATIENTS WITH ANTERIOR SHOULDER INSTABILITY

Pol E Huysmans, Amstelveen, NETHERLANDS, Presenter
Victor Van der Halst, Amsterdam, NETHERLANDS
Henk-Jan Van der Woode, Amsterdam, NETHERLANDS
J W Willems, Amsterdam, NETHERLANDS
Onze Lieve Vrouwe Gasthuis (OLVG), Amsterdam, NETHERLANDS

PURPOSE. The MR-arthrography of the shoulder is the imaging modality of choice for patients with anterior shoulder instability. To investigate the reliability of the MR Arthrography we compared the outcomes of the MR-arthrography with those from the shoulder arthroscopy.

METHOD: 22 MR-arthrograms of patients with anterior shoulder instability were reviewed in consensus by 2 radiologists. Labrum, glenohumeral ligaments, rotator cuff, cartilage and bone defects were scored for both MR-arthrography and arthroscopy. The radiologists were not informed about the results of the arthroscopy. The data from the MR-arthrograms were compared with the data obtained from videotapes of the shoulder arthroscopies.

RESULTS: In all 22 cases the anterior labrumlesion was seen on the MR-arthrography (sensitivity 100%). It was not possible with the data from the MR-arthrography to distinguish between the different types of labrum lesions. Lesions from the superior labrum (SLAP) were diagnosed with a sensitivity of 50% and a specificity of 100%. Rotator cuff pathology was present in 6 cases, 5 times it was recognized on the MR-arthrography. There were 5 false-positive findings of cuff-pathology on the MR. MR-arthrography identified the SGHL, MGHL and the anterior band of the IGHL with a sensitivity and specificity of respectively 100% and no true-negative findings, 88% and 50%, 93% and no true-negative findings. The assessment of the quality of the gleno-humeral ligaments with the MR-arthrography did not correspond with the quality and condition found at surgery. All Hill-Sachs lesions (21) were scored by the radiologists, they could not accurately differentiate between a deep (bone) and shallow (cartilage) defect. The specificity (100%) of the MR-arthrography for determining abnormalities of the cartilage of the humeral head or the glenoid is much higher than the sensitivity (17-24%).

CONCLUSION: MR-arthrography of the gleno-humeral joint is an excellent method for determining anterior labrum lesions. More subtle information about the labrum lesions or the con-
Paper #15
SIGNIFICANCE OF POSTOPERATIVE ARTHRO MRI IN PREDICTING 5 YEAR RESULTS OF ARTHROSCOPICALLY TREATED RECURRENT SHOULDER DISLOCATIONS
Franz Landsiedl, Vienna, AUSTRIA, Presenter
Nicolas Aigner, Vienna, AUSTRIA
Matthias Wlk, Vienna, AUSTRIA
Thomas Matyka, Vienna, AUSTRIA
Christian Krasny, Vienna, AUSTRIA
Orthopädisches Spital Wien-Speising, Vienna, AUSTRIA

Aims of the study:
Is it possible to predict the 5 years results of arthroscopically treated recurrent shoulder dislocations by performing a postoperative Arthro MRI?

Material and methods:
30 patients were included in this prospective study. 27 unselected patients with posttraumatic instability were treated using a single or double tunnel transglenoidal suturing technique. In 3 non traumatic patients an arthroscopic in-in-technique with capsular plication and attachment to the intact anterior labrum was performed. In the posttraumatic patients the quality of the labrum ligament complex (LLC) was graded as perfect without any gap or good with minor gaps between glenoid and LLC. Furthermore a capsular width quotient dividing the posterior by the anterior capsular width was calculated. All patients were reevaluated clinically 19 months (range 12-32 months) postoperatively. A second follow up examination was done 63 months (range 51-73 months) postoperatively. Redislocations and resubluxations were graded as failures.

Results:
First follow up 3 failures, second follow up 8 failures. All three non traumatic patients showed a perfect attachment of the plicated capsule to the anterior glenoid. There was one failure. Transglenoidal technique: Perfect reattachment without any gap. 11, failures 2. Reattachment with minor gap: 14, failures 4 (difference n.s.). Unclear situation: 2 failure 1. Capsular width quotient in stable patients 1,82 and in unstable patients 1,69 (difference n.s.)

Conclusion:
According to the results of this study it is not possible to predict the 5 year stability of arthroscopically operated recurrent shoulder dislocations by an Arthro MRI performed 6-8 months postoperatively.

Paper #16
MRI FINDINGS IN SUCCESSFUL ARTHROSCOPIC BANKART RECONSTRUCTIONS
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Pablo Lacruz, Buenos Aires, ARGENTINA
Santiago Butler, Buenos Aires, ARGENTINA
Juan Pablo Previgliano, Capital, ARGENTINA
Enrique Pereira, Capital, ARGENTINA
Daniel Alonso, Capital, ARGENTINA
IDAT, Buenos Aires, ARGENTINA

Purpose: To evaluate the MRI postoperative findings, the accuracy of arthroscopy for labrum relocation and its correlation with the clinical outcome.

Results:
Twenty patients obtained a good or excellent clinical result (Constant 80-100)(UCLA 28-35). In this group of patients the MRI showed accurate labrum relocation with type 1 or 2 labrum reconstruction in all cases except one. Two patients were not satisfied with their outcome due to instability symptoms and pain. One of them had a type 3 labrum location and a type 4 was shown in the other.

Discussion and Conclusions: The findings of our study demonstrate that there is a high correlation between the arthroscopic labrum repair over or at the edge of the glenoid and the satisfactory results. The aim of any arthroscopic reconstruction should be relocate the labrum at the same level or over the glenoid rim.

Paper #17
ARTHROSCOPIC SHOULDER STABILIZATION WITH SUTURE ANCHOR TECHNIQUE IN RUGBY PLAYERS.
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Hugo Montenegro, Buenos Aires, ARGENTINA
Nicolas Carrasco, Buenos Aires, ARGENTINA
Cristian Collazo, Capital, ARGENTINA
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PURPOSE
The purpose of this study is to evaluate the shoulder stabilization in acute and chronic dislocation, mechanics of injuries, surgical findings, types of lesions and results with arthroscopic suture anchor technique in this very controversial topic.

MATERIAL AND METHODS
In a prospective study from September ‘96 to October ‘00, on 119 rugby players with traumatic anterior shoulder instability an arthroscopic procedure was performed. 93 cases were treated with suture anchor technique performed by the senior author.

Exclusion criteria:
- bone defects hill-sachs > ?, glenoid rim fr >= 25% (inverted pear) 16 chronic cases
- big capsular redundancies with inadequate quality of tissue 2 cases
- previous surgery 2 cases
- hypotrophic varieties of capsulolabral complex 2 cases
- impingement and rotator cuff tear 1 case
- acute humeral GHL detachment 1 case
Male patients Mean age 22 years range (14-35) Dominant side 70%

Mechanics of injuries:
The most frequent initial mechanism was fall in flexion, abduction and external rotation (55 %) followed by tackle in extension, abduction and ext. rotation (35%).
Surgical finding
- In acute instability, capsular tear with complete labrum detachment (type III lesion) was found in 11 cases (73.3%), 3 cases (20%) with bone glenoid avulsion. Capsular tear with partial labrum detachment (type II lesion), 3 cases (20%) and in only 1 case (6.6%), capsular tear without labrum detachment (type I lesion). A 75% of osteochondral Hill-Sachs lesions was identified.
- In chronic cases we found in 57 cases (73%) of labrum and GHL detachment (complete or partial) being 25 cases of them (43.8%) A.L.P.S.A. lesions, all this cases had some degree of capsular involvement. Only 6 cases (7.7%) had isolated capsular redundancies (pockets).
- In the 95% of the chronic cases we founded the bone hill-Sachs lesion.

RESULTS
"Rowe scale"
- Suture anchor
  - Acute instability: 13 Excellent, 1 Good, 0 Fair, 1 Poor (6.6%)
  - Chronic instability: 68 Excellent, 3 Good, 0 Fair, 7 Poor (8.9%)
- Results
  - Acute: 15 Rugby cases, 1 Recurrence (6.6%)
  - Chronic: 78 Rugby cases, 7 Recurrence (8.9%)

CONCLUSION
- Significant bone deficiencies were found in chronic cases. In 16 cases was indicated an open surgery. All patients in the acute group were treated with arthroscopic suture anchor technique.
- The most frequent lesion founded in shoulder instability was the labrum detachment, in chronic cases a high percentage of this detachment was ALPSA lesion.
- In all instability cases (acute and chronic) capsular and glenohumeral ligaments were injured. In all the cases different degree of arthroscopic capsulaplication was performed.
- Using the suture anchor technique in rugby players, with a correct patient selection, identifying the type and characteristics of the lesion, with an accurate reconstruction surgical technique, we can obtain over 90% of excellent results.

Paper #18
**ARTHROSCOPIC RECONSTRUCTION OF RECURRENT GLENOHUMERAL INSTABILITY WITH GLENOID DEFICIENCY: A NEW TECHNIQUE FOR MANAGING ANTERIOR-INFERIOR INSTABILITY COMPlicated By SIGNIFICANT BONE LOSS.**

John N Mehalik, Van Nuys, CA, USA, Presenter
Stephen J Snyder, Van Nuys, CA, USA
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Optimal treatment of recurrent anterior-inferior instability of the shoulder remains controversial. There are many reports of heterogeneous groups of patients in the literature suggesting continued superiority of open reconstruction. Others have reported excellent results with anatomic arthroscopic anterior reconstruction in certain patient groups, while attempting to identify situations where open reconstruction may be preferable. In particular, a significant glenoid bony deficiency after fracture-dislocation or chronic instability has been identified as a contraindication to arthroscopic management. In our ten year review of 270 arthroscopic anterior reconstruction procedures performed by a single surgeon (SJS), we have identified 23 shoulders with significant (>15%) glenoid bone deficiency. Our current technique for managing this complex problem has been utilized in the last nine cases. This is an all-arthroscopic ante-

rior reconstruction using titanium screw-in anchors and a posterior-inferior capsular plication using absorbable sutures. To date (average follow-up 18 months), we have had no failures in this group and each has returned to work/sport without restriction. The purpose of this investigation is to review this technique and the early clinical results.

(A Technique Video will accompany this section)

We focused on a study group of nine shoulders in eight patients, who demonstrated a significant glenoid bone deficiency at surgery, treated by the same technique by a single surgeon. The average patient age was 31 years, 8 months at the time of surgery. The patients averaged 18.7 months from the reported injury date until the definitive surgery was performed. The amount of glenoid bone loss noted at surgery averaged 21.1% and each patient was noted to have a Hill-Sachs lesion (average Grade 2). At final follow-up (average 17.9 months), the patients had near full range of motion, with forward flexion 166.7, abduction 164.4, external rotation 65.5, and internal rotation 60 degrees. The average A/P glide was 1 9/5. Each patient returned to work or sport without restriction and reported no pain or instability.

As demonstrated by the video of the technique, anatomic arthroscopic reconstruction, coupled with posterior capsular plication can accurately and reproducibly center the humeral head on the glenoid and provide a stable restraint to anterior-inferior translation. To date, we have had no re-dislocations or subluxations in any patient we have treated with this technique, including a patient with 40% anterior-inferior glenoid bone loss. We feel this technique offers a distinct advantage over open techniques due to the ability to address the plastic deformation in the posterior capsule that accompanies many Bankart lesions. The patients regain full range of motion and are able to return to high demand occupations or sport without instability.

Paper #19
**DIMENSIONS OF THE TRANSFERRED CORACOID PROCESS IN THE LATERJET PROCEDURE**

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Karin van Rooyen, Cape Town, SOUTH AFRICA
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Aim of the study:
To define the anatomic limitations in harvesting the coracoid process, in the treatment of shoulder instabilities with bone loss.

Material and Methods:
100 Dry human scapulae were studied. We measured 1) the distance between the conoid tubercle and the tip of the process, corresponding to the length of the horizontal arm of the coracoid process, and 2) the distance of the vertical ramus of the process and the orifice of the suprascapular notch to the conoid tubercle.

Results:
Coracoid process anterior to the conoid tubercle measured 21.5 mm (SD 0.9 mm). In 10%, it was larger than 30 mm. In 66%, the posterior aspect of the conoid fused with the vertical ramus and the lateral lip of the suprascapular notch.

Discussion:
Arthroscopic treatment of shoulder instability is likely to fail
when critical bone loss has occurred. We previously documented the need for a sufficient size of bone block to prevent recurrence. The amount of coracoid process that can be harvested is limited by the proximity of neural structures and the coracoclavicular ligaments. We measured the horizontal arm of the coracoid process anterior of the conoid tubercle. This amount of coracoid appears to be of a size sufficient to expand the glenoid vault, and to hold 2 AO small fragment screws. It can be safely be harvested if the conoid ligament is respected. Partial sacrifice of the trapezoid ligament is unavoidable but will not compromise coracoclavicular stability. Extending the coracoid osteotomy medial to the conoid tubercle encroaches onto the vertical ramus of the coracoid and can damage the suprascapular nerve. Posterior advancement of the osteotomy can extend into the antero-superior glenoid.

Paper #20
LAG SIGNS IN ACUTE COMPLETE TEARS OF THE SUPRASPINATUS TENDON. DOES A SUBACROMIAL LIDOCAINE INJECTION HELP IN THE CLINICAL DIAGNOSIS? A PROSPECTIVE STUDY
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Anne Katrine Belling Sørensen, Hellerup, DENMARK
Uffe Jørgensen, Hellerup, DENMARK
Marianne Nygaard, Hellerup, DENMARK
Annabel Lee Krarup, Hellerup, DENMARK
Carsten Sloth, Næstved, DENMARK
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Introduction: Compared to other tendon injuries, tears of the rotator cuff tendons may be difficult to diagnose in the acute stage. This may delay treatment and influence the prognosis of surgical repair. Most previous studies on this diagnostic dilemma are retrospective and deal mainly with chronic cuff tears. Hertel et al. showed that simple tests examining the inability to maintain certain positions of the arm, the lag signs, were sensitive for complete tears of the rotator cuff tendons. We hypothesized, that complete tears were indifferent to subacromial lido-caine injection due to loss of tendon integrity, and that this could be a valuable additional diagnostic test in the Emergency Ward. The study was designed to evaluate the value of clinical examination with and without subacromial lido-caine within the first weeks after an acute injury to the shoulder.

Material and Methods: From February 1998 till March 2000, a total of 104 patients with an acute injury to a previous healthy shoulder were included in a prospective diagnostic project comparing clinical findings with ultrasound. Only persons who were unable to active abduct the shoulder above 90 degrees, and whose radiographs showed no signs of fracture or joint dislocation were included. Of these, 29 (9 female, 20 male, median age 55) had a complete tear of the supraspinatus tendon diagnosed by arthroscopy. The patients were evaluated at median 12 (3-49) days after the injury with the classic drop arm test (DAT) and Hertel’s external rotation lag sign (ERLS) specific for supra- and infraspinatus tears with and without subacromial lido-caine injection as well as with ultrasound. The control group consisted of the remaining 75 patients where the combined clinical and ultrasound examination revealed an intact cuff (=IC).

Results: The sensitivity and specificity was 41% and 80% for the DAT and 45% and 77% for the ERLS. After subacromial lido-caine injection the similar figures for the DAT were 19% and 95%, and 19% and 92% for the ERLS. The active abduction at median 12 (3-49) days after the injury improved from median 80 (0-180) degrees to median 110 (20-180) degrees after subacromial lido-caine injection.

Conclusion: The lag signs specific for supraspinatus tears have a low sensitivity and an acceptable specificity in acute cases. After effective pain relief, the sensitivity for both tests was reduced to 19%, whereas the specificity increased. Pain seems to be the limiting factor in maintaining the arm position rather than loss of tendon integrity in an acute rotator cuff tear. Acute complete tears of the supraspinatus tendon cannot be detected by the clinical tests alone.

Paper #21
ULTRASOUND IN THE PRE-OPERATIVE EVALUATION OF PATIENTS WITH RECURRENT ANTERIOR SHOULDER INSTABILITY.
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Olof Lundin, Göteborg, SWEDEN
Adad Baranto, Göteborg, SWEDEN
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Introduction: The purpose of this study was to evaluate the value of Ultrasonography (US) in the pre-operative evaluation of patients with recurrent anterior shoulder instability.

Patients and methods: Thirty-four consecutive patients with unilateral, recurrent instability of the shoulder were included in the study. An experienced radiologist examined all the patients, using a 7.5 MHZ transducer, with the arm in different positions, one of which was used to provoke apprehension of the shoulder. Special attention was paid to evaluation of the joint capsule, the anterior labrum, especially in terms of a Bankart lesion and the anterior ligament-capsular complex. All patients were subsequently operated on. In all patients an arthroscopy of the shoulder was performed, followed by either open or arthroscopic stabilisation of the shoulder.

Results: US disclosed an unstable anterior labrum (equivalent to a Bankart lesion) in 28 patients, the Bankart lesion was verified in all these patients during arthroscopy. In two patients, arthroscopy disclosed an injured labrum, which had healed in an antero-medial position at the scapular neck. In these two cases, US failed to show any lesion. In four cases no Bankart lesion was found at arthroscopy, but increased shoulder laxity. In these cases, US did not show any Bankart lesion, however, a judgement of the joint capsule was not possible in these patients.

Conclusion: The principal finding of the present study was that US showed a high correlation with the arthroscopic findings. There were no false positive investigations and only a few false negative ones. The possibility to perform a dynamic investigation increased the usefulness of the US. It is concluded that US can give important pre-operative information in patients with recurrent, anterior shoulder instability. Further studies are, however, needed in order to be able to evaluate the joint capsule, labral injury, and the size of the ligament-labral injury.

#21
Aim: We report the results of the modified Bankart repair, proposed by Neer, by addition of a capsular shift on the humeral side.

Material and methods: Retrospective study of 77 patients operated for traumatic antero-inferior instability. All of the patients had a Bankart lesion. Detachment of the labrum was closed with suture and polyethylene anchors (TAG, Acufex), before a capsular shift was performed. Independent observers examined 64 of the 77 patients (83%) at a mean follow-up period of 45 months (24 to 120). The patients were young (average 27 years), and athletic (89%). 39 patients presented with recurrent dislocations, 18 patients presented with recurrent subluxations and 7 patients presented with painful and unstable shoulders.

Results: According to the Rowe and Duplay scores, the results were excellent in 27 cases, good in 22 cases, moderate in 9 cases and poor in 6 cases. A recurrence of instability was observed in 7 cases (12%), at an average of 25 months following operation (7 days to 6 years) in the form of dislocation (2 cases) or subluxation (5 cases). In 5 cases a traumatic cause was found. Among factors associated with the recurrence, we noted young age (< 20 years), hyperlaxity (ER > 85°), high risk sports, a large Hill-Sachs fracture, a stretched and poor capsule, and a large number of preoperative dislocations or subluxations (> 5). No true osteoarthritis with glenohumeral joint narrowing was observed at the last follow-up.

Discussion/Conclusion: The operation of Bankart modified by Neer produces stable, “virgin” and well-functioning shoulders in the majority of patients. Nevertheless, the results in terms of stability in this series are not as good than those reported in literature specifically in a young and athletic population.

Methods: In this retrospective study, we treated 46 patients (31 men and 15 women) at the age of 29.7 (19-43) with the diagnosis post-traumatic antero-inferior shoulder instability with an arthroscopic stabilization. The patients were divided in two groups: In the first group with 25 patients we performed a capsule-labrum retraction with Fastak-anchors. In the second group (21 patients), we performed additionally a capsular shrinkage of the antero-inferior joint capsule with the Holmium-Yag-laser. The re-examination was done in a postoperative time of 21.8 months (17-27). The results were determined by the subjective patient opinion, the relaxation rate and the change in the Constant-Score.

Discussion: There was no significant improvement regarding the relaxation rate, the subjective patient satisfaction and the obtained Constant Score by additionally performing capsular shrinkage of the antero-inferior joint capsule, as by the exclusive capsule-labrum retraction. The anatomical reconstruction of the capsule-labrum-complex seems to be the crucial component in the arthroscopic stabilization regarding to the postoperative results.

Introduction: Damage to the antero-inferior capsule tissues is common shoulder injury following an anterior dislocation. Open and arthroscopic techniques can be used to repair the capsulolabral structures using transosseous sutures or a range of suture anchor devices. In general, clinical results of open procedures remain superior compared to arthroscopic. This may reflect differences in technique and apposition of soft tissue to bone. This study examined the contact force and contact area at the glenoid labrum-bone interface in an open transosseous Bankart repair and in a rabbit patella tendon model between the suture sites and to assess how tying adjacent sutures to each other alters these contact parameters.

Methods: Twelve Bankart capsulolabral avulsion lesions were created in fresh-frozen human shoulder specimens (mean age 53 years old) using a # 10 blade. The lesions were repaired with a standard transosseous suture technique using # 2 Ethibond (Ethicon, Sommerville, NJ). The patellar-tendon proximal tibia interface was examined in a rabbit model. The patella tendon (PT) was isolated off the tibial tubercle and freed from surrounding retinacular structures by sharp dissection. The PT was repaired to the proximal tibia using 2 mini anchors (Mitek, Westwood, MA) and sutured with 2-0 Ethibond (Ethicon, Sommerville, NJ). The contact force and area at the labrum-bone interface in the shoulders or the patella tendon-tibia interface between sutures was measured using an electronic pressure sensor (Iscan 6911, TekScan, South Boston, MA) (figure 1). A single or double strand knot was tied between adja-
cent suture sites and the contact area and force recorded for up to 10 minutes. Data was analysed using a Students t-test using (Statistica, Statsoft, Tulsa, OK).

Results Contact the contact force and area increased significantly when a single or double strand of suture was tied over the soft tissue bridge. Figure 2 demonstrates and example of a double strand repair. A peak in force was observed as the sutures were tied which relaxed with time. The double strand technique resulted in a greater mean contact force and area compared to the single strand technique at equilibrium (single strand average force=70.1g, area=6.75mm²; double strand average force=95.15g, area=8.0mm²; p<0.05). Similar results were found in the rabbit PT model.

Discussion The contact conditions at the tissue-bone interface are increased when suture strands from adjacent transosseous repair sites are linked. Increasing contact force or contact area may improve healing at the bone-soft tissue interface, and reduce the risk of ‘spot welding’ repairs. This, in turn, may reduce the failure rate of Bankart repairs following open or arthroscopic surgery but remains to be determined from clinical results.

Paper #25
MEASUREMENT OF TENSION FORCE IN A BUCKET HANDLE MENISCUS LESION USING A HUMAN CADAVER MODEL
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Karl-Heinz Gröbel, Magdeburg, GERMANY
Wolfram Neumann, Magdeburg, GERMANY
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INTRODUCTION: New biodegradable meniscus implants have been developed recently and several studies investigated the biomechanical properties of these meniscus-implant-complexes (2). The amount of force acting on a meniscal lesion remains unclear. The purpose of the following study was to investigate the tension force acting at the inner part of a bucket handle lesion using a human cadaver model.

MATERIAL & METHODS: Human cadaver knees with intact menisci and no signs of cruciate or collateral ligaments deficiency were used for testing. The knees were mounted in a special tibial and femoral holder, considering the 6 degree of freedom of the joint and fixed to a material testing machine (TIRATEST 2425). A Steinmann-pin was inserted through to the patella in a horizontal fashion and fixed to the femur via a chain (TIRATEST 2425). A Steinmann-pin was inserted through to the patella in a horizontal fashion and fixed to the femur via a chain in order to simulate the quadriceps force. Axial loading of 700 N was applied to the knee joint by the material testing machine. A bucket handle tear of 25mm at a distance of 3mm from meniscosynovial rim was created at the posterior horn of the medial meniscus. The inner portion of the bucket handle lesion was refixed with a single 2/0 suture wire. The wire was connected to a specially designed little tension sensor, which was anchored at the periphery of the meniscus. For the creation of the meniscus lesion the medial and lateral collateral ligament was detached temporarily from the femur. Under axial loading of 700N the tension force at the meniscus lesion during internal and external rotation was measured. Each testing was repeated eight times at 0°, 20° and 40° of knee flexion using internal and external rotation.

RESULTS: The average tension force at the meniscus lesion under internal and external rotation in 0° of knee flexion was 2.43±1.21N and 2.23±0.49N respectively. In 20° of knee flexion under the same internal and external rotation the tension force yielded 2.59±0.73 N and 1.61±0.74 and under 40° of flexion 1.09±0.19N and 1.38±0.08N respectively. No significant difference was observed between the applied internal and external rotation at 0°, 20° and 40° of knee flexion. Significantly lower force was found under 40° of knee flexion in comparison to full extension (p<0.05).

DISCUSSION: The results have shown, that tension force at a meniscus lesion under axial and rotation force are very low. In the current study lesions close to the meniscosynovial rim were tested. It remains questionable whether forces at the meniscus lesion will increase in case of a torn anterior cruciate ligament. Allen et al (1) found significantly higher resultant forces at the medial meniscus, but the testing as not performed under axial loading. Good intrinsic healing capacity of the meniscus periphery but also low tension forces at the lesion seems provide a good chances for healing of meniscal lesions. Biomechanical studies of different refixation devices have shown superior pull-out strength and one can conclude that the implants provide sufficient stability for refixation of torn menisci.


Paper #26
MRI – ANALYSIS OF THE DEFORMATION OF HEALTHY, REPAIRED MENISCI AND MENISCUS ALLOGRAFTS UNDER SEVERAL LOADING CONDITIONS AND ANGLES OF FLEXION
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Carsten Tilskeu, Muenster, GERMANY
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Purpose: The aim of this study was to evaluate the deformation of the menisci under weight bearing conditions in full extension and 30° of flexion in 15 healthy knees of 15 young volunteers, 5 meniscal allografts and 10 refixed menisci by means of MRI.

Material and Method: Sagittal T1-weighted MR images of 15 volunteers with intact knees were studied. The subjects (9 men, 6 women, mean age 30 years) had their feet placed in a specially made holder that allowed measurement under loading conditions. Images of the medial meniscus and the lateral meniscus were obtained in extension and in 30° of flexion. Two independent observers each performed two measurements of the height of the posterior horns, and the internal and external distance between the anterior and posterior horns of the menisci.

Results: The mean height of the posterior horn of the medial meniscus was 6.8 mm, that of the posterior horn of the lateral meniscus was 7.6 mm. With 50% weight-bearing (MM 6.3 mm, LM 7.2 mm), and full weight bearing (MM 6.0 mm, LM 6.9 mm) there was a statistically significant decrease in meniscal height (t-test for related samples, p<0.05). At constant weight-bearing and a change in knee position (0° vs 30°), there was no signifi-
cant difference. The mean internal interhorn distance was 19.9 mm for the medial meniscus, and 12.3 mm for the lateral meniscus. Both with 50% weight-bearing (MM 22.6 mm, LM 12.9 mm) and with full weight-bearing (MM 24.3 mm, LM 13.9 mm), there was a statistically significant increase in the distance (p>0.05). Knee position did not statistically affect the internal interhorn distance. The mean external interhorn distance was 44.6 mm for the medial meniscus, and 34.4 mm for the lateral meniscus. Both with 50% weight-bearing (MM 45.1 mm, LM 35.1 mm) and with full weight-bearing (MM 45.7 mm, LM 35.8 mm), there was a statistically significant increase in this distance (p<0.05). When the loading was kept constant and the knee position varied from 0° to 30°, there was a statistically significant decrease in the external interhorn distance of both the medial and the lateral meniscus. The small group of allo-
grafts and the repaired meniscus had a similar biomechanical behavior as the uninjured menisci.

Conclusion: (1) The height of the posterior horn of the medial and the lateral meniscus decreases with loading. (2) The internal distance between the anterior and posterior horns increases with loading. (3) The external interhorn distance increases with loading. (4) Knee position significantly affected the external interhorn distance only. This MRI analysis of the biomechanical behaviour of the menisci could serve as a benchmark for subsequent studies of repaired or transplanted menisci.

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**Paper #27**
**DYNAMIC MR PERFUSION IMAGING ASSESSMENT OF MENISCAL REPAIR**

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Richard Bleakley, Toronto, CANADA
Lawrence White, Toronto, CANADA
David Salonen, Toronto, CANADA
Moore Morelli, Toronto, CANADA
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**Background:**
The MR imaging assessment of the postoperative meniscus following meniscal repair is complicated by persistent surfacing intrameniscal signal intensity on short echo-time images, a classic MR imaging criterion of a primary meniscal tear, which may be seen at the site of a meniscal repair despite histologic and arthroscopic evidence of healing.

**Purpose:**
To assess the potential of gadolinium enhanced dynamic MR perfusion imaging as a noninvasive method of detecting vascularity, a requisite for successful meniscal healing, at the site of a meniscal repair. To preliminarily investigate the potential utility of dynamic MR perfusion imaging as a means of differentiating normal physiologic changes of early healing or repair maturation from imaging findings of a nonhealed residual or recurrent meniscal tear.

**Methods and Materials:**
21 gadolinium enhanced dynamic perfusion MR imaging studies were performed in 7 patients at 6, 12 and 24 weeks post arthroscopic meniscal repair. All MR imaging was performed on a 1.5 Tesla MR imaging system utilizing a dedicated extremity quadrature coil. In all cases conventional MR imaging (sagittal and coronal proton density, sagittal and axial T2 weighted) preceded dynamic perfusion MR acquisitions. Dynamic perfusion imaging consisted of rapid sequential (temporal resolution 1.5 sec) single slice spoiled gradient recalled echo imaging (TR 13.2, TE 2.7, Flip 30°) performed in the sagittal plane through the site of the meniscal repair concurrent with the bolus intravenous injection of gadolinium contrast material (0.1 mmol/kg). MR imaging studies were assessed by two muscu-
oskeletal radiologists for conventional MR imaging signal intensity changes and dynamic perfusion findings at the repair site. In all cases imaging findings were correlated to findings at clinical physical examination.

**Results:**
In all studies (21/21, 100%) surfacing increased proton density and T2 weighted signal intensity was seen on conventional MR imaging studies at the site of meniscal repair. Dynamic perfusion MR imaging showed rapid intrameniscal enhancement in a linear pattern along the meniscal repair site in all cases. In 2 patients (6 studies) perfusion imaging at the repair site was partially degraded by susceptibility artifacts related to surgical instrumentation or suture material. Physical examination illustrated indirect findings of early successful meniscal repair in all patients.

**Conclusions:**
Dynamic perfusion MR imaging allows for the noninvasive evaluation of early vascularity at the site of a meniscal repair in patients with clinical and physical findings of successful meniscal repair. Such imaging findings may prove of benefit in the assessment of successful meniscal repair and associated healing, and differentiation of such findings from cases of failed repair or recurrent meniscal tears.

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**Paper #28**
**MENISCUS REPAIRS: A 12 YEAR REVIEW.**

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**Purpose:**
Classical teaching suggests that recent, peripheral and vertical meniscal tears in young people are repairable. This study reviewed meniscus repairs over a 12 year period. In particular, other more difficult meniscal tears including radial, avulsion and complex tears were repaired in all age groups and at varying times from injury.

**Methods:**
A database and chart review of meniscus repairs undertaken during the 12 years since 1990 was undertaken. Patients were followed clinically for up to 12 months or until fully functional. Longer follow up of the more difficult cases was undertaken. Repeat arthroscopy or MR scanning was undertaken only rarely for clinical reasons.

**Results:**
There were 288 menisci repaired in 265 patients. There were 192 medial and 96 lateral menisci. There were 181 males and 84 females with a mean age of 26.6 years (12 – 70). Most patients had concurrent ACL reconstruction surgery but 55 had isolated meniscus repairs. While most tears were vertical, 9 were radial and 22 were complex in nature. Specific techniques were developed for these cases. A mean of 3.63 sutures (or devices) were used (1 – 12). Failure based on clinical grounds is known to have occurred in only 10 patients with 7 of these being re-

**Conclusions:**
Repairing a torn meniscus is beneficial to the patient in the long term. If the meniscus is suitable for repair and a techni-
cally good repair is undertaken then healing can be expected in the majority of cases. Even some of the more difficult and complex tears can heal if treated appropriately.

**Paper #29**

**REPEAT MENISCUS REPAIR**

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Eighteen consecutive repeat meniscal repairs were performed over an eleven year period, 17 by the senior author (KED) and 1 by another surgeon. At most recent follow-up 14 of 18 patients (13 repeat meniscus repairs and 1 second repeat meniscus repair) had clinically intact menisci. These patients (14 knees) comprised the study group. All were available for follow-up with a mean follow-up after repeat meniscal repair of 7.33 years (range 3.25 to 13.75 years). The average durability of the initial repair was 3.46 years (range 0.17-14.67 years). Five patients post-operatively sustained a tear of the meniscus at the site of re-repair. Four of these patients underwent partial meniscectomy. Excluding these four patients, the mean Lysholm score for the remaining 14 patients was 82.1 (range, 38-100). The mean Tegner score for this group was 5.6 (range, 2-8). On IKDC rating, five knees received an overall grade A score (normal), six knees received an overall grade B score (nearly normal), and three knees received an overall grade C score (abnormal). Ten of the 14 knees in the study had follow-up of 5 years or greater after repeat meniscus repair. Weightbearing AP radiographs were obtained with the knee in full extension and in 45° flexion on these 10 knees. The radiographs revealed grade 0 changes (normal) in 5 of the involved knee compartments and grade 1 changes (sclerosis or mild narrowing measuring 1-2mm) in the remaining five. We note that repeat repair of suitable return menisci has a 72% survival rate to date. This appears to be somewhat lower than that associated with primary repair. However, repeat repair in suitable cases provides relief of symptoms and allows return to strenuous levels of function for most patients, while appearing to preserve the biomechanical role of the meniscus.

**Paper #30**

**COLLAGEN MENISCUS IMPLANTS (CMI): MULTICENTER CLINICAL TRIAL RESULTS AND LONG TERM FOLLOW-UP**

William G Rodkey, Vail, CO, USA, Presenter

J. Richard Steadman, Vail, CO, USA

Steadman Hawkins Clinic, Vail, CO, USA

PURPOSE: A collagen based material, the Collagen Meniscus Implant (CMI), was developed as a regeneration scaffold for meniscus cartilage and was tested in US feasibility studies then in international multicenter clinical trials. The initial purpose was to assure safety, implantability, and ability of the CMI to support new tissue ingrowth, then to establish clinical efficacy.

METHODS: The CMI is made of purified type I collagen fibers from bovine Achilles tendons. Proteoglycans, including hyaluronic acid and chondroitin sulfate are added, and the material is aldehyde cross-linked and terminally sterilized with gamma irradiation. The positive results of a Phase II feasibility study of 8 patients led to FDA Investigational Device Exemption (IDE) approval of a large multicenter randomized (CMI versus meniscectomy alone) clinical trial of 288 patients in the United States. These 288 patients were enrolled at 14 sites throughout the US. Additionally, about 100 non-randomized patients were enrolled at 10 sites in Europe and two sites in Japan. Current indications for use of the CMI include partial medial meniscus loss with intact rim and no Grade IV chondral defects. Patients in the US multicenter trial underwent frequent clinical exams and relook arthroscopy with biopsy at one year post-implantation. Phase II feasibility study patients underwent relook arthroscopy at 6 or 12 months with biopsy and then again 5 to 6 years after implantation.

RESULTS: No serious or life-threatening complications have been attributed to the CMI. Patients routinely returned to daily activities by 3 months and most were fully active by 6 months, then continued to improve through at least two years as evidenced by Tegner and Lysholm scores. ELISA testing failed to detect any increase in antibodies to the collagen material. No increased degenerative joint disease was observed, nor was there radiographic evidence of further joint space narrowing. Sequential MRI examinations revealed progressive signal intensity changes indicating ongoing tissue ingrowth, regeneration, and maturation of the new tissue. At relook arthroscopy, gross appearance and shape of the regenerated tissue generally were similar to native meniscus cartilage with solid interface to the host meniscus rim in the majority of patients. Histologically, the collagen implant was progressively invaded and replaced by cells similar to meniscocellulars with production of new matrix. No inflammatory cells or histologic evidence of immunologic or allergic reactions were observed. Approximately 100 patients in the US multicenter trial have now undergone one year relook and biopsy. Average Lysholm scores for the eight Phase II feasibility patients improved from 75 at the time of the index surgery to 5 to 6 years earlier to 88 at final follow up. Average Tegner Activity Scores improved from 3 at index surgery to 6 at final evaluation. Similarly, patient self assessment improved from 2 to 4 to 1 to 0 to 1 (1=normal, 4=severely abnormal), and the Visual Analog Pains Scale improved from 23 to 11 (0=no pain, 100=worst pain). The initial relook revealed 76% defect filling, and those patients continue to have 70% of the defect filled 5 to 6 years later. The tissue appears stable and virtually unchanged since the initial relook.

CONCLUSION: The Collagen Meniscus Implant is implantable, biocompatible, and bioresorbable. It supports new tissue regeneration as it is resorbed, and the new tissue appears to function similar to normal meniscus tissue. Based on the relook procedures, the chondral surfaces are protected by the CMI-regenerated tissue for at least 6 years. No serious or life-threatening complications directly related to the CMI have thus far been reported, and most patients are functioning well based on clinical examination and outcomes assessment. Relook arthroscopy results are positive and encouraging, even through 6 years post-implantation. Similar positive European observations resulted in obtaining the EU CE mark in 2000. Regulatory approvals are currently pending in Japan and Australia. The use of the CMI in the US continues under the FDA IDE study, and final US FDA approval has not yet been received.

**Paper #31**

**PATIENT FUNCTIONAL OUTCOMES 5-YEARS FOLLOWING ALLOGRAFT MEDIAL MENISCUS TRANSPLANTATION**

David N M. Cal boredom, Louisville, KY, USA, Presenter

John Nyland, Louisville, KY, USA

Peter Hester, Louisville, KY, USA

University of Louisville, Louisville, KY, USA

Purpose: To describe patient functional outcomes at 5-Years following allograft medial meniscus transplantation.

Materials and Methods: Eight patients (51 +/- 5 years of age, 3 female, 5 male) who were 55 +/- 0 years status-post allograft...
MEDIAL MENISCUS TRANSPLANTATION RESPONSSED TO LIKERT-TYPE CAT-EGORICAL SCALE QUESTIONS ON A MAILED SURVEY (MENISCUS ALLOGRAFT CLINICAL REGISTRY, CRYOLIFE, MARIETTA, GA) ABOUT PRE- TO POST-SURGERY CHANGES IN KNEE JOINT FUNCTION, OVERALL ACTIVITY LEVEL, PERCEIVED KNEE JOINT STABILITY, ABILITY TO WALK WITHOUT A LIMP, AND THEIR ABILITY TO SQUAT, STAIR CLIMB, KNEEL, RISE FROM A CHAIR, RUN, JUMP, AND STOP AND START QUICKLY DURING GAIT. SUBJECTS ALSO COMPLETED TWO 10 CM VISUAL ANALOG PAIN LEVEL SCALES (END RANGE DESCRIPTORS 0 = NO PAIN AND 10 = PAIN AS BAD AS POSSIBLE) FOR OVERALL PRE-SURGERY AND POST-SURGERY PAIN. PRE- AND POST-SURGERY MEDIAN VALUES WERE DETERMINED FOR CATEGORICAL VARIABLES AND WERE STATISTICALLY EVALUATED USING A SERIES OF MANN-WHITNEY U TESTS. PRE- AND POST-SURGERY MEAN PAIN LEVEL VALUES WERE DETERMINED AND WERE ASSESSED STATISTICALLY USING A ONE-WAY ANOVA (P < 0.05). SUBJECTS WERE ALSO ASKED IF THEY WOULD UNDERGO MENISCAL TRANSPLANTATION AGAIN GIVEN THE SAME SITUATION AND IF THEY CONSIDERED THEIR SURGERY TO HAVE BEEN A SUCCESS.

RESULTS: STATISTICALLY SIGNIFICANT PRE- AND POST-SURGERY DIFFERENCES WERE OBSERVED FOR RISING FROM A CHAIR (3 = MODERATELY DIFFICULT TO 5 = NOT DIFFICULT AT ALL, P = 0.03), PERCEIVED STABILITY (3 = KNEE GIVES WAY OCCASIONALLY IN DAILY ACTIVITIES TO 6 = KNEE NEVER GIVES WAY, P = 0.04), LIMPING (2 = SLIGHT TO 3 = NONE, P = 0.03), STOPPING IN TRAFFIC QUICKLY DURING GAIT (2 = EXTREMELY DIFFICULT TO 4 = MINIMALLY DIFFICULT, P = 0.03), JUMPING AND LANDING ON THE INVOLVED LEG (1 = UNABLE TO DO TO 4 = MINIMALLY DIFFICULT, P = 0.004), STRAIGHT AHEAD RUNNING (3 = MODERATELY DIFFICULT TO 5 = NOT DIFFICULT AT ALL, P = 0.03), SQUATTING (2 = MODERATELY IMPAIRED TO 4 = NO PROBLEMS, P = 0.02) AND CLIMBING STAIRS (3 = UP AND DOWN WITH A HAND RAIL TO 5 = NORMAL, P = 0.03). VISUAL ANALOG SCALE PAIN LEVELS WERE SUBSTANTIALLY REDUCED (7.6 +/- 2 CM VS. 0.8 +/- 0.6 CM, P < 0.0001). THE MAJORITY OF PATIENTS (7/8, 87.5%) reported that they would undergo meniscal transplantation again given the same situation and that they considered their surgery to have been successful.

CONCLUSIONS AND SIGNIFICANCE: IN ADDITION TO SUBSTANTIALLY REDUCED PERCEIVED PAIN, LIMPING, AND INSTABILITY, AT 5-YEAR POST ALLOGRAFT MEDIAL MENISCUS TRANSPLANTATION PATIENTS REPORTED SIGNIFICANT IMPROVEMENTS IN FUNCTIONAL ACTIVITIES INCLUDING RISING FROM A CHAIR, STOPPING AND STARTING QUICKLY DURING GAIT, JUMPING AND LANDING ON THE INVOLVED LEG, RUNNING STRAIGHT AHEAD, SQUATTING, AND CLIMBING STAIRS. THESE RESULTS PROVIDE ENCOURAGING SUPPORT FOR THIS SURGICAL PROCEDURE. DATA COLLECTION CONTINUES AS ADDITIONAL PATIENTS REACH 5-YEAR POST-SURGERY.

**Paper #33**

**THE FAMILIAL PREDISPOSITION TOWARD TEARING THE ANTERIOR CRUCIATE LIGAMENT**

Kevin Flynn, London, CANADA
Cheryl Pedersen, London, CANADA
Trevor Birmingham, London, CANADA
Alexandra Kirkley, London, CANADA
Peter J. Fowler, London, CANADA, Presenter
University of Western Ontario, London, CANADA

**PURPOSE:** A CASE-CONTROL STUDY OF 130 SURGICAL CASES AND 130 MATCHED CONTROLS WAS CONDUCTED TO INVESTIGATE WHETHER THERE IS A FAMILIAL PREDISPOSITION TOWARD TEARING THE ANTERIOR CRUCIATE LIGAMENT (ACL) OF THE KNEE.

**METHOD:** PATIENTS WHO HAD UNDERGONE ACL RECONSTRUCTION WERE MATCHED WITH INDIVIDUALS WITHOUT AND ACL INJURY FOR AGE, GENDER, AND ACTIVITY LEVEL. ALL 260 SUBJECTS COMPLETED A QUESTIONNAIRE DETAILING THEIR FAMILY HISTORY OF ACL INJURIES.

**RESULTS:** CHI SQUARE ANALYSIS INDICATED THAT A SIGNIFICANTLY GREATER (P<0.05) NUMBER OF SURGICAL CASES (41 SUBJECTS, OR 31.54%) HAD AT LEAST ONE RELATIVE (FIRST, SECOND, OR THIRD DEGREE) WITH AN ACL INJURY COMPARED TO THE MATCHED CONTROLS (24 SUBJECTS, OR 18.46%). INDIVIDUALS WITH AN ACL TEAR WERE TWO TIMES MORE LIKELY TO HAVE A RELATIVE WITH AN ACL TEAR COMPARED TO INDIVIDUALS WITHOUT AN ACL INJURY (ODDS RATIO = 2.03, 95% CONFIDENCE INTERVAL = 1.14 TO 3.63). WHEN EXPRESSED AS THE PERCENTAGE OF THE TOTAL NUMBER OF RELATIVES, THERE WAS A GREATER PROPORTION OF RELATIVES WITH ACL INJURIES IN THE SURGICAL CASE GROUP (64 OUT OF 1582 RELATIVES, OR 4.05%) COMPARED TO THE CONTROL GROUP (36 OUT OF 1626 RELATIVES, OR 2.21%).

**CONCLUSION:** THESE RESULTS SUPPORT THE SUGGESTION THAT A FAMILIAL PREDISPOSITION TO ACL INJURIES EXISTS.
PAPER ABSTRACTS

Paper #34
ARTHROSCOPICALLY ASSISTED ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION. AN ANALYSIS OF IMPACT ON HEALTH-RELATED QUALITY OF LIFE AND KNEE FUNCTION
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Alessandro Beccarinì, Perugia, ITALY
Stefano Lupparrèlì, Perugia, ITALY
Sergio Cecconi, Perugia, ITALY
Centro Ortopedico Umbro - Perugia, Perugia, ITALY

Purpose: A prospective case-series patient-centered study evaluating Health-Related Quality of Life and knee function in patients affected by anterior cruciate ligament (ACL) lesion treated with arthroscopically assisted anterior cruciate ligament reconstruction.

Materials and Methods: there were 60 patients (37 males and 23 females, mean age 30.73 ± 7.97 SD years) affected by ACL lesion as confirmed by arthroscopy. All patients were treated with arthroscopically assisted ACL reconstruction. A bone patellar tendon bone graft was employed in 40 patients, double looped semitendinosus and gracilis graft being used in the remaining 20 patients. The SF-36 and Lysholm score were administered preoperatively, at 6 months and at 12 months from surgery to assess Quality of Life and knee function respectively. The SF-36 pre-operative scores were compared with an Italian age-matched healthy control group (n = 367) as published in the Literature. A comparison between subjective and objective post-operative outcome was also performed. One sample t-test, ANOVA for repeated measures and Tukey’s test were used for statistics (P < 0.05).

Results: The mean pre-operative SF-36 domain scores were PF 76.13 ± 22.13 SD; RF 41.47 ± 37.50 SD; BP 63.34 ± 22.24 SD; GH 77.81 ± 16.09 SD; VT 62.18 ± 17.15 SD; SF 69.82 ± 23.50 SD; RE 58.76 ± 42.79 SD; MH 66.32 ± 19.16 SD. All domain scores but GH significantly differed from an age-matched healthy control group. The mean post-operative SF-36 domain scores at 6 months were PF 89.21 ± 11.42 SD; RF 72.36 ± 34.28 SD; BP 75.89 ± 21.31 SD; GH 80.94 ± 12.69 SD; VT 70.39 ± 12.96 SD; SF 83.47 ± 17.17 SD; RE 83.36 ± 28.75 SD; MH 74.95 ± 16.28 SD. All domain scores but RF did not significantly differ from an age-matched healthy control group. The mean post-operative SF-36 domain scores at 12 months were PF 93.94 ± 10.01 SD; RF 92.76 ± 16.34 SD; BP 84.94 ± 18.05 SD; GH 81.78 ± 14.72 SD; VT 72.23 ± 16.91 SD; SF 90.00 ± 12.48 SD; RE 95.66 ± 11.30 SD; MH 78.63 ± 14.59. All domain scores related to physical health did not significantly differ from an age-matched healthy control group. Scores related to mental health were significantly higher than the norm. The mean pre-operative Lysholm score was 69.92 ± 12.73 SD, at 6 and at 12 months was 89.08 ± 9.30 SD and 92.15 ± 10.30 SD respectively.

Conclusion: Patients with ACL lesion exhibit a significant worsening of their Quality of Life in the absence of any other comorbidity factor when compared to age-matched healthy individuals preoperatively. Surgery seems to improve both Quality of Life except for physical-related activities and self-perceived knee performance at 6 months. At 12 months patients exhibit a return to normality as to Quality of life with even an increase in the scores related to mental health. These results would suggest that an ACL tear may deeply affect not only knee function but also patients’ Quality of Life. The latter, however, can be reversed to normality by surgery. Additionally, we suggest that SF-36 should be used to assess the influence of surgery over 12 months.

Paper #35
EXPERIMENTAL STUDY OF ANTERIOR AND INFERIOR LABRAL LESIONS. CONSEQUENCES FOR SHOULDER STABILITY.
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Institut d’Anatomie, Paris, FRANCE

Aim: To determine whether lesions of the glenoid labrum, influence anterior and inferior shoulder stability in a cadaver model that leaves all surrounding soft tissues, including the capsule, intact.

Material and method: Sequential arthroscopic resection of the labrum only was performed in 17 fresh cadaver shoulders. The labrum was divided into five zones: superior, anterosuperior, anteroinferior, inferior and posterior. Inferior and anterior stability were tested at every step.

Results: Inferior stability: in 4 shoulders we found a pre-existing severe sulcus. In 11 shoulders no amount of resection resulted in any degree of inferior translation. Resection of the inferior zone increased inferior translation to a severe sulcus in 2 shoulders that already had lesions of both anterior zones Anterior instability: in none of the 17 shoulders could a dislocation be provoked. In 8 shoulder no amount of instability could be provoked by any amount of resection. In 5 shoulders we found a preexisting moderate (3) to severe (2) anterior drawer. On arthroscopic examination these shoulders had pre-existing lesions in one (moderate drawer) or two zones (severe drawer). In the others 3 shoulders anterior translation increased after resection of one or both anterior zones. Increase in posterior translation never resulted from these resections.

Conclusion: Resection of the anterior labrum can maximally result in subluxation, but not in dislocation of the shoulder. Resection of the superior or inferior part of the labrum does not influence anterior stability. Resection of the anterior and inferior labrum results in an increased inferior translation. Therefore, we propose that pure lesions of the glenoid labrum (with an intact capsule) do not play a consistent role in recurrent glenohumeral dislocation.

Paper #36
REVISITING THE OPEN BARKANT EXPERIENCE IN A LONGTERM FOLLOW-UP
Lennart Magnusson, Västerås, SWEDEN, Presenter
Jari Toomas Kartius, Trollhättan, SWEDEN
Lars Ejerhed, Uddevalla, SWEDEN
Ingrid Hultenheim, Göteborg, SWEDEN
Lennart Magnusson, Västerås, SWEDEN, Presenter

Purpose of the study: To make an unbiased long-term evaluation after open Bankart reconstruction.

Materials and methods: Fifty-four patients (54 shoulders) with symptomatic, recurrent, anterior post-traumatic shoulder instability were operated on using an open Bankart reconstruction procedure involving suture anchors. All the patients had a Bankart lesion. Forty seven/54 (87%) of the shoulders were re-examined by independent observers, after a mean follow-up period of 69 (48-114) months.

Results: The recurrence rate, including both dislocations and subluxations, was 8/47 (17%). The Rowe score was 90 (24-100) points at the follow-up and the Constant score was 88.5 (41-
100) points. The external rotation in abduction was 90 (25-125) degrees, as compared with 97.5 (60-125) degrees for the non-injured shoulders (p<0.0001).

Conclusions: In the long-term, the open Bankart procedure revealed an unexpectedly high number of patients with failure in terms of stability. The results of the present study emphasise the importance of performing unbiased long-term follow-up studies after the surgical reconstruction of anterior, post-traumatic shoulder instability using any type of technique.

**Paper #37**

**MOTION FRACTION ANALYSIS FOR EVALUATION OF FUNCTIONAL RECOVERY AFTER BANKART REPAIR OF SHOULDER INSTABILITY**

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Koing-Woo Kwun, Taegu, KOREA
Skin-Kun Kim, Taegu, KOREA
Sang-Wook Lee, Korea, KOREA
Dong-Kyu Shin, Taegu, KOREA
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**Purpose:** To develop an objective guideline for muscle coordination during rehabilitation after shoulder instability repair, we serially compared glenohumeral to scapulothoracic motion fraction after arthroscopic and open Bankart repair.

**Materials & Methods:** We reviewed 24 patients of anterior shoulder instability treated from May, 1996 to June, 1999. Arthroscopic Bankart repair was in 16 cases and open Bankart repair was in 8 cases. Average age was 26 years old and involved in dominant arm in 15 cases. Patients suffered instability for 3.1 years before operation and mean follow-up was 2 year 9 months (1 year 9 months - 4 year 10 months). Glenohumeral to scapulothoracic motion fraction recovery was compared to functional recovery of Rowe's Bankart Grading scale.

**Results:** At six months follow up, motion fraction was recovered in full elevation but delayed recovery in 90 degrees elevation in both arthroscopy and open group. Average 2.3 years follow up, motion fraction was recovered in both 90 degree and full elevation in arthroscopy group. Average 2.8 years follow up, still delayed recovery in 90 degrees elevation in open group. In arthroscopic surgery, 2 cases (13%) were redislocated, and 4 cases (25%) showed mild instability. In open case, 1 case (13%) showed mild instability. According to functional result by Rowe grading scale, satisfactory results were 12 cases (76%) in arthroscopic repair and 7 cases (88%) in open cases.

**Conclusion:** Motion fraction could be the guideline for rehabilitation program to avoid reinjury and promote muscle coordination exercise in both arthroscopic and open Bankart repair of shoulder instability.

**Paper #38**

**ACCELERATED REHABILITATION AFTER ARTHROSCOPIC BANKART REPAIR**

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Kwon-Ick Ha, Seoul, KOREA
Min-Wook Jung, Seoul, SOUTH KOREA
Moon-Sup Lim, Pusan, SOUTH KOREA
Young-Min Kim, Seoul, SOUTH KOREA
Jong-Hyuk Park, Seoul, SOUTH KOREA
Samsung Medical Center, Seoul, SOUTH KOREA

**Background:** An increased stress within a certain limit enhances healing of a ligament and improves function of the joint. In this prospective randomized clinical trial, we compared the clinical results of early motion versus the conventional immobilization after the arthroscopic Bankart repair in the selected patient population.

**Methods:** We performed an arthroscopic Bankart repair using suture anchors in sixty-two patients with traumatic recurrent anterior instability of the shoulder and randomized them into two groups; Group I (twenty-eight patients; mean age, 28 years) was managed with three weeks of immobilization using an abduction sling and conventional rehabilitation program, and Group II (thirty-four patients; mean age, 29 years) was managed with an accelerated rehabilitation program, which consisted of staged range of motion and strengthening exercises, from the immediate postoperative day. Selection criteria of patients were non-athletes with recurrent anterior shoulder instability who have a classic Bankart lesion with a robust labrum. The patients were followed for a mean of thirty-one months (range, twenty-seven to forty-five months; Standard deviation, nine months). Analysis of outcome included pain scores at the first six weeks and at the final follow up, range of motion, return to activity, recurrence rate, patients’ satisfaction with each rehabilitation program, and shoulder scores assessed by the American Shoulder and Elbow Surgeons Shoulder Index, the rating system of the University of California at Los Angeles and Rowe et al.

**Results:** The recurrent rate was not different between the two groups (p = 0.842). None of the groups developed recurrent dislocation. Two patients from each group had positive anterior apprehension. Patients who underwent accelerated rehabilitation resumed functional range-of-motion faster (p<0.001) and returned earlier to the functional level of activity (p<0.001). Accelerated rehabilitation decreased postoperative pain (p=0.013) and more patients were satisfied with this program (p<0.001). The shoulder scores, patients’ return to activity, pain score, and the range-of-motion were not different between the two groups at the final follow-up (p>0.05).

**Conclusion:** Early mobilization of the operated shoulder after arthroscopic Bankart repair does not increase the recurrence rate in selected group of patients. Although the final outcomes are approximately the same in both groups, the accelerated rehabilitation program promotes functional recovery and reduces postoperative pain, which enables patients an early institution of their desired activities.

**Paper #39**

**INTRAOPERATIVE AND LATE COMPLICATIONS IN ARTHROSCOPIC ANTERIOR SHOULDER INSTABILITY RECONSTRUCTION.**

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Emmanuel Antonogiannakis, Athens-Cholargas, GREECE
Christos K Vianakopoulou, Athens, GREECE
Paul Labrinakos, Athens, GREECE
Georgios Anastasios Babalis, N. Iraklio Attikis, GREECE
Christos Karabalis, Athens, GREECE
Panos Efstratiou, Athens, GREECE
401 General Army Hospital, Athens, GREECE

**We present our experience from the treatment of several complications which occurred during arthroscopic reconstruction of shoulder instability.**

Between September 1999 and May 2001 we treated 50 patients with anterior shoulder instability with arthroscopic Bankart repair. Of them 49 were males aged 19-33 years and 1 was female 24 years old. All operations were performed in the lat-
Arthrotic reconstruction of shoulder instability is a safe method with few complications.

**Paper #40**

**ARTHROSCOPIC REPAIR OF FULL THICKNESS ROTATOR CUFF TEARS USING BIOABSORBABLE TACKS**

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Julie McBirnie, FRCS, Scotland
Sara Miniaci, Canada
Toronto Western Hospital, Toronto, Ontario, Canada

Introduction: Techniques of rotator cuff repair continue to evolve. Although arthroscopic repair is becoming accepted, technical considerations of anchor placement and knot tying make this a difficult procedure. Tacks would simplify arthroscopic repairs but clinical reviews assessing their non-existent efficacy are lacking.

Purpose: This study was performed to evaluate the 2-year clinical results of arthroscopic rotator cuff repairs performed with bioabsorbable tacks (Suretac II).

Materials and Methods: A retrospective review of prospectively collected data of 135 patients (86 males, 49 females) with mobile, full-thickness rotator cuff tears repaired arthroscopically by one surgeon using biodegradable tacks was performed. Average patient age was 52 years (range 23-74) and average time to review was 36 months (range 24-70 months). The patients were evaluated using the ASES and Constant Shoulder score, and the Short Form 36 health survey (SF36).

Results: Average size of tears measured 2.5 cm (range 1-5 cm) and on average 2 Suretacs (range 1-5) were used for the repair. Thirty-two patients had tears larger than 3 cm and 25 patients had tears that measured 5 cm or larger. The average total ASES score improved from 29 to 89 points with pain improving 7 to 12 and function from 7 to 25 points. All of these results were statistically significant (p<0.01). There was a significant improvement in all components of the SF36 survey. The average postoperative Constant score was 89 with the pain measuring 12 points, ROM 39 and power 23 points.

Discussion: These results show that arthroscopic repair of mobile, full-thickness rotator cuff tears using bioabsorbable tacks produces satisfactory outcomes with regard to objective orthopedic criteria. The advantages of arthroscopic repair are many but the procedure can be difficult. The use of tacks facilitates cuff repair without compromising the clinical result.

**Paper #41**

**ARTHROSCOPIC SUBSCAPULAR TENODESIS IN SHOULDER MULTIDIRECTIONAL INSTABILITY**

Alberto Pienovi, San Isidro, Argentina, Presenter
Rafael Jose Tossi, Buenos Aires, Argentina
Luciano Quevedo, San Isidro, Argentina
Daniel Varela, San Isidro, Argentina
CTO, San Isidro, Argentina

Introduction: Shoulder instability is a frequent pathology among athletes. It may happen with true dislocation episodes, with subluxation or mainly with symptoms related to this pathology such as pain, subachromial impingement or lesions in the rotator cuff of different grades.

Methods: In this prospective study, not randomized, we propose a rational classification that allows the identification of predisposing factors and the different lesion grades in order to select a determined arthroscopic treatment, increasing in complexity and repair. 186 cases were studied in this paper, which underwent an arthroscopy for shoulder instability. 56 cases were considered for this study as they were multidirectional instabilities and the multiple factors described in this paper were analyzed in these cases. Subscapular tenodesis was performed in 21 patients as an arthroscopic technique to stabilize the articulation. We have classified these factors in four groups in order to obtain a rational orientation of the arthroscopic treatment and to decide which one should be used in each case. Subscapular tenodesis, in patients of the Group IV, was performed through arthroscopy, of the visible part of the tendon. The fixation to the anterior side of the Labrum was carried out through a transglenoid suture. To this technique, the repair of lesions was associated according to each case, such as reinsertion of the Labrum, co-planning of the Hill-Sachs lesion, repair of the SLAP and or capsule-ligamentary shift.

Results: The average follow-up was 26.7 months (15 to 37 months). Results were excellent or very good in 15 patients (71.4%), without re-dislocation or recurrence of symptoms, 5 patients (23.8%) had regular results with a return to the sportive activity but with a decrease in performance and with symptoms that impede a competitive practice of sports and 1 patient (4.76%) had a bad result due to re-dislocation and permanence of initial symptoms.

Discussion: Advances in arthroscopic techniques have allowed surgeons to be more selective and to evaluate each case in particular in order to perform more specific techniques for each particular patient. This study establishes that, in order to reach a foreseeable result, each procedure must be planned and surgeons must be trained and have the adequate technology for the treatment of instability and to produce a predictable result.

**Paper #42**

**OPERATIVE STABILIZATION OF TRAUMATIC POSTERIOR SHOULDER INSTABILITY**

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Craig R Bottoni, Honolulu, HI, USA
Thomas M DeBernardino, West Point, NY, USA
Dean C Taylor, West Point, NY, USA
United States Military Academy, West Point, NY, USA

Purpose: To evaluate the results of operative stabilization in patients with traumatic posterior instability of the shoulder.

Methods: 23 consecutive patients underwent surgical stabilization for traumatic posterior instability of the shoulder. All patients were evaluated using physical exam, Rowe score, and outcome measures utilizing the WOSI (Western Ontario Shoulder Instability Index) and SANE (single assessment numeric evaluation) scores.

Results: 24 shoulders in 23 patients underwent posterior shoulder stabilization, 14 arthroscopically and 12 by open technique. All patients had a distinct traumatic etiology leading to the instability. All patients had posterior apprehension and increased posterior translation on preoperative physical exam.
Peoperative imaging revealed posterior rim calcification or reverse Bankart lesions in 21 shoulders (87.5%). At arthroscopy, posterior labral lesions, reverse Bankart lesions, or humeral head defects were observed in all cases. Average follow-up was 30 months (range 10-52). The average SANE, WOSI, and Rowe Scores were 85, 97, and 82, respectively. Nineteen of twenty-four shoulders were rated good or excellent (80%) and returned to unrestricted sports and activity.

**Paper #44**

**BIOMECHANICAL ANALYSIS OF A NEW BIOABSORBABLE SCREW AND WASHER COMPARED TO STANDARD SUTURE ANCHOR REPAIRS FOR ROTATOR CUFF REPAIR**

Robert A Pedowitz, San Diego, CA, USA, Presenter

Charles Petit, San Diego, CA, USA

Robert Boswell, San Diego, CA, USA

Andrew Makar, San Diego, CA, USA

James P Toste, San Diego, CA, USA

UCSD Arthroscopy and Sports Medicine Fellowship, San Diego, CA, USA

Introduction: The primary purpose of this investigation is to compare the in-vitro biomechanical performance, under cyclic loading conditions, of a new bioabsorbable screw and toothed washer implant to standard suture anchor techniques for rotator cuff repair. The present study compared this implant to standard fixation methods.

Methods: We created 1 X 2 cm defects in the infraspinatus tendon of 40 bovine shoulders (3-6 months). There were five repair groups (n=8 per group) consisting of either two Bionx BioCuff bioabsorbable (PDLLA) screw and toothed washer implants (Bionx, Inc., Tampere, Finland) or two Mitek Super QuickAnchor Plus (G4) anchors with #2 Ethibond suture (Mitek Surgical Products, Westwood, MA). Four suture techniques were tested: (I) single-loaded anchors with simple sutures, (II) double-loaded anchors with simple sutures, (III) single-loaded anchors with horizontal mattress sutures, or (IV) single-loaded anchors with modified Mason-Allen sutures. Repairs were loaded at 5-second cycles from 10N to 180N using an MTS 858 Mini Bionix (MTS Corp., Eden Prairie, MN). The number of cycles to gap formation of 5 and 10 mm were recorded.

Results: Five mm gap formation occurred significantly later for BioCuff screws (787 +/- 313 cycles) than for suture Group I (26 +/- 13), Group II (32 +/- 11), Group III (110 +/- 81), and Group IV (6 +/- 2). Ten mm gap formation occurred significantly later for BioCuff screws (1665 +/- 407) than for suture Group I (166 +/- 55), Group II (703 +/- 179), Group III (802 +/- 212), and Group IV (352 +/- 178) (p<0.05). There was no significant difference in the sliding of the stitch. For anchors with modified Mason-Allen sutures, Repairs were loaded at 5-second cycles from 10N to 180N using an MTS 858 Mini Bionix (MTS Corp., Eden Prairie, MN). The number of cycles to gap formation of 5 and 10 mm were recorded.

Discussion: This study demonstrated early gap formation under cyclic loading conditions with standard suture anchor techniques for rotator cuff repair. The BioCuff screw and washer provided more stable fixation under identical conditions. This may translate into fewer failures in the early post-operative period under standard rehabilitation protocols.

**Paper #45**

**INFLUENCE OF THE DRAWING OF THE EYELET SUTURE ANCHORS ON THE RESISTANCE OF THE SUTURE THREADS.**

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Introduction: Suture anchors used for the fixation of soft tissue on bone suggested several studies to evaluate the quality of their holding into the bone. However, none of these studies concerned the influence of the drawing of the eyelet of the anchors on the resistance of stitches. Our goal was to study this aspect of the problem.

Material and methods: The tested anchors were: Statak 4 (Zimmer, Warsaw, IN, USA), Corkscrew 3.5, Fastak 2.4 (Arthrex, Naples, FL, USA), PeBA C 6.5 (OBL, Scottsdale, AZ, USA), Mitek GII (Mitek, Norwood, MA, USA), Harpoon 2 (Arthrotek, Warsaw, IN, USA), Ultrafix (Linvatec, Largo, FL, USA), Vitis 3.5 and 5 (Tornier, St Ismier, France). The used material sutures were: Vicryl dec 5, Flexidene dec 5, PDS dec 4. Three trial types were performed on machine INSTRON 8500 + to study the suture breakage strength. A buckle of constant length was realized and a load was applied according to the anchor axis until break of the thread. Two modalities were performed: the first one by linear increase of the load at a 1.25 mm/sec speed and the second one by 5 cyclic compulsory drive with the frequency of 1 Hz with an increasing load of 10 N at each cycle. To study the fatigue of every thread with regard to every anchor, we imposed upon the thread crossed through the anchor eyelet a sinusoidal coming and going of 10 mm with a frequency of 0.03 Hz, one extremity of the thread being fixed and the other one supporting a constant load of 20 N. Every repair was tested for every anchor and every trial type was performed 3 times.

Results: The ultimate breakage load of each of the threads did not seem affected in a significant way by the drawing of the eyelet. The break of the assembly occurred mostly at the suture knot, sometimes at the eyelet (Harpoon, Fastak, Vitis) for Flexidene suture. On the other hand, important differences were noted in the thread fatigue tests; a thread braided on core such Vicryl is sharply more successful than the 2 other tested threads, whatever is the anchor. Besides, the resistance in the sliding is very different from an anchor to another: 100+/-20 cycles for Corkscrew 3.5 in 3+/-1 cycles for Vitis 3.5 with Vicryl or 6+/-1 cycles for Harpoon 2 with Flexidene.

Conclusion: The drawing and the manufacturing of every eyelet influence the resistance in the sliding of the stitch. For anchors weakening the thread after some comings and goings, we can suppose that simple tightening of the knot damages the thread and could be responsible of premature failure of the soft tissue fixation. The best results are obtained when there is a chamfer and a throat at the eyelet.

**Paper #46**

**PEGGED GLENOIDS FAIL TO IMPROVE FIXATION: TWO TO FIVE YEAR CLINICAL FOLLOW-UP**

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INTRODUCTION: Aseptic loosening of glenoid components is a common problem with total shoulder arthroplasty. In vitro biomechanical studies have suggested that a multiple pegged design would have better long-term fixation when compared to the standard keel design. Despite more than 10 years of use, there is no short-term or mid-term clinical follow-up studies to support the concept that an all-poly peg design has greater longevity than an all-poly keel glenoid design. The purpose of
this study is to evaluate mid-term (up to 5 years) follow-up on a single surgeon's experience with all-poly pegged glenoids fixed with cement.

METHODS: Retrospective analysis of 19 consecutive surgeries by a single surgeon between 1992 and 1996. A five-peg all-poly glenoid component fixed with bone cement was used in each case. Clinical outcomes as well as radiographic analysis were evaluated at yearly intervals including active range of motion, pain visual analogue scales, function and quality of life visual analogue scales, ASES score, and Simple Shoulder Test. Radiographic analysis of loosening as well as failure requiring revision were examined.

RESULTS. A 21% (4/19) revision rate at 5 years was observed. 71% (14/19) demonstrated some amount of radiolucency at follow-up. At two year follow-up there was a significant (p<0.05) decrease in pain (VAS 7.8 to 1.3) with a significant increase in function (7.0 to 1.3) quality of life (6/4 to 1.7) and ASES (33.5 to 82.9). All range of motion parameters improved. There were no differences in any of the outcome measures between sequential years of follow-up.

CONCLUSION: This is the first clinical follow-up study evaluating the results of using a five-peg all-poly glenoid component which was proposed as a potential solution to glenoid loosening. The glenoid component, the most popular multiple-peg design, has an alarmingly high rate of radiolucency at early follow-up. Signs of loosening worsen with time with a revision rate of 21% at mid-term follow-up of up to 5 years. Further investigation into potential modes of failure (mechanical versus biological related to wear particles) is essential before concluding that a multiple peg all-poly glenoid design offers improved or equal longevity to a standard keeled glenoid design.

Paper #47
ARTHROSCOPIC BICEPS TENODESIS: USING SUTURE ANCHORS THROUGH THE SUBCLAVIAN PORTAL
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Biceps tenodesis has traditionally been performed through an open anterior incision. Even when arthroscopic rotator cuff repair has been performed, frequently an additional open procedure had to be performed to address the biceps rupture, partial rupture or subluxation. Recently, there has been great interest in performing this arthroscopically. Techniques have included using an interference screw or with two suture anchors through an anterior cannula. Additional proficiency in arthroscopy of the bicipital groove aids in completely evaluating the biceps tendon.

In cases where the biceps is partially ruptured, subluxed or the proximal end is still visible in the joint, a biceps tenodesis can be performed using standard arthroscopic techniques and suture anchors. I developed the Subclavian portal in 1997 for arthroscopic repair of rotator cuff tears. During repair of the Supraspinatus, the biceps tendon is observed running adjacent to it as it enters the bicipital groove. The Subclavian portal was described as a portal for introducing a pointed suture grasper through the rotator cuff. The biceps can be easily incorporated with this technique, so it became an ideal angle for introduction of suture anchors directly through the rotator cuff tendon and into the humeral head at the edge of the articular cartilage. Anchors inserted through the Subclavian portal reproduce the 45° Deadman angle, which was described for placing, anchors in rotator cuff repair. The bone is roughed first with a motorized shaver. Once the anchor is inserted through the tendon and into the bone, the suture is retrieved with a crochet hook and pulled out the lateral portal for tying. Two anchors provide secure repair and the biceps tendon stump is intraarticular but in an anatomic location with no additional prominence under the supraspinatus. Rotator cuff repair can then be performed over this if needed. If the rotator cuff is intact, an intraarticular biceps repair can be performed by inserting the 3.5mm anchor through the cuff and biceps, pulling one suture above and one below the biceps, and then tied through an anterior cannula, intraarticularly. Release of the biceps is not performed until the repair is accomplished, which prevents the tendon from retracting down the bicipital groove.

The anatomy of the Subclavian portal will be reviewed and the technique of the arthroscopic biceps tenodesis will be presented. The Subclavian portal is located 1 to 2 cm medial to the acromioclavicular joint and lies directly under the clavicle. This is directly above and slightly medial to the coracoid. The portal passes through the skin and directly inferior to the distal clavicle, then passes anterior and inferior to the acromioclavicular joint before entering the subacromial bursa. This portal is best utilized after a subacromial decompression has been performed. The acromial branch of the thoracoacromial artery is then cauterized which decreases the risk of bleeding. The anchor is inserted with it oriented medial to lateral, which provides the proper orientation for anchor insertion. Initial cases and preliminary results will be provided. Patient satisfaction is high with good relief from bicipital pain and excellent cosmetic results. Using the Subclavian portal provides the optimal angle for anchor insertion and facilitates arthroscopic biceps tenodesis.
over the baseline temperature during each procedure performed. Regardless of the position of the electrocautery device in the inferior capsule, there were no fluctuations of temperature along the nerve and branches.

Conclusions & Significance: In this cadaveric model, the arthroscopic technique of a capsular release did not cause an increase in the temperature of the axillary nerve and its branches. This was evident in 10 cadaveric specimens we tested at an arm position of 0º adduction. The area of the capsule released was only 0.5 cm away from the glenoid. Previous studies have found the safe zone for an arthroscopic capsular suture plication to be within 1 cm of the glenoid. No previous studies have utilized this current model in looking at a safe zone with the variable of temperature and a capsular release. It is apparent in this model that the safe area to perform an arthroscopic capsular release is close to the glenoid. However, further clinical studies and anatomical studies may be necessary.

Paper #49
THE TWIST-LOCK CONCEPT OF TISSUE FIXATION WITHOUT KNOTS: OBSERVATIONS ALONG THE HONG KONG SKYLINE

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Introduction: Perhaps the single biggest technical obstacle to the widespread application of arthroscopic tissue fixation is the high degree of difficulty of arthroscopic knot-tying. This study introduces a novel suture anchor system, the “twist-lock” system, which obtains tissue fixation by means of sutures without knots.

The twist-lock concept of knotless fixation is based upon a friction-multiplier mechanism which eliminates the technical challenges of arthroscopic knot-tying. This concept was inspired by the knotless lashing used to construct the hundred story high bamboo scaffolding frames that supported construction workers as they built the great Hong Kong skyscrapers. The twist lock system enhances internal interference of the suture limbs by two mechanically-verifiable friction-multiplier mechanisms: the cable friction effect and the wedge effect. After theoretically verifying the strength characteristics of the twist-lock system, the authors chose to test its strength experimentally and to compare its strength to that of a standard knotted suture anchor system.

Materials and Methods: Unicellular polyurethane, which has been demonstrated to accurately mimic the mechanical properties of cancellous bone, was used for implantation of suture anchors for the purpose of comparing the load to failure of the twist-lock system to the Corkscrew anchors system (N = 10 for each system). For the Corkscrew system, #2 Ethibond from the anchor was tied to create a suture loop with six half-hitches, alternating posts on the last 3 throws. For the twist-lock system, the two suture limbs of #2 Ethibond from the anchor were twisted 3 times in order to create a similarly sized loop secured by twists rather than knots. Axial single pull loading was performed with an Instron testing machine at 1 mm/sec crosshead speed with a 5 N preload. Load to failure and mechanism of failure were noted so that we could compare failure of a loop secured by a knot to failure of a loop constructed without a knot but secured by the twist-lock mechanism.

Results: The average load to failure for the twist-lock group was 137.2 N, and the average for the Corkscrew group was 123.0 N, a difference of 14.2 N. This study showed that the twist-lock anchors failed at a load that was 12% higher than that of the Corkscrew group (p=0.02). The mode of failure for the twist-lock construct was suture breakage at the suture “nest” adjacent to the eyelet in each case. For the Corkscrew construct, the mode of failure was breakage of the suture at the knot in all cases.

Conclusions: This study validates the theoretical basis of a knotless friction multiplier mechanism (cable friction effect and wedge effect) incorporated into a suture anchors system which eliminates the formidable technical difficulties of arthroscopic knot tying. We believe that the greater load of failure of the knotless twist-lock system in comparison to a knotted suture anchor system is due to a decrease in the partial fiber failure of suture that is created by knot-tying. Despite the fact that it utilizes no knots, the twist-lock system was consistently stronger than the standard knotted suture anchor system. This technique of suture fixation without knots has the potential to greatly simplify arthroscopic tissue fixation.

Paper #50
ARTHROSCOPIC SUPRA-SPINATUS REPAIR: ARTHRO-CT SCAN ASSESSMENT OF THE HEALING

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Arthroscopic repair of the rotator cuff is a new approach for the management of the rotator cuff tears. However, it remains scepticism with regards to the reliability of this method. The purpose of this study was to evaluate the healing of the rotator cuff after arthroscopic repair, using arthro-CT scan, MRI or ultrasonography.

Methods: 48 arthroscopically repaired supraspinatus tendons in 47 patients were evaluated. The average age was 56 (34 to 76). The initial Constant score was 40,56 (13 to 67). The pre-operative anatomic lesions (arthro-CT scan or MRI) were: 41 small and 7 medium full-thickness tears. The post-operative management consisted in a simple sling during 6 weeks, immediate passive motion and active elevation only after 6 weeks. Arthro-CT scan (40), ultrasonography (3) and MRI (2) were utilized to determine if the tendon was intact at 6 months.

Results: At an average follow-up of 34 months, the Constant score was 81.6 (43 to 99). At 6 months, the integrity and the quality of the tendon healing on the tuberosity were evaluated. In 16 cases, the tendon was “normal”. In 16 cases, it was “nearly normal” (irregularity on its inferior surface). In 6 cases, we found an aspect of partial-thickness tear and in 7 cases, it was a full-thickness tear. We did not find any correlation between clinical results and anatomic findings.

Conclusion: The clinical results suggest, in selected patients with small to medium supra-spinatus tears, the arthroscopic repair can produce excellent outcome. The post-operative arthro-CT scan showed that this technique provide a satisfactory healing rate.
Paper #51 MUSCLES AND FOREARM ROTATION EFFECT
VALGUS LAXITY OF THE ELBOW
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Introduction: Accurately diagnosing the presence and degree of ulnar collateral ligament (UCL) injury is often difficult, even for experienced clinicians. Valgus laxity of the elbow is difficult to confirm clinically with various reports recommending examination in pronation, supination and neutral rotation and varying degrees of elbow flexion. There have been no studies performed assessing valgus laxity with the UCL intact and cut in varying degrees of flexion and rotation with the entire upper extremity musculature intact. The purpose of this study was to determine the effect of forearm rotation and elbow flexion on valgus laxity.

Methods: Twelve fresh frozen cadaveric upper extremities with no radiographic evidence of arthritis, previous fracture or surgery of the elbow were used. The entire upper extremity was used to maintain the origins and insertions of all muscles that cross the elbow that may provide passive stability. The thawed arms were held in a custom instrumented elbow laxity testing device that permits the measurement of varus/valgus laxity of the elbow while applying a pre-specified valgus torque. Valgus laxity was measured using a Microscribe digitizing system. Using a muscle splitting approach to limit injury to other structures and maintain their effect on elbow stability, the anterior band (AB) of the anterior oblique ligament (AOL) and the posterior band (PB) of the AOL were sectioned randomly and sequentially. Valgus laxity was directly measured (in degrees) with the forearm in pronation (P), supination (S) and neutral rotation (NR) at 300, 500, and 700 degrees of elbow flexion across 2 Nm and 2 Nm force with the ligament intact, joint vented, following cutting of the anterior or posterior half of the AOL, and following complete sectioning of the AOL. ANOVA was used for statistical analysis with p<0.05 set for statistical significance.

Results: In all cases, NR had more valgus angular displacement than P for all degrees of elbow flexion with the ligament intact, AB transected and complete cutting of the AOL at 1 and 2 Nm of torque (p<0.05). With the PB only cut, N had more angular displacement at 300 flexion with 1Nm torque, and at 300 and 700 with 2Nm force (p<0.05). NR revealed more valgus displacement than S in all degrees of elbow flexion with the AOL intact and completely transected at 2 Nm (p<0.05), while at 1Nm of torque, NR resulted in more displacement than S at 300 and 500 for both intact and complete AOL transection (p<0.05). With the AB only cut, NR resulted in more displacement than S at all degrees of elbow flexion and both torque forces (except 500 with 1 Nm force) and with the PB only cut, (p<0.05) NR resulted in a similar pattern when compared with N versus P (p<0.05). Supination resulted in more forearm valgus displacement as compared with P at 300 and 500 of elbow flexion with an intact ligament at both 1Nm and 2Nm torque (p<0.05), however, there was no difference at either force when the AOL was completely cut (p>0.05). With the AB cut at 300 of flexion with 1Nm force and at 500 of flexion with 2Nm force S resulted in more valgus displacement than P (p<0.05), otherwise there was no statistically significant difference between pronation and supination at any other degree of flexion and no difference at any degree of flexion – extension with AB only or PB only cut (p>0.05). At 1Nm of force, 300 of flexion resulted in more valgus angular displacement than 500 with AOL cut and in S, (p<0.05) while more displacement was noted with complete AOL transection in NR versus 700 (p<0.05). There was no statistical difference in valgus displacement with flexion angle at 2 Nm testing (p>0.05). There was no difference in cutting the PB or AB first in testing (p<0.05). In all cases, 2 Nm force resulted in more displacement than 1 Nm force (p<0.05), and fully transected AOL resulted in more angular displacement than the intact ligament (p<0.05).

Discussion: The results of this study confirm the importance of forearm rotation in the assessment of valgus laxity of the elbow. Neutral rotation is the best position to examine the elbow for valgus laxity. The results from this study differ from previous published data because the entire upper extremity was used and all musculature and their insertions were maintained. Although the muscles are not activated, they contribute to stability by passive muscle length and bulk effects.

Paper #52 EXTRACORPORAL SHOCK WAVE THERAPY (ESWT) IN PATIENTS WITH TENNIS ELBOW
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Objectives
The aim of the study was to compare the effect of extracorporeal shock wave therapy (ESWT) in patients with chronically tennis elbow with a conventional conservative treatment.

Methods
Thirty-six patients (38 elbows) with chronically tennis elbow and previously unsuccessful conservative treatment of at least 6 months were prospectively randomized into two groups with a random list. Treatment of group 1 (20 elbows) started immediately after enrollment with three sessions of ESWT (3000 shock waves/session of 0.2 ml/mm²) at weekly intervals. No local anaesthesia was applied. In the patients of group 2 (18 elbows) conservative treatment was continued for 12 weeks. After this period they were treated using the protocol of group 1. Patients were followed up at 6, 12 and 24 weeks and one year after ESWT. A clinical investigation was performed regarding pain during activities of daily living and pain followed by typical provocation tests (resisted wrist extension and middle finger extension) on a visual analogue scale ranging from 0 (no pain) to 100 (maximal pain). Statistical analysis was done with the non-parametrical Wilcoxon test for paired samples and the non-parametrical Mann-Whitney test for unpaired samples.

Results
No significant difference of pain (65.9 ± 20.3 to 66.2 ± 23.7) after further conservative treatment (3 months) was seen (group 2). Six months after ESWT pain during activities of daily living decreased by 78% on the visual analogue scale (VAS) and pain followed by typical provocation tests decreased significantly in both groups (p 0.01). One year after ESWT pain during activities of daily living had decreased even more by 85% on the visual analogue scale compared to prior to ESWT while pain followed by provocation tests did not improve any further in both groups (p < 0.01).

Conclusion
In our study we could not find any significant differences of pain and function after further conservative treatment of 3 months in patients with chronic tennis elbow. After ESWT pain and function improved significantly.

Keywords: tennis elbow, extracorporeal shock wave therapy (ESWT)
INTRODUCTION: The distal biceps tendon inserts into the proximal radius at the bicipital tuberosity. Tendon avulsion requires surgical repair for normal function. Severe fractures of the radial head with interosseous membrane disruption may require a prosthetic or biologic implant. The literature is sparse as to the anatomy of the proximal radius, tuberosity morphology, or the biceps insertion.

PURPOSE: The purpose of this study was to characterize the clinically relevant morphology of the proximal radius and further define the anatomy of the distal biceps tendon.

METHODS: 178 specimens from the Haemann-Todd Osteologic Collection at the Cleveland Museum of Natural History were evaluated to determine the morphological characteristics of the proximal radius. Sixty-one males and 28 females were selected as to the anatomy of the proximal radius, tuberosity morphology, or the biceps insertion.

RESULTS: The biceps tendon inserts onto the ulnar aspect of the tuberosities ridge after twisting 90 degrees. Small and medium ridge types encompass 77% of the tuberosities. Then tendon insertion footprint is 14.31 mm by 1.82 mm wide. The tuberosity is 20.2 mm (+5.2) distal to the radial head. It is 22.1 mm (+11) long and 17.1 mm (+19) wide. The tuberosity single cortex measurement was 12.54 mm (+1.43) and the two cortex measurement was 14.8 mm (+1.3). The angle between the bicipital tuberosity and the radial styloid was 124 (+11) degrees.

DISCUSSION and CONCLUSION: this study quantified the morphology of the proximal radius, tuberosity morphology and size, and defined the insertional “footprint” of the biceps tendon.

INTRODUCTION: The anatomy of the triceps brachii insertion has been described as three muscular heads contributing to a single tendon. At the time of surgery for a suspected triceps tendon rupture in a young healthy male, we identified an intact superficial tendon with a separate deep tendon insertion that was ruptured. We performed an anatomic study to determine the insertional anatomy of the triceps brachii tendon.

METHODS: Eight adult fresh-frozen elbow cadavers were dissected to determine the insertional anatomy of the Triceps Brachii tendon. The long, lateral and medial muscle bellies were identified proximally and followed distally to their insertion.

RESULTS: The long and lateral heads joined to form a superficial insertion on the olecranon in all cases. The medial head had a separate and distinct insertion on the olecranon which was deeper and was comprised of less tendinous tissue, as compared to the long-lateral head insertion. These two insertions were adjacent, but clearly distinct. They were separated by a tissue plane in all specimens, as well as in our patient.

DISCUSSION and CONCLUSION: The Triceps Brachii tendon insertion has two separate and clearly defined components at the olecranon. The superficial insertion comes from the long and lateral heads, while the deep insertion is from the medial head. The insertional anatomy of the Triceps Brachii tendon at the elbow has not previously been described and has important implications for surgical repair of these tendon injuries.

INTRODUCTION: A firm attachment of a tendon graft to the bone is a significant factor for the success in anterior cruciate ligament (ACL) reconstruction. Our previous studies have shown that the bonding strength of the flexor tendon autograft to the tunnel wall is inferior to that of the bone-patellar tendon-bone (BPTB) graft in the earliest several weeks after ACL reconstruction (JARR, 2001). Therefore, it is important to study therapeutic methods to increase the bonding strength of the flexor tendon graft in this early phase. It has been well known that transforming growth factor-beta (TGF-beta) stimulates the cell proliferation and col-
lagen synthesis in tendon fibroblasts. Therefore, we have hypothesized that administration of TGF-beta 1 into the bone tunnel may enhance in vivo healing of flexor tendon graft within the tunnel in ACL reconstruction. The purpose of this study is to test this hypothesis with a canine model.

MATERIALS AND METHODS
Twenty-eight adult beagle dogs were divided into four groups, Groups I, II, III and IV, of 7 animals each. In each animal, ACL reconstruction with suture-post fixation was performed in the right knee. In Groups I, II, and III, the doubled flexor digitorum superficialis tendon having a diameter of 4 mm was used as a graft, and the distal end having a 15-mm length was placed in a 4-mm-diameter tibial tunnel, and the proximal end was routed through over-the-top of the lateral femoral condyle. At the time of graft placement in the tibial tunnel, no additional treatment was applied in Group I. In Group II, 0.1-ml fibrin sealant was applied to the tendon-bone gap at the time of graft placement. In Group III, 2-ng recombinant human TGF-beta 1 mixed with 0.1-ml fibrin sealant was applied in the same manner. In Group IV, the BTB graft having a width of 4 mm was used as a graft to obtain the biomechanical control data concerning the bone-to-bone healing. No animals were immobilized postoperatively, and all were sacrificed at 3 weeks. In each group, five and two dogs were used for biomechanical and histological examinations, respectively. For biomechanical examination, after the sutures tethering the graft to the tibia were cut, pullout tests of the graft from the tibia were carried out in order to determine anchoring strength of the graft within the tibial bone tunnel. In histological observation, the posterior aspect of the tendon-bone interface, the anterior aspect of the tendon-bone interface, and the tendon substance were examined with light and polarized light microscopy. Statistical analysis was made using the ANOVA.

RESULTS
Each tendon graft in Groups I, II and III was pulled out from the tibial tunnel. In Group IV, 80% of the BTB grafts were pulled out from the tunnels with bone plugs, and the remaining one graft failed in the mid-substance of the tendon. The ultimate load of the graft-tibia complex in Group III was significantly greater than that in Group I or II, while there were no significant differences between Groups III and IV. The tendon-bone gap was filled with granulation tissue in Groups I, II and III. In the granulation tissue at the posterior tendon-bone gap, perpendicular collagen fibers connecting the tendon to the bone, which resembled Sharpey’s fibers, were more abundant in Group III than in Groups I and II. In the anterior tendon-bone gap, the perpendicular collagen fibers were observed equally in Groups I, II and III. Interestingly, the newly formed bone on the wall of the bone tunnel surrounding the granulation tissue was thicker in Group III than in Groups I and II. Concerning the tendon substance located within the tunnel, the number of fibroblasts observed in the surface portion in Group III was higher than that in Groups I and II.

DISCUSSION
In ACL reconstruction using the flexor tendon autograft, TGF-beta 1 applied into the bone tunnel significantly increases the bonding strength of the tendon graft to the tunnel wall at 3 weeks after the surgery. A part of the mechanism may be explained by collagen fiber generation and new bone formation. This study clearly demonstrated that the administration of TGF-beta 1 into the bone tunnel significantly enhance intraosseous tendon graft healing in ACL reconstruction. Subsequently, the ultimate load of the flexor tendon graft-tibia complex became comparable to that of the BTB graft-tibia complex. As to the clinical relevance, application of some specific growth factors involving TGF-beta 1 has a possibility to become a therapeutic option to increase the bonding strength of the graft to the tunnel wall in ACL reconstruction with the flexor tendon graft.

Paper #56
COMPARISON OF RADIOGRAPHIC KNEE MEASUREMENTS IN NORMAL AND ACL-DEFICIENT SUBJECTS
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A vast amount of information has been reported in the sports medicine literature regarding the measurements of the distal femur and their relationship to injuries to the anterior cruciate ligament. There has been very little mention regarding notch height and tibial spine dimensions and their role in injuries to the ACL. We looked at both tunnel view and lateral view radiographs of 25 ACL-deficient and 25 uninjured, healthy “control” male knees. Ages ranged from 18-40 for the ACL group (mean=29.6, SD=7.3) and 20-40 for the Control group (mean=30.1, SD=6.4). Similarly, we looked at radiographs of 25 ACL-deficient and 25 “control” female knees. Ages ranged from 14-45 in the ACL group (mean=26.4, SD=9.8) and 20-38 in the Control group (mean=28.3, SD=6.3). Specific criteria was required for inclusion in either group.

A total of six different measurements about the knee were taken to the nearest millimeter. These included the femoral notch width, femoral condylar width, femoral anterior notch height, femoral posterior notch height, tibial spine width, and tibial condylar width. All measurements were performed by the same investigator (TKG). Using these six basic measurements, additional ratios and differences (notch height difference, notch spine difference, notched width index, notch height index, notch spine index, and spine width index) were calculated and statistically analyzed using both two-tailed t-tests and logistic regression by an unbiased, third-party statistician. Normal distribution was noted of all variables and male and female analyses were carried out separate from one another.

For males, t-tests showed significant differences between the ACL and Control groups for the notch width, spine width, notch height difference, notch width index, notch height index, and the spine width index. T-test analysis for the female groups showed significant differences for the spine width, notch height difference, notch height index, and the spine index width. Interestingly, the well-studied notch width and notch width index in females was not significantly different.

In regards to analysis via logistic regression, only the notch height index and spine width index were significant. Eighteen (72%) of the ACL group and 19 (76%) of the Control group were correctly classified with the odds ratio of the notch height index = 6.23 and the odds ratio of the spine width index = 11.65. For the females, only the spine width index was significant. Nineteen (76%) of the ACL group and 16 (64%) of the Control group were correctly classified with the odds ratio of the spine width index = 5.44.

We concluded that our study, unlike previous reported projects, reveals that measurements of the tibial side of the knee may help identify and predict ACL injuries as much if not more so than the traditional measurements obtained from the femoral side. The notch width or notch width index may not be as good an identifier for ACL injury as previously reported. We have
shown here that a spine width index < 0.151 is a strong predictor of potential ACL injury in either sex. In addition, a relatively small anterior notch height coupled with a small spine width may predispose one to a notch impingement, leading to anterior cruciate ligament disruption.

**Paper #57**
**COMPARISON OF HAMSTRING TENDON ACL RECONSTRUCTION USING THE SEMITENDINOUS ALONE AND SEMITENDINOUS WITH THE GRACILIS TENDON**
Alberto Gobeti, Milan, ITALY, Presenter
Benjamin Tuy, Milan, ITALY
Orthopaedic Arthroscopic Surgery International, Milan, ITALY

**INTRODUCTION:** The use of hamstring tendons in ACL reconstruction is steadily increasing. Some have reported using only the semitendinosus tendon as a quadrupled graft while others use both the semitendinosus and gracilis tendons. We reviewed our results with ACL reconstruction using the semitendinosus tendon alone versus the combined semitendinosus and gracilis to determine if there were any differences in the clinical outcome.

**METHODS:** We performed 4-stranded hamstring tendon ACL reconstruction using the semitendinosus tendon alone as a quadrupled graft (ST) in 50 patients and a doubled semitendinosus and doubled gracilis tendon (STG) in combination in another 50 patients. The average age in the ST group was 31, with 31 males and 19 females while the average age in the STG group was 28.8 with 26 males and 24 females. At an average follow-up of 36 months (range 24-70 months), we compared the two groups in terms of clinical assessment, knee laxity, standard knee scores, and isokinetic and functional strength tests.

**RESULTS:** In the ST group, the average knee scores were: Lysholm, 95; Tegner, 7.4; Noyes, 85; and subjective score, 89%. In the STG group, the average scores were: Lysholm, 94; Tegner, 6.5; Noyes, 82; and subjective score, 87%. In the ST group, 84% had normal or nearly normal knees by IKDC score, with 7 abnormal knees. In the STG group, 86% were classified as normal or nearly normal by IKDC score, with 6 abnormal and 1 severely abnormal. There was less than 3 mm side-to-side difference in AP translation in 90% of patients in both groups. There were no significant differences in isokinetic strength deficits of the hamstrings and quadriceps in both groups.

**DISCUSSION:** Hamstring tendon ACL reconstruction using only one tendon (semitendinosus) has comparable results to reconstruction using 2 tendons (semitendinosus and gracilis). There is no significant difference in terms of standard knee scores and knee laxity, and isokinetic strength. There is ample evidence in the literature showing regeneration of the semitendinosus tendon. Sparing the gracilis tendon may minimize morbidity related to harvest of the hamstring tendons.

**CONCLUSION:** We recommend using only the semitendinosus tendon for hamstring ACL reconstruction since there is no additional benefit from concurrent harvest of the gracilis tendon. This may also reduce donor site morbidity.

**Paper #58**
**RESULTS OF PERCU TANEOUS NEEDLING OF CYSTS OF THE CRUCIATE LIGAMENTS**
John B King, London, UNITED KINGDOM, Presenter
Otto Chan, London, UNITED KINGDOM
S Verma, London, UNITED KINGDOM
S Lane, London, UNITED KINGDOM
Sporte Medicine The Royal London Hospital, London, UNITED KINGDOM

**Introduction**
Since our group reported the surgical results of a small series of cysts in the ACL in 1993 the department of Radiology has been refining percutaneous techniques in the management of localised musculoskeletal disorders. We have collected 11 ganglion cysts of the cruciate ligaments which have been treated with percutaneous aspiration and injection of steroid.

**Methods**
The history was (in most cases) a deep seated pain. It was difficult to localise and felt mainly at the extremes of flexion or extension. All individuals were sportsmen but there was no history of specific injury over and above the “routine knocks.” The diagnosis was MRI examination. Only cases which showed a fluid collection either in the cruciate or within its sheath were included, with a presumptive diagnosis of a “ganglion cyst”. Some seemed to involve the sheath of both cruciates. Aspiration was undertaken under local anaesthetic usually with CT control; the wall was punctured, aspiration attempted and steroid injected. Three days restriction of sports activity followed.

**Results**
The lesions fell into three groups. There was a general infiltration of the ligament with spreading of all the fibres, in others there was a local disruption of fibres but with a significant band intact and in the third there was an obvious ganglion without disruption of the ligament.

No patient got infected. Most described the procedure as uncomfortable but repeatable. The symptoms were immediately altered (improved) in all 11. This improvement was sustained in 8. Of the other three one had mild residual discomfort, one had discomfort kept in check with physiotherapy and the third later developed an effusion for which no cause was found but redo MRI showed the cyst to be present but asymptomatic. No patient went onto arthroscopic surgery. This procedure provides symptomatic relief without the more extensive arthroscopic surgery.

**Paper #59**
**THIRTY-YEAR FOLLOW-UP OF ISOLATED ANTERIOR CRUCIATE LIGAMENT INJURIES: LONG-TERM RESULTS OF TREATMENT WITH PRIMARY REPAIR**
Dean C Taylor, West Point, NY, USA, Presenter
Matt Posner, Forest Park, IL, USA
Walton W Curl, Winston-Salem, NC, USA
John A Feagin, Teton Village, WY, USA
Keller Army Hospital, West Point, NY, USA

Over 25 years ago Feagin and Curl reported on the diagnosis and treatment of isolated ACL tears. The purpose of this study is to provide long-term follow-up of this group of patients.

**METHODS:** This is a retrospective, observational study of arthroscopic surgery performed between 1964 and 1970 for isolated ACL tears. The original 64 patients studied were identified and thirty-two patients were contacted for follow-up. Two patients are deceased. The average age at the time of the ACL repair was
20 years, and the average time to follow-up from the index procedure was 34 years. Outcome measures included subsequent operations, Lysholm scores, KOOS scores, IKDC scores and SANE ratings.

RESULTS: Twenty patients (63%) had subsequent operations to the same knee, and 6 of 32 had operations to address persistent instability of the knee. The average Lysholm score was 70.0, average SANE score 68.5, and average KOOS score 69.1. IKDC subjective ratings were 6 normal, 11 near normal, 6 abnormal and 9 severely abnormal. IKDC symptoms ratings were 8 normal, 8 near normal, 10 abnormal and 6 severely abnormal. The average Tegner Activity Score was 3.7.

DISCUSSION: In this group of patients, surgical treatment of isolated ACL tears, consisting of primary repair in most cases, resulted in good functional results at two years; however, the results deteriorated by 5 years. The data, with more than 30-year follow-up, demonstrate that even with decreased activity demands, the majority of these patients continue to have significant knee symptoms; however, a significant number of patients have had good long-term results.

**Paper #60**

**AWARENESS TRAINING REDUCES ACL INJURIES IN TEAM**

**Lars Engerbretsen, Oslo, NORWAY, Presenter**

Grethe Myklebust, Oslo, NORWAY

Odd Egil Olsen, Oslo, NORWAY

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A Søhlberg, Trondheim, NORWAY

Ingeborg Brække, Oslo, NORWAY

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**Introduction:** The incidence of ACL injuries in female division I-III in Norway is 4-8% (Myklebust et al. 1996). While the team looses important players and as such becomes less of a force, the player herself is the one at loss with knee instability, followed by surgery and possibly by late osteoarthritis. As many as 70% of players with ACL injuries may get OA within 15 years (Roos et al. 1996). Only 50% of the players are able to return to the previous skill-level (Myklebust et al. 2000). Studies from volleyball and soccer have suggested that an awareness programme may reduce the incidence of ACL injuries (Caraffa et al., Bahr et al.).

**Methods:** The incidence of ACL injuries in division I-III was studied in 58 teams (942 players) during the season of 98-99. Videos from the injuries in 98-99 were studied by a group of 3 orthopaedic sports doctors and 3 handball coaches. Based on their findings an awareness programme was constructed for the 99-00 season for the same team. The goal was to run the programme for 15 minutes 3 times a week during 5 weeks in pre-season followed by once a week during the season. Compliance was studied and judged as good if 75% of the players did at least 15 sessions of training before the season started. The number of new ACL injuries was studied during the 99/00 season. The following season the programme was changed to a more handball specific protocol based on the results from 99-00, and the injuries were again recorded.

**Results:** In total only 15/58 teams (29%) had more than 75% of the players doing the programme > 15 times (15 of 52). In the elite division 42% did the programme (5 of 12), in division II only 23% and division III 21%. The number of ACL injuries were reduced in all three divisions, although most pronounced in the elite division (50% from 14 to 7). The reduction was not statistically significant. The following season (00-01) physical therapists were hired to supervise all 58 teams. This resulted in further decrease of injuries with a 40% reduction overall and 50% in the elite division.

Conclusion: An awareness programme has been developed for preventing acl injuries in team handball. After 2 year follow up, it seems to reduce the total number of ACL injuries by at least 40%.

**Paper #61**

**ACL REPLACEMENT IN SHEEP WITH OPEN PHYSES: AN EVALUATION OF RISK FACTORS FOR GROWTH DISTURBANCES.**

**Romain Seif, Homburg/Saar, GERMANY, Presenter**

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Frank Adam, Homburg/Saar, GERMANY

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**Objective:** An in vivo sheep model was used to examine the effect of different transphyseal ACL reconstruction techniques on longitudinal growth. The following risk factors for growth disturbances were analyzed: (1) injury to the perichondral groove of Ranvier on the femoral side, (2) transphyseal bony bridge formation with respect to different graft diameters and (3) transphyseal graft fixation using a biodegradable interference screw on the tibial side.

**Methods:** Unilateral ACL reconstruction using an autologous Achilles tendon graft and rigid button fixation was performed in 24 4-month-old Merino sheep. The tunnel diameter was 5 mm in all groups. In group I (N=6) the transphyseal tunnels were left empty. In groups II, III and IV (N=6 in all groups) ACL reconstruction was performed using either a double-stranded graft with a diameter of 5 mm (groups II and IV) or a single stranded graft with a diameter of 3 mm. In group IV a supplemental transphyseal fixation using a biodegradable interference screw fixation (5 mm) was used on the tibial side. The grafts were all tensioned with 40 N. Six months after the procedure, the animals were euthanized. Longitudinal growth was evaluated using X-rays of the operated and nonoperated legs. MRI was used to quantify the physeal injury and to evaluate potential deformities of the physis. Bony bridge formations over the physis were analyzed histologically.

**Results:** Longitudinal growth was 1.6 (+/- 0.7) cm (95 %) on the tibial side and 2.5 (+/- 0.7) cm (13.4 %) on the femoral side. One animal showed no longitudinal growth and was excluded from the study. Macroscopic analysis revealed one graft failure (group III). Quantification of the physeal injury revealed an injury of 1.7 (+/- 1.8) % of the surface of the femoral physis and 1.7 (+/- 0.1) % of the tibial physis. Regarding the longitudinal growth of all sheep, there was a small but significant shortening of the lateral femur of 1.5 (+/- 0.8) mm (p=0.01). In the same time there was a significant lengthening of the lateral tibia of 0.7 (+/- 0.9) mm (p=0.01). There were no length changes on the medial side. In group I the tunnels were filled with bone after 6 months. Despite this important bony bridge formation, there were no major growth disturbances unless the perichondral groove of Ranvier on the femoral side was injured and the tunnels had not been filled with tendon grafts. In these cases (group I: N=3) a significant shortening of the lateral femoral condyle of 7.8 mm (4 %) in average could be noted (p=0.02). Such major growth disturbances could be prevented if the femoral tunnel was filled with a tendon graft, even if the perichondral groove...
was injured (groups II-IV). The comparison of groups II and III showed that a complete filling of the tunnels with a graft of an identical diameter did not prevent bony bridge formation over the physis. However, these small bony bridges did not result in significant tibial or femoral shortening. Transphyseal fixation of the graft with a biodegradable interference screw resulted in a dip deformity of the physis, but no shortening of the affected tibia could be noted (group IV).

Conclusion
(1) The perichondral groove of Ranvier is a structure at risk for major growth disturbances in transphyseal ACL reconstructions, especially on the femoral side. (2) Transphyseal bony bridge formation may not be completely prevented by filling the tunnels with tendon grafts. (3) The presence of a transphyseal bony bridge was not associated with growth disturbances. (4) Transphyseal fixation of the graft with a biodegradable interference screw resulted in a deformity of the physis, but did not affect longitudinal growth of the tibia.

Paper #62
ANATOMIC, PHYSEAL SPARING ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION IN SKELETALLY IMMATURE PATIENTS USING QUADRUPLE HAMSTRING GRAFTS
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Background:
Intra-substance tears of the anterior cruciate ligament, once considered rare in children and adolescents with open physes, are now being reported with increasing frequency. When a child or adolescent presents with a torn anterior cruciate ligament, the physician is faced with a treatment dilemma. The natural history of conservatively treated complete ACL tears is generally poor in skeletally immature patients. Even so, many authors still advocate a conservative approach because of the risk of iatrogenic bone growth disturbance that may be caused by surgical intervention. The purposes of this study are to describe an intra-articular ACL reconstruction technique that follows the generally accepted principles of ACL reconstruction in adults, but theoretically minimizes the risk of physeal injury by not transgressing either the tibial or femoral physis; and to determine the results of this technique using quadruple hamstring ACL reconstruction for children and adolescents who have open femoral and tibial physes.

Methods:
From 1993 to 1999, 12 patients (with a mean age of 13 years, 3 months) had ACL reconstruction with quadruple hamstring tendons. Eight of the twelve patients had a meniscal repair and one had repair of the biceps tendon, fibular collateral ligament and arcuate complex. All patients returned for followup at a mean of 4.1 years (range 2 to 8.2 years).

Results:
The mean growth from the time of surgery to followup was 16.5 cm (range 7.6 to 38.0 cm). The difference lower limb length, as measured on ortho-roentgenograms, was not clinically significant. The mean score on the IKDC subjective evaluation form was 96.5 (range 86 to 100). KT 1000 ligament laxity testing revealed a mean side-to-side difference of 1.5 mm. Seven patients rated normal and five rated nearly normal when evaluating according to the criteria of the objective 2001 IKDC knee examination form.

Conclusion:
We conclude that this surgical technique can be performed in preadolescent patients with efficacy and relative safety.

Paper #63
CORRELATION OF INTERCONDYLAR NOTCH CROSS SECTIONS TO THE ACL SIZE: A HIGH RESOLUTION MR TOMOGRAPHIC IN VIVO ANALYSIS
Michael Dienst, Salt Lake City, UT, USA, Presenter
Guenter Schneider, Homburg/Saar, GERMANY
Katrin Allmeyer, Homburg/Saar, GERMANY
Kristina Volker, Homburg/Saar, GERMANY
Thomas Geor, Homburg/Saar, GERMANY
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Purpose: To correlate cross sections of the intercondylar notch to cross sections of the anterior cruciate ligament (ACL) with an attempt to explain the observation that a small intercondylar notch predisposes to a rupture of the ACL.

Type of Study: In vivo MRI study.

Methods: High resolution MR imaging was performed on a 1.5 T magnet using a dedicated extremity-coil in 10 left and 10 right knee joints of 20 volunteers (10 male, 10 female, 20-40 years of age) with no history of knee abnormalities. Continuous axial T2-weighted MR images with a slice thickness of 2 mm perpendicular to the longitudinal axis of the ACL were acquired. Two ACL cross sectional areas APCL and A were measured by manual tracing. APCL at the contact area to the posterior cruciate ligament (PCL) and mean A of a 1 cm long midsubstance part of the ACL. For imaging and evaluation of the osseous limits of the intercondylar notch a 3D-dataset of the knee was acquired. Three planes (anterior notch inlet, middle notch plane and posterior notch outlet) were calculated and analyzed for measurement of the notch area AN and notch width index NWI. For statistical evaluation, linear regression analysis (Pearson coefficient r, significance p < 0.05) was performed. Mean values between male and female were compared using a t-test (significance p < 0.05).

Results: Regression analysis showed a highly significant correlation (p < 0.001) of the cross-sectional areas of the midsubstance ACL (A, APCL) to the anterior notch inlet and posterior notch outlet. The correlation between the cross-sectional notch area (AN) on the middle notch plane and both cross-sectional areas of the midsubstance ACL (A, APCL) was significant (0.001 < p < 0.05). The NWI showed a significant correlation (0.001 < p < 0.05) only to the notch area (AN) on the anterior notch inlet. Female participants had significantly smaller cross-sectional areas of the ACL (A, APCL) and notch areas on all 3 notch planes (p < 0.05). No significant differences in the NWI between the sexes was found.

Conclusions: The smaller the intercondylar notch the smaller the cross-sectional area of the ACL. In addition to the published impingement of the ACL at the anterior and posterior roof of the notch, a biomechanically weaker ACL may be the reason for disposition to ACL rupture in patients with a small intercondylar notch. The higher incidence of ACL injuries in female is possibly related to this anatomic finding. In contrast to other authors, which have been suggesting the NWI as the best indicator for notch width measurement, the results of this study show that measurement of the inlet and outlet areas of the notch are superior to predict ACL size.
INTRODUCTION: Differences in results of ACL reconstruction between males and females have been reported. Some authors report greater laxity in females compared to males undergoing ACL reconstruction with a semitendinosus autograft while some report no difference in laxity between males and females using the patellar tendon autograft. The purpose of this study is to determine if there are differences in the results of ACL reconstruction between males and females using the patellar tendon and semitendinosus autografts.

METHODS: Two groups of 40 athletes underwent ACL reconstruction using either a bone-patellar tendon-bone (BPTB) or a quadrupled semitendinosus autograft (ST). There were 26 males and 14 females in the BPTB group and 22 males and 18 females in the semitendinosus group. All patients were operated on by the same surgeon within 6 months of injury and underwent aggressive rehabilitation programs. At an average of 36 months, the patients were assessed with clinical evaluation, computerized knee laxity analysis, isokinetic and functional strength tests, and standard knee scores. Differences between males and females in each group were analysed by statistical analysis using student's t-test.

RESULTS: We found no significant difference in isokinetic and functional strength tests between males and females in both groups. In the BPTB group, 74% of males and 93% of females had a side-to-side difference of less than 3 mm. In the ST group, 82% of males and 76% of females had less than 3 mm of side-to-side difference. The average side-to-side difference in the ST group was 2.3 for the females versus 1.7 mm in the males.

DISCUSSION: Our results suggest that there is a slight anterior laxity in females undergoing hamstring tendon graft ACL reconstruction compared to males. Also, we noted higher incidence of anterior knee pain in female patients undergoing BPTB ACL reconstruction compared to the males (20% vs 14%). In the ST group, the incidence of anterior knee pain in females was 12% vs 8% in males.

CONCLUSION: For female athletes undergoing ST ACL reconstruction, there is a slightly increased anterior laxity compared to the males, but this was not statistically significant. For female athletes undergoing BPTB ACL reconstruction, there was no trend towards increased laxity.

Paper #65
COMPACCTION DRILLING DOES NOT INCREASE THE INITIAL FIXATION STRENGTH OF THE HAMSTRING GRAFT IN ACL RECONSTRUCTION IN A CADEAVER MODEL
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Harri Siivuinen, Tampere, FINLAND
Markku Järvinen, Tampere, FINLAND
Teppo L. N. Järvinen, Tampere, FINLAND, Presenter
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Twenty-two pairs of human cadaver tibiae (44 tibiae in total) were used to assess the initial fixation strength of quadrupled hamstring tendon grafts fixed with round threaded tibia-spe-
cific bioabsorbable interference screws (BioRCL, Smith & Nephew Inc.) in tibial bone tunnels, the tunnels made with either compaction drilling or conventional extraction drilling. The specimens were first subjected to a cyclic loading test (1500 loading cycles between 50 and 200 N at 0.5 Hz frequency) and the surviving specimens were then loaded to failure at a rate of 1.0 m/min (single cycle load-to-failure test). During the cyclic loading test, no significant stiffness or displacement differences were observed between the two drilling techniques. Three specimens failed in the compaction drilling group, while there were no failures in the extraction drilling group. In the subsequent single cycle load-to-failure test, the average yield load was 446 +/- 86 N in the compaction drilling group and 455 +/- 115 N in the extraction drilling group (p=0.33). Significant group differences were neither found with regards to displacement at yield load, stiffness, or mode of failure. Trabecular bone mineral density at the site corresponding to the actual site of the tibial bone drill hole in the ACL reconstruction was determined using peripheral quantitative computed tomography (pQCT) and no significant difference was found between the compaction drilling group (179 +/- 39 mg/cm3) and the extraction drilling group (173 +/- 32 mg/cm3). In conclusion, considering the initial fixation strength of a hamstring tendon graft in ACL reconstruction, compaction drilling does not provide any advantage over the conventional extraction drilling.

Paper #66
BIOMECHANICAL PROPERTIES OF HAMSTRING GRAFT FIXATION TECHNIQUES WHICH ALLOWS FOR CIRCUMFERENTIAL GRAFT INGROWTH. EXPERIMENTAL STUDY WITH ROENTGEN-STEREOMETRIC-ANALYSIS (RSA).
Frank Adam, Homburg/Saar, GERMANY, Presenter
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Introduction
Hamstring tendon grafts are increasingly used in ACL reconstruction. A maximum of bone contact inside the tibial tunnel is recommended for stable ingrowth of the graft. Some doubt exists about the elasticity of fixation and the primary stability that can be achieved with graft fixation techniques which allow for circumferential graft ingrowth. The purpose of the present study was to evaluate the ultimate failure load, stiffness of fixation and slippage of Hamstring grafts fixed with Washer-Lock (Arthrosision), Cross-Pin (Mitek) or Suture-Disc (Aesculap) technique. We designed a standardized experiment to compare these groups in an animal model with high precision RSA.

Materials and Method
We used 30 porcine specimens for the study. The extensor hallucis longus tendon of the front leg was folded to a four-stranded graft and sutured with a baseball stitch. Graft diameter was 9mm in all samples. The graft was anchored within a tibial tunnel of the same diameter and 40mm length. The sutured end of the four-stranded graft was fixed with a Washer-Lock (WL) or two Cross-Pins (CP). In the Suture-Disc (SD) group 8 polyester sutures (Ethibond 5USP) were knotted over a titanium button. Ten trials were performed in each group. The tibial bone and the tendon-graft were marked with tantalum beads. After fixation preloading with 100N was performed over 2 minutes. The grafts were then loaded axially under RSA control increasing the force in steps of 50N to load of failure. Micromotion between tendon graft and tibial bone was measured with RSA.

• The FDA has not cleared the drug and/or medical device for the use described in this presentation (i.e., the drug or medical device is being discussed for an “off-label” use).
Results
Accuracy of RSA for the in vitro study was evaluated 0.03mm. Load at failure was significantly higher (p<0.01) for the WL and CP fixation (722±173N, 647±129N) compared to SD fixation (445±37N). Failure was caused in the WL and CP group by tendon rupture. The SD fixation failed in all cases by rupture of the suture material. Stiffness of fixation was significantly higher for WL and CP fixation (492±226N/mm; 416±173N/mm) compared to SD fixation (111±26N/mm, p<0.01). Graft slippage of more than 0.5mm was observed at lower loads for SD fixation (47N) compared to WL and CP (344N, 250N). Slippage of the graft at 200N was significantly higher in the SD group (1.85mm) than for the WL (0.83mm) and CP (0.3mm) fixation. Graft motion between loaded and unloaded graft (elastic deformation or Bungee cord effect) at 200N for the SD was measured 1.32mm, for the CP 0.50mm and for the WL 0.22mm in average.

Conclusions
After graft fixation with linkage suture material knotted over a titanium button the construct had a low linear stiffness and the graft slipped out of the bone tunnel at lower loads. Low linear stiffness allows for a high amount of elastic deformation (Bungee cord effect). Graft slippage was observed at loads that may occur during rehabilitation after ACL reconstruction. Direct fixation of a quadrupled tendon graft by using a Washer-Lock or Cross-Pins is preferable to Suture-Disc fixation.

Keywords: ACL reconstruction, Hamstring tendon, Fixation technique, Biomechanics, RSA

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**Paper #67**

**THE USE OF CAOS (COMPUTER ASSISTED ORTHOPAEDIC SURGERY SYSTEM) TO EVALUATE THE INTRA- AND THE INTER-SURGEON RELIABILITY IN TUNNEL PLACEMENT FOR ACL RECONSTRUCTION**

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Patrick Genoud, Geneva, SWITZERLAND
Domizio Sava, Geneva, SWITZERLAND
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Objectives: 1) To evaluate surgeon reliability in tunnel placement for ACL reconstruction with the use of the CAOS system; and 2) to evaluate the efficiency of CAOS to assist the surgeon with tunnel position.

Background: The success of anterior cruciate ligament reconstruction depends upon the correct placement of tibial and femoral tunnels. Failures are usually due to mal-position of the tibial and / or femoral tunnels.

Design/Methods: A standard arthroscopic approach was performed in three cadaver knees and 14 surgeons (5 orthopaedic fellows, 5 general orthopaedic surgeons and 4 knee surgeons) were asked to place femoral and tibial tunnels. They, then, placed femoral and tibial tunnels with the use of the CAOS system. All the points were recorded and compared to tibial and femoral reference points (from the ideal graft) using a data processing software on Matlab.

Results: Intra-surgeon reproducibility was 1.1 mm on the femur and 1.4 mm on the tibia. The mean variability was 3.1 (1.4) mm and 3.4 (0.8) mm. The inter-surgeon variability was 6.3 (3) mm on the femur and 5.6 (1.6) mm on the tibia.

Conclusions: Intra-surgeon reproducibility is good, but variability is high which is a concern as regards clinical consequences. The inter-surgeon variability is great and depends upon experience. The CAOS system allows a more precise placement on the femur, and on the tibia only in the medio-lateral axis.

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**Paper #68**

**ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION USING PATELLAR TENDON AUTOGRAFT: TEN TO FIFTEEN YEAR FOLLOW-UP EVALUATION**

Moises Cohen, São Paulo, BRAZIL, Presenter
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Purpose: Retrospective reviewed the results of anterior cruciate reconstruction using the central third of patellar tendon, after 10 to 15 year follow up. The auality of the degenerative changes and the sports return were evaluated.

Methods: 62 patients were examined according generic questions of a vality of live and specific about the knee physical examination, functional test, KT-1000R, radiographic study an included in SF-36, Lysholm and objective IKDC protocols. The subjective satisfaction and the level of sports return were considered.

Results: After ten fifteen year follow up, the Lysholm score was 23 (37.1%) patients excellent (95-100), 26 (41.9%) good (84-94), 11 (17.7%) fair (63-83) and 2 (3.2%) bad (< 64). The relation between the satisfaction level and the SF-36 score showed just 5 (8.1%) patients unsatisfaction. Even the high level of subjective satisfaction (91.9%) the final evaluation of the objective IKDC was, no patient as normal (A), 31 (50%) almost normal (B),23 (37.1%) abnormal (C) and 8 (12.9%) severely abnormal. In general the range of motion was decreased in the operated knees. The Lachman test was negative in 27.4%, (+)in 40.3%, (++) in 20.9% and (+++) in 11.3%. The Pivot Shift was considered normal in 33.9%, (+) in 56.3% and (++) in 9.7%. The KT-1000 showed 32.3% of abnormal results compartment (>3mm). Degenerative changes were detected in the medial compartment of 41 (66.2%) patients, lateral compartment in 36 (58%) and femoropatellar in 46 (74.2%) patients. It was found a strong relation between degenerative arthritis and previous meniscectomy. The Caton-Deschamps index was normal in 54(87.1%) patients and low patela was found in 8 (12.9%) with no significant relation between degenerative arthritis and previous meniscectomy. The sports return occurred in 66.1%, change of the sports in 16.1% and no return in 17.7%. The worst results of Lachman test and pivot shift corresponded to the worst levels of sports return activities.

Conclusions: 1. The general and knee specific score were less rigid than the IKDC objective; 2. The best interpretation of the results occurred in the subjave and objective protocols associa- tions; 3. The degenerations champs were predominant in the femoropatellar joint; 4. The meniscectomy determined the degenerative change on the lateral and medial compartment; 5. The ACL reconstruction was not enough to avoid the degenerative changes in the articular surface.
Paper #69
ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION. A PROSPECTIVE RANDOMIZED STUDY OF PATELLAR AND HAMSTRING TENDON AUTOGRaFTS
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Erik Linke, Helsinki, FINLAND
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We prospectively compared the outcome of anterior cruciate ligament reconstruction using patellar tendon autograft with outcome using hamstring tendon autograft. Ninety-nine patients with laxity due to a torn anterior cruciate ligament underwent arthroscopically assisted reconstruction with graft randomization according to birth year. Excluding preoperative Lysholm score there were no significant differences between the 2 groups in preoperative and operative data. A standard rehabilitation regimen was used for all patients including immediate mobilization without a knee brace, protected weight bearing for 2 weeks, and return to full activity at 6 to 12 months postoperatively.

Forty-three patients in the patellar tendon group and 46 patients in the hamstring tendon group were available for clinical evaluation at a minimum of 21 months after surgery (range 21 to 38 months). The results revealed no statistically significant differences with respect to clinical and instrumented laxity testing. International Knee Documentation Committee ratings, isokinetic muscle torque measurements, Lysholm (knee score), Tegner (activity level) and Kujala patellofemoral knee score. The patellar and hamstring tendon autograft anterior cruciate ligament reconstructions showed equal results 2 years after surgery. Both techniques seem to improve patients' performance.

Paper #70
THE EFFECT OF KNEE FLEXION ANGLE AT THE TIME OF GRAFT FIXATION IN ACL RECONSTRUCTION WITH A PATELLAR TENDON GRAFT
Julian A Feller, Melbourne, AUSTRALIA, Presenter
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Background: There are a number of surgical variables during anterior cruciate ligament (ACL) reconstruction which can potentially affect graft tension and function.

Aim: To determine whether the angle of knee flexion at the time of graft fixation affects the clinical outcome following ACL reconstruction using a patellar tendon (PT) graft.

Methods: Using a prospectively created database of patients undergoing ACL reconstruction by a single surgeon, 90 eligible patients were identified who had undergone a reconstruction for an isolated ACL rupture between 3 weeks and 12 months following injury. A PT graft was fixed proximally with an Endobutton and distally with a bioabsorbable interference screw. At the time of distal fixation the knee was flexed to 70 degrees in 33 patients and was at 0 degrees extension in 17 patients. An independent research assistant reviewed all patients at 12 months. Variables recorded included extension and flexion deficits, KT-1000 measured anterior knee laxity, anterior and kneeling pain severity, Cincinnati score and IKDC rating.

Results: There was a trend towards increased extension deficit in the group fixed at 70 degrees (0: mean 0.04 deficit, 70: mean 1.3 deficit, p = 0.055). No other difference was identified between the two groups. There was no correlation between extension deficit and anterior knee laxity.

Conclusion: Fixation of a PT graft with the knee at 0 rather than 70 appears to result in less extension deficit without compromise of stability or function.

Paper #71
THE PREVALENCE OF ANTERIOR KNEE PAIN AFTER ACL RECONSTRUCTION – A CONTROLLED CLINICAL TRIAL
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Jonathan Embersen, London, UNITED KINGDOM
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AIM
We determined prospectively the incidence and prevalence of anterior knee pain following ACL reconstruction using autogenous ipsilateral bone-patella-tendon-bone graft in a cohort of 60 patients.

METHODS
Sixty operations were performed consecutively in 60 knees by the same surgeon and all patients underwent the same rehabilitation protocol. The frequency and severity of anterior knee pain experienced during activities of daily living, sports, prolonged sitting, stair climbing and kneeling was recorded using the Shelbourne and Trumper anterior knee pain questionnaire, the patellofemoral study group anterior knee pain questionnaire and a pain visual analogue scoring system. The location of pain and any perceived sensory change was recorded using patient-drawn diagrams. The minimum post-operative follow-up was 2 years. All results were compared with a healthy control group of 50 subjects with no history of knee surgery.

RESULTS
The average age of the control and treated groups were 22.8 and 35.6 years respectively (p<0.0001). 74% of the control group experienced no pain compared to 22.2% of the treated group at 2 years following surgery. However we noted a significant improvement in both anterior knee symptoms and sensory change in the treated group with time from 2 years to 5 years post operation (p=0.04). At 4.5 years the pain experienced in the treated group was less than that before operation and similar to that in the control group (p=0.07).

CONCLUSION
We postulate that in our series of patients anterior knee pain following ACL reconstruction with autogenous bone-patella tendon-bone graft diminishes within 3 years to that found in a young and healthy population.

Paper #72
TUNNEL WIDENING AFTER ACL RECONSTRUCTION IS DEPENDENT ON TYPE OF FIXATION USED. A PROSPECTIVE RANDOMIZED STUDY COMPARING TWO DIFFERENT FIXATION METHODS FOR HAMSTRING GRAFTS.
Peter Faunoe, Aalborghoj, DENMARK, Presenter
Soeren Kaalund, Randers, DENMARK
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Purpose: To compare the incidence of tunnel widening (TW) in patients undergoing ACL reconstruction with hamstring graft using either A) transfixation implant, (Transfix, Arthrex) in femur and interference screw (Arthrex) in tibial tunnel or B)
endobutton in femur and bicortical screw and washer distally to the tibial tunnel.

Material and Method: 100 patients were included and randomized. 87 patients was assessed at a one year follow-up. The evaluation included standardized X-rays, KT-1000, IKDC and Lysholm score. The diameter of the tunnel at one year follow-up was, after correction for magnification, compared to the originalreamed diameter. A more than 2mm enlargement was considered TW.

Results: In the group, where transfixation in femur and interference screw in tibia was used, 7/41 had developed femoral TW and 9/41 in tibia. In the endobutton group 20/46 had TW in femur and 16/46 in tibia. (Fishers exact test <p=0.05) No difference was found with respect to Lysholm score, IKDC or arthroscopic evaluation.

Conclusion: There was a significant reduction of TW in both femur and tibia using fixation points close to the joint comparing to the system where the distance between the fixation points is long. We conlude that the position of the fixation site and the quality of the fixation device are major factors in the development of TW after ACL surgery.

Paper #73
ASSESSMENT OF THE PATELLO-FEMORAL JOINT FOLLOWING ACL RECONSTRUCTION, USING PATELLAR TENDON GRAFT VERSUS HAMSTRING QUADRUPLED GRAFT
Mohamed Hossam Elshafie, Alexandria, EGYPT, Presenter
Mohamed Emad Eid, Alexandria, EGYPT
Alexandria University, Alexandria, EGYPT

Objectives: The aim of this prospective study was to evaluate the effect of ACL reconstruction on Patello-femoral joint, comparing between the BPTB graft and doubled STG graft.

Material and Methods: Seventy-seven patients which underwent ACL reconstruction using BPTB graft and doubled STG graft were studied, 40 in the BPTB group and 37 in the STG group. The procedure was standard in both groups. In the BPTB group, the patellar tendon defect was not closed and the graft was fixed with metal interference screws, for the STG group the graft was fixed using the endobutton for the femoral side and spiked washer and screw for the tibial side. Postoperatively all patients had the same accelerated rehabilitation program. All patients were evaluated clinically and radiologically at 18 months postoperatively. The clinical examination includes, 1- Presence of PF pain. 2-Patellar crepitus. 3-Patellar irritability. 4- Range of motion. 5-Thigh atrophy. The radiological examination was taken pre-operatively and at late follow-up, the following were recorded, 1- Patellar height (Insall/Salvatti ratio). 2- Sulcus angle. 3-Lateral PF angle. 4-Merchant congruence angle (CA). The pre-operative radiographic measurements were compared to the postoperative value and this was correlated to the clinical findings.

Results: Anterior knee pain was present in 45% and 13.5% in both the BPTB group and STG group with a significant difference. Patellar irritability and patellar crepitus were higher in the BPTB group. Flexion contracture was present in 20% and 5.4% in both BPTB and STG group respectively. There was a positive correlation between the presence of PF pain as compared to patellar irritability, flexion contracture, and patellar crepitus in the BPTB group. Also there was a positive correlation between PF pain and thigh atrophy in both groups. Radiological investigation showed, a significant patellar tendon shortening (65%) in the BPTB group as compared to the preoperative values. There was a significant decrease in the Merchant congruence angle (CA) in the BPTB group as compared to the preoperative recorded value. Significant correlation was found between PF pain and patellar tendon shortening, but not to the postoperative recorded CA in the BPTB group. The STG group did not show significant changes in the PT length, or CA. The Lateral PF angle and the sulcus angle showed no significant changes post-operatively.

Conclusions: In the BPTB group, there was a higher incidence of PF pain which correlated significantly with the PT shortening, patellar crepitus, patellar irritability, flexion contracture and thigh atrophy. In spite of significant changes in the Merchant congruence angle postoperatively in the BPTB group, it was not correlated to PF pain or PT shortening. In the STG group of ACL reconstruction, lower incidence of PF pain was found, with no significant changes in the PT length or Merchant angle.

Paper #74
HAMSTRING-ACL-REPLACEMENT IN CHILDREN AND ADOLESCENTS
Andree Ellermann, Pforzheim, GERMANY, Presenter
Christian Sobau, Viernheim, GERMANY
ARCUS Sportklinik, Pforzheim, GERMANY

Looking at the controversy discussion about indication, transplant choice and fixation techniques in active ACL-injured patients with open physes we decided to operate even in childhood using a hamstring graft.

24 patients (14 female/10 male) operated at an age between 10 to 18 years (mean 14,3) were examined at mean I/f/u of 32 months (range 13-77) postoperatively. ACL-replacement was performed with a four strand hamstring reconstruction using an Endobutton and a Suture Washer for fixation. The manually drilled tunnels were positioned transepiphyseal in the anatomic position. The mean diameter of the tunnels were 7,75 mm (range 6-10) on the femoral and 8,3 mm (range 6-11) on the tibial side.

Measured with the IKDC-Score 79% were classified as normal or nearly normal. Mean Tegner Score was 7,1 (range 5-9). Three patients developed an instability within the first 12 months, two of them due to an adequate trauma. Clinical and radiological examinations did not show growth disturbances in any patient. The results did not correlate to gender.

Presuming a bad progression in conservatively treated ACL-injured young patients and performing a careful operative treatment (small tunnel diameters, ligamentous graft, extracortical fixation, etc.) the above mentioned technique shows satisfying results and enables the young patient to return to every day activity and sports on a satisfying level.

Paper #75
ARTHROSCOPIC FIXATION OF THE FRACTURES OF THE INTERCONDYLAR EMINENCE VIA NEW PORTAL
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O Ahmet Atay, Onur Terek and Guersel Lekibicigil, TURKEY

A new technique is described for arthroscopic reduction and internal fixation of fractures of the intercondylar eminence of the tibia. In this technique cannulated screws are placed through “Transquadricipital tendinous” portal. Avulsion fracture of the intercondylar eminence at the insertion of the anterior cruciate ligament (ACL) is the bony equivalent of a
ligamentous rupture. This mode of ACL failure is mostly seen in children and adolescents. However, these fractures are also seen with increasing frequency in adults. Satisfactory reduction is essential to prevent nonunion or malunion of a fracture, which in turn can cause persistent problems such as knee pain, loss of extension and laxity of the ACL. The management of fractures is uncomplicated and straightforward when they are minimally displaced. However, the treatment of displaced and complete separation fractures has been controversial and there is no common agreement about reduction and fixations of these fractures.

Twelve patients (7 male, 5 female) who were treated with this technique for displaced Type II and Type III fractures of the intercondylar eminence of the tibia were reviewed at mean forty-nine months. At follow-up all of the patients had a high rate of excellent or good results without any case of non-union of the fracture or related complications, such as functional instability.

Placement of cannulated screws through transquadricipital tendinous portal achieved fragment reduction easily and provided rigid fixation while avoiding arthrotomy. This procedure performed on a daily basis, under general anesthesia and allowed early mobilization and return to activity at sixth week.

This report describes a new technique of arthroscopic reduction and antegrade cannulated screw fixation of displaced intercondylar eminence of tibia fractures through transquadricipital tendinous portal.

Paper #76

FOAM-REINFORCED TIBIA FROM AN ELDERLY HUMAN IS A BETTER ALTERNATIVE THAN ANIMAL TIBIA FOR EVALUATING ACL FIXATION DEVICES

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Background: Cortical and cancellous soft-tissue fixation methods are tested in animal bone because knees from young humans are in short supply. Animal bone is denser than human bone, which may overestimate fixation properties, which include stiffness, rate of slippage, and yield. The purpose of our study is to describe a simple, inexpensive tech-nique for reinforcing tibia from elderly humans with liquid polyurethane foam and then determine whether foam-reinforced tibia is a better substitute for young tibia than porcine tibia for evaluating soft-tissue fixation methods.

Methods: Stiffness, rate of slippage and yield were determined for fixation of a four-strand tendon graft with a cortical device (WasherLoc) and a cancellous device (metal interference screw) in foam-reinforced tibia from elderly humans (average 83 years), porcine tibia (skeletally mature), and young human tibia (average 35 years). Statistics were performed using a MANOVA and unpaired T-test.

Results: The overall fixation performance and individual fixation properties of a cortical and cancellous fixation method tested in foam-reinforced tibia from elderly humans were similar or more conservative than fixation properties in young human tibia. Porcine tibia overestimated the fixation properties of young human tibia.

Conclusions: Testing a cortical and cancellous soft-tissue fixation method in foam-reinforced tibia is a reasonable alternative when young human tibia is not available. The use of animal bone overestimates the performance of cortical and cancellous soft-tissue methods and should be avoided.

Paper #77

ELEVATED LATERAL PATELLAR FORCE IS RELATED TO INCREASED LATERAL PATELLAR SPIN

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INTRODUCTION
Patellofemoral pain accounts for 33.2% of all knee disorders in women and 18.1% of all knee disorders in men. It is widely assumed that this pain is caused by abnormally high pressures on the lateral facet of the patella. Surgical procedures and rehabilitation protocols aimed at relieving patellofemoral pain are designed to realign the patella so that a more even distribution of contact pressure is achieved in the joint. It is not clear which features of patellar tracking are linked to high forces and pressures on the lateral patellar facet, and therefore it is not clear which features of patellar tracking must be corrected to relieve these high forces and pressures.

RESEARCH QUESTION
Which features of patellar tracking are linked to elevated contact force on the lateral patellar facet?

METHODS
Nine unembalmed human cadaver knee joints were tested. Each specimen was flexed in a test rig (Oxford rig) designed to simulate a continuous loaded squat while allowing unconstrained movement between the tibia and the femur. Specimens were flexed continuously from full extension to 70 degrees of flexion under a vertical hip load of 120 N. A motion analysis system (Qualisys, Glastonbury, CT) measured movement of marker clusters fixed rigidly to the femur, tibia and patella. Patellar tilt, flexion, spin and medial-lateral shift were determined by representing patellofemoral movement with a sequence-independent gyroscope coordinate system.

A new technique was used to measure contact force and pressure and determine how they were distributed across the patella. Contact pressure and force distribution were measured with a sensor (Iscan, Tekscan, Boston, MA) fixed to the patella. Prior to loading the specimen, landmarks describing the proximal, distal, medial and lateral orientation of the patella as well as the patellar circumference and ridge were identified. Landmark position and contact mechanics data were merged using a custom computer program to determine the distribution of force and pressure on the lateral and medial patellar facets.

Kinematics and pressure distribution were measured for continuous loaded flexion of the knee with the following extensor mechanism alignments:

• normal alignment (all knees)
• after simulating patellar malalignment by moving the proximal extensor mechanism laterally to create a mean O-angle increase of 7.5 degrees (all knees)
• after coronal osteotomy to move the tibial tubercle medially in knees with elevated O-angles (7 knees) or
• after moving the extensor mechanism medially to create a mean O-angle decrease of 5 degrees from normal (2 knees)
We tested the hypotheses that increased force on the lateral patellar facet is correlated with increased a) patellar tilt b) patellar spin c) patellar flexion and d) medial-lateral patellar position at full extension with scatter plots and the Pearson correlation coefficient.

RESULTS AND DISCUSSION

Increased lateral patellar spin (rotation moving the superior pole of the patella laterally) correlates significantly with increased force on the lateral patellar facet at full extension ($r = 0.52$; $n = 9$; $p < 0.05$) for the range of spin studied (-6.5 to +13.1 degrees).

Although similar ranges of patellar tilt and flexion were studied (patellar tilt range -12.9 to +9.2 degrees; patellar flexion range -9.9 to +4.2 degrees) there was no significant correlation between either tilt or flexion and increased lateral facet force.

There was no significant correlation between medial-lateral shift (range -4.7 to +4.8 mm) and increased lateral facet force.

We found no evidence for the widely-held view that elevated lateral contact force is related to changes in patellar tilt or medial/lateral position. The importance of patellar spin in predicting lateral facet force is especially noteworthy because spin is rarely assessed during physical or radiological exam for patellofemoral disorders. The results suggest that diagnostic tests for patellar malalignment should focus on assessing patellar spin and that treatments for patellofemoral syndrome should aim to restore patellar spin to normal.

ACKNOWLEDGEMENTS

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Paper #78

BIOMECHANICAL COMPARISON OF THREE TYPES OF SCREW FIXATION IN A CADAVER TRANSVERSE PATELLAR FRACTURE MODEL

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OBJECTIVE: Arthroscopy aided percutaneous cannulated screw fixation has been recently described for the treatment of select patellar fractures. The aim of this study was to compare the mechanical characteristics of three different types of screw fixation constructs, including two that are used in arthroscopy aided techniques, in a cadaver transverse patella fracture model.

MATERIALS & METHODS: 11 fresh cadaver patellae (mean age 56) with intact quadriceps & patellar tendons were harvested. A transverse fracture was created with an oscillating saw and then fixed with two parallel 4.0 mm partially threaded cannulated screws. Three types of screw constructs were tested: Group 1: Screw fixation alone, Group 2: Screws and rectangular cerclage wiring through the screws, Group 3: Screws and crossed anterior tension band wiring (again passed through the screws). The patellae were mounted on a specially designed distal femur jig and loaded at 45 degrees of flexion with custom clamps holding the attached tendons. A material testing device was used to distract the constructs after a pre-tensioning load of 10 kg.

RESULTS: The mean load necessary for 3mm distraction at the fracture site was 37.3 kg for Group 1, 56.7 kg for Group 2, and 67.2 kg for group 3. All constructs failed at the fracture site. The weakest construct was two parallel screws. The difference between Group 1 and Group 3 was statistically significant ($p=0.013$) but no significant difference could be observed between Group 2 and Group 3 ($p=0.199$).

CONCLUSION & CLINICAL SIGNIFICANCE: Cannulated screws provide stable fixation in patellar fractures of young patients. However, screw fixation is jeopardized in older patients with osteopenic bone. Berg has described an anterior crossed tension band wiring passed through the cannulated part of the screws to increase the stability in osteopenic bone. However, this construct cannot be used in arthroscopic percutaneous techniques as an anterior incision is necessary to tighten the crossed wires. We have described a rectangular cerclage wiring through cannulated screws to increase the fixation stability in arthroscopic techniques. This biomechanical study confirms that, the addition of cerclage wiring through the cannulated screws increases the load to failure of the screw fixation construct. Rectangular cerclage wiring not only produces a fixation stability comparable to anterior crossed cerclage wiring but also has the advantage of being used in an arthroscopy aided percutaneous manner.

Paper #79

THE MORPHOLOGY OF THE PATELLA: ANALYSIS IN 190 CASES OF RECURRENT PATELLAR DISLOCATION

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Introduction

The aim of this study is to analyse the morphology of the patella in patellar recurrent dislocation and to know if there is a patellar dysplasia.

Material and methods

140 patients (190 knees) are included in this retrospective study. There was 80 females and 60 males. The mean age was 22.6 years (13-47). The patellar morphology was analysed by X-rays (axial and lateral views in 30° of flexion) for all cases. We were interested in the measure of the patellar tip, so called the “nose.” The patellar tendon has also been measured. The width of patella was measured using CT-scan ($n = 158$). The patella was also studied by MRI ($n = 64$). The length of patella, of articular surface, of patellar tendon and of the width too were measured.

Results

By using the Grelsamer’s classification, there was 80% normal “noses” in our series. We found that more the patellar nose is short, more the patellar tendon is long ($p < 0.05$). By using the Wiberg’s classification, there was more dysplasic patella (stage C) among the male ($p = 0.007$). There is a correlation between the Wiberg’s classification and the Malague classification too. The length of patellar medial side and the patellar angle were two factors directly linked to the Wiberg’s classification. The patellar width measured by CT-scan was 39.1mm. By MRI, we found a mean patellar tendon of 53.8mm, a mean articular surface of 30.8mm, a patellar length of 40.6mm and a mean width of 38.7mm. No correlation was found between trochlear dysplasia and patellar morphology.

Discussion

Since Wiberg in 1941, few authors in literature had analysed the patellar morphology. We think a particular morphology does exist in recurrent patellar dislocation. The hypoplasia of medial side in Wiberg stage C, the aspect of short patellar nose confirm this hypothesis.
Conclusion

The hypothesis of patellar dysplasia was rarely studied in relation to trochlear dysplasia, the main factor of recurrent patellar dislocation. The decrease of medial side, the variable size of patellar bone is some characteristic in recurrent patellar dislocations.

Paper #80

EVALUATION OF LATERAL PATELLAR RETINACULUM IN UNSTABLE PATELLA USING MRI

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Purpose: The pathophysiology of the unstable patella is confused with many factors involved. There are two types of patellar mobility. One is seen in the patella with lateral patellar retinaculum (LPR) tightness and the other is hyper mobile patella. The purpose of this study was to evaluate the thickness of LPR in these two types of the patella using MRI axial images, and to compare that with normal LPR.

Materials and Methods: 18 cases with 30 unstable patella were divided into two groups by physical examination using passive patella tilt test and passive patella glide test. One group was unstable patella with LPR tightness (Group LT), and the other was unstable patella without LPR tightness (hyper mobile patella) (Group HM). Group LT included 14 cases with 23 knees, and Group HM included 4 cases with 7 knees. These two groups were compared to 30 cases with 30 normal knees without any symptoms derived from the patello-femoral joint. Thickness of LPR was measured using NIH Image 1.61 (U.S. National Institutes of Health) on MRI axial images. The portions of measurement were patella attachment of LPR, midsubstance of LPR and lateral femoral epicondyle attachment of LPR.

Results: The results showed that the LPR in Group LT was thicker than that of the HM and control groups, especially at the midsubstance of LPR and near its attachment of lateral femoral epicondyle.

Conclusion: We concluded that MRI axial image is useful not only for the evaluation of the alignment of bony structures or condition of articular cartilage, but also of the tightness of LPR. MRI axial image is one of the diagnostic options to apply the LPR release to the unstable patella.

Paper #81

10 YEAR RESULTS OF ARTHROSCOPIC SURGERY FOR PATELLAR TENDONITIS

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Introduction

Treatement of Patellar Tendonitis can be difficult, and non-operative therapy such as electrotherapy, stretching, eccentric quadriceps exercises, NSAID and steroid injections may not be effective. Various techniques have been described for the surgical treatment of the condition, including division of the tendon from its insertion to the inferior pole, reattachment, excision of the inflammatory lesion and excision of the inferior pole of the patella. The results of these techniques have met with mixed success. The technique of arthroscopic decompression of patellar tendonitis was first undertaken in 1991.

Objective

We report the 10 year experience of using this technique.

Methods

Patients presenting with this condition were subjected to clinical, radiological and MRI assessment. If the symptoms continued to be significant despite non-operative treatment, patients were counselled and consented for the arthroscopic procedure. The procedure used a Dyonics shaver the fat pad was elevated from the area of the patella to expose the non-articular inferior pole of the patella. The tendon fibres were then elevated from the anterior surface of the inferior pole, and the 5mm tip of the patella was excised taking particular care to ensure that the full AP thickness was removed. Patients were mobilised full weight bearing and discharged as a day case with anti-inflammatory medication for 3 to 6 weeks. Range of motion exercises and general physiotherapy was undertaken for 6 weeks and only then was rehabilitation, cycling and non-impact activity allowed. Jogging and sports was allowed after 9-12 weeks as tolerated.

Results

Seventy three knees underwent surgery, in four cases a simultaneous bilateral procedure was performed and in 11 cases previous surgery had been performed elsewhere. The average age was 33 years, 64 of the cases were male. The average duration of symptoms was 20 months and all patients had undergone non-operative treatment prior to the index procedure. The average duration of follow up was 26 months. Clinical review demonstrated that patients experienced a significant improvement in the clinical grade of symptoms and function with 85% (99 of 69) knees achieving a good or excellent result. The average time to return to work and driving was 3 weeks and to sport was 7 weeks. Four patients required subsequent surgery of arthroscopy and a further resection of the inferior pole. One patient a further arthroscopy and lateral release for lateral retinacular pain and subluxation. Two patients required a steroid injection because of continuing symptoms and one other patient had a poor result with no improvement in her symptoms, but refused further follow up or treatment.

Conclusion

The procedure of arthroscopic decompression of patellar tendinosis by arthroscopic excision of the inferior pole of the patella, results in 85% good or excellent long term results. This is superior to the other reported techniques for the treatment of patellar tendonitis. The procedure is safe, reproducible, with no complications and few failures. We conclude that excision of the inflammatory nodule and fat pad in this condition is unnecessary, other than to obtain visualisation of the inferior pole of the patella. The success of this procedure supports the suggestion that this condition is produced by a compression of the tendon and is best treated by decompression of the inferior pole patella.

Paper #82

THE RELATION BETWEEN KNEE FLEXORS AND EXTENSORS IN SOCCER PLAYERS

Edison Schwansee Thiele, Curitiba, BRAZIL, Presenter
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Introduction

The balance between knee flexors and extensors can be very important in preventing overuse injuries. The extensors gener-
ate the knee extension power, and the flexors must act to
descelerate the tibia during knee extension, that way absolving
the energy developed by the quadriceps muscle (Garret et al, 1984). If either the quadriceps is relatively stronger or the ham-
strings are relatively weaker, a muscle lesion might happen.In
athletes with a 10% difference between flexors and extensors,
there is a probability of muscular and tendinous lesions (Safran
et al, 1989). We also observe that athletes with flexors strength
less than 60% of the quadriceps are more susceptible to lesions.
Grace et al (1984) did not identify any relation between muscular
imbalance and lesions in 172 american football college play-
ers. Our study has 2 objectives: determine the concentric
flexion/extension torque in soccer athletes, to compare the ago-
nist/antagonist relationship in diferent speeds. The sample was
composed by 9 under 20 soccer players, with no history of pre-
vios lesions. The data were obtained with an evaluation with
the equipment Cybex 2000, e treated statiscally by the package
STATISTICA 6.0. We used the Student t test to detect differences
between flexors and extensors.

Paper #83
LONG-TERM RESULTS OF TREATMENT OF QUADRICEPS TENDON RUPTURES
Massimo Cipolla, Roma, ITALY
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Clinica Valle Giulia, Roma, ITALY
Purpose: To show the long-term follow-up results of the surgi-
cal treatment of an uncommon injury of the knee: rupture of the
quadricips tendon.

Materials and Methods: Between 1990 and 2000 in our Clinic 16
patients were operated on because of a partial or complete tear
of the quadriceps tendon; 10 patients (all male, average age
61.5 years) suffered for a fresh rupture of the suprapatellar ten-
don (2 partial, 8 complete ruptures including 2 retears), while 6
patients (all male, average age 29.5 years) were affected by the
chronic stage of “double patella” following an unrecognized
avulsion of the tendon from the superior pole of the patella.

The 2 partial tears were repaired by reabsorbable sutures; the 6
complete primary ruptures were treated in 3 cases by end-to-
tend non-reabsorbable transosseous sutures (Flexidene,
Brunneau*) and in the three more recent cases by non reab-
sorbable anchors (Arthrex*); the 2 retears were treated by non-
reabsorbable transosseous sutures added to a wire-loop
cerclage of the patella; the 6 neglected avulsions by removal of
the bony fragments and reconstruction of the tendon by non
reabsorbable transosseous sutures added to 7.5 mm. PDS-band
(Ethicon*). A straight-leg splint was applied in all cases and
range of motion exercises started after 15-20 days from surgery,
weight-bearing was allowed after 4 weeks from surgery. Two
patients (1 partial tear, 1 retear) reported a retear after 6
months from surgery.

Results: All patients regained a full range of motion after 8-12
weeks from surgery and could walkwithout any impairment
after 12 weeks from surgery; clinical and instrumented investi-
gation (U.S. , M.R.I.) could reveal after 6 months from surgery a
good process of healing of the tendon tissue with the inconstant
presence of some calcifications and a variable loss of the
maximum strength at isokinetic testing.

Conclusions: Quadricips tendon rupture is an uncommon tear,
peculiar of elderly sports involved patients, that can be some-
time be missed at diagnosis; this pitfall is more frequent in
proximal avulsions among younger patients. The treatment,
consisting in different kind of repairs, is generally effective, but
can nevertheless expose to a retear and can’t avoid some loss
of strength of the extensor mechanism of the knee.

Paper #84
BIOLOGIC DYNAMIC PATELLAR TENDON REPAIR
Roberto Yanez Diaz, Santiago, CHILE
Vicente Gutierrez, Santiago, CHILE, Presenter
Fernando Manuel Gonzalez, Santiago, CHILE
Fernando Radice Dieguez, Santiago, CHILE
Francisco Javier Vergara, Santiago, CHILE
Clinica las Condes and Hospital Dipreca, Santiago, CHILE

Introduction: Acute Patellar Tendon rupture is a challenge in
their treatment. There are two options after the direct repair:
One is immobilize to protect the repair and the other is to use
a metallic cerclage. Imobilization produces stiffness and
muscle wasting, and cerclage may rupture and should be
removed.

Material and Methods: 8 knees in 8 patients were operated on
after an acute Patellar Tendon rupture, and the tendon was repaired
in the usual manner. Semitendinosus Tendon was harvested
from the same side and used as a biological augmentation of
the repair. The 8 patients with an average age of 31 years (range
20 to 42 years old) were evaluated and the average follow-up
was 35 months (range 12 to 48 months). Clinical, functional
(Cybex) and imagenological (MRI and Sonography) evaluations
were performed.

Results: All the patients recovered at an average of 6 month
returning to athletics without restrictions. The range of motion,
isocinetic evaluation and stability was the same than contralateral.

Conclusion: Biological Dynamic Patellar Tendon Repair is an
excellent option for treatment of acute Patellar Tendon rupture
especially in athletes, allowing a rapid return to their activities.

Paper #85
STRESS RELAXATION OF HUMAN ANKLE LIGAMENTS
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John Neprine, Randwick, AUSTRALIA
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University of New South Wales, Sydney, AUSTRALIA

Introduction: The soft tissue constraints of all joints play an
important role in the native biomechanics as well as following
arthroplasty. While a number of studies have examined the ulti-
mate biomechanical properties of ankle ligaments in bone-liga-
ment-bone constructs, the viscoelastic properties of the ligaments
alone have not been characterized to any great respect. This
study compared the mechanical response of ankle ligaments within
physiologic loads and viscoelastic response in stress relaxation.

Materials and Methods: Three fresh frozen ankles (mean age 65)
were dissected of all superficial tissue to expose the ligaments
surrounding the joint. Eight ankle ligaments were retrieved
from each specimen by meticulously detaching them from their
bony origins. The ligaments included Medial - Anterior and
Posterior Tibiotaral (ATT & PTT), Tibiocalcaneo (TC), Laterally -
Anterior and Posterior Tibiofibula (ATF, PTf), Anterior and
Posterior Taliofibula (AtAf, PtAf), Calcaneofibula (CF). A 5mm
length was used as the gauge length for all ligaments. The liga-
ments were immersed in a warm water bath (37°C) and width
and thickness data measured with a digital caliper and tested
using a Mach-1™ Micromechanical testing system (Biosyntech,
Quebec, Canada). The ligaments were subjected to a step test
(30% strain, 60 sec relaxation). Preconditioning was then per-
formed (10 steps @30% strain). Immediately following the pre-conditioning a step test was performed (30% strain, 180 sec relaxation). This testing regime was followed by 20%, 10% and 50% step strains with 20 minutes rest between (each held for 180 sec). Data was analyzed using an analysis of variance.

Results: No ligament slippage was noted within the load ranges used in this study. Hysteresis curves were plotted for each specimen demonstrating the ligaments were preconditioned within 10 cycles under the loading conditions. Stress relaxation curves were obtained from each step test and plotted for each type of ligament (figure 1). The stress relaxation varied among each different ligament. The peak stresses were calculated for 30% strain for all ligaments. The peak stresses for the 30% strain step test (from highest to lowest) were as follows: CF, ATaF, PTaF, ATtF, TC, ATT, PTT and, PTdF. The thickest ligaments were found on the medial side (ATT - 3.5mm, PTT - 3.1mm and TC- 3.1mm).

Discussion: The medial ligaments were the thickest and broadest of the ligaments. This is consistent with previous anatomic studies. It comes as no surprise then that these have been found to be among the strongest ligaments in previous failure studies. All ligaments demonstrated a non-linear response with similar stress relaxation response.

EXPERIMENTAL TWO INSTRUMENTED TESTS FOR ANTERIOR ANKLE JOINT LAXITY: AN EVALUATION IN THE CLINICAL SETTING

João Espregueira-Mendes, Porto, PORTUGAL, Presenter
Paulo Amado, Porto, PORTUGAL
H.S. Sebastião and Porto University, Porto, PORTUGAL

INTRODUCTION: The appearance of new instruments based on the radiofrequency, using controlled thermal energy, opens new possibilities in arthroscopic surgery.

There are many surgical applications with this type of energy, based on thermal contraction of the collagen fibbers with molecular reorganisation. Nevertheless, results of the few studies published are contradictory in literature and with short follow-up. We used this treatment in patients chronic ankle instability and symptoms not solved with conservative attitudes.

MATERIAL and METHODS: We study 30 patients with chronic instability of the ankle, checked by clinical evaluation and stress X-ray (pre-op and post-op), 18 males and 12 females, with ages between 17 and 37 years, all performing sports activity, with a follow-up from 3 to 7 years. They were all operated by arthroscopy (same surgeon) using VAPR-T to retract the external ligament with a monopolar probe.

RESULTS: The results were evaluated by the AOFAS score. In this series of 30 ankles, 29 had symptomatic and objective improvements in pain and stability and 1 maintained painful symptoms with instability (reoperated with Bronstrom modified procedure). The radiological evaluation protocol showed normal values of the external angle in 25 patients.

CONCLUSION: The results of this study pointed the significant useful of radiofrequency in arthroscopic treatment of chronic instability of the ankle.

Paper #87

CHRONIC ANKLE INSTABILITY: RESULTS WITH ARTHROSCOPIC SHRINKAGE WITH TERMAL RETRACTION

João Espregueira-Mendes, Porto, PORTUGAL, Presenter
Paulo Amado, Porto, PORTUGAL
H.S. Sebastião and Porto University, Porto, PORTUGAL

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CONCLUSION: The results of this study pointed the significant useful of radiofrequency in arthroscopic treatment of chronic instability of the ankle.

Paper #88

TWO INSTRUMENTED TESTS FOR ANTERIOR ANKLE-JOINT LAXITY: AN EVALUATION IN THE CLINICAL SETTING

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Ruby Corvelein, Amsterdam, NETHERLANDS
Inger Sierevelt, Amsterdam, NETHERLANDS
Mark Smeulders, Amsterdam, NETHERLANDS
Nieck CN van Dijk, Amsterdam, NETHERLANDS
Orthopaedic Research Center Amsterdam, Department, Amsterdam, NETHERLANDS

INTRODUCTION: As a diagnostic tool and for postoperative follow-up studies, an objective measure for anterior ankle laxity can be obtained through the use of an instrumented tester. Two such testers were developed for the measurement of anterior laxity of the ankle joint complex. The purpose of this study was to evaluate the reproducibility of these testers and their functionality in a clinical setting.

METHODS: The two devices used for the study are a quasi-static ankle tester and a dynamic ankle tester. The test devices both comprise of a vertical construction to fixate the lower leg, a horizontal construction to apply a load to the calcaneus and to measure the amount of displacement. Movement of the foot-
plate enables measurement of displacement in the anterior direction. The dynamic ankle tester measures the anterior displacement of the calcaneus in relation to the tibia as a result of a hammer hitting the heel-plate. The impulse of the hammer pushes the foot forward. The resulting anterior-posterior and medio-lateral translation are measured. The load-displacement event takes place within the reflex time of the muscles, so involuntary muscle contraction cannot influence the test results. The translation values of the calcaneus in relation to the tibia as measured with the quasi static ankle tester are the result of a manually applied load up to maximally 150N. Twenty-four volunteers visited the clinic twice with minimally 1 week in between. During the first visit, 2 different observers tested the patients with both instrumented tests. Stress-radiographs were made with help of the Telos® device. During the second visit, one observer performed the manual test, the second performed both instrumented tests. Reliability coefficients were calculated to investigate inter- and intra-observer reliability. Paired t-tests were performed to determine systematical errors between the observers. Pearson correlation coefficients were determined to investigate the correlation between the two testers, manual testing and Telos® stress testing.

RESULTS AND DISCUSSION
Intra-observer reliability coefficients for the dynamic test and quasi-static test were 0.84 and 0.82 respectively (p<0.01). Inter-observer reliability was 0.83 for the dynamic and 0.82 for the quasi-static test (p<0.01). Small but significant systematical errors between the observers of 0.58 mm (6%) and 2.84 mm (12%) for the dynamic test and the static test respectively were found (p<0.01 for both tests). There were no correlations between the two testers on the one hand and the manual and Telos® test on the other, nor was there a correlation between the manual and Telos® test.

CONCLUSIONS
The reproducibility and repeatability of both test devices are good. The systematical errors represent low clinical significance but call for further improvement of the measurement procedure. Which test (device) is the best and most reliable is not yet clear. Also the manually performed test and the TELOS® test with radiographs need re-evaluation.

Paper #89
RETROCALCANEAL BURSOSCOPY: AN ENDOSCOPIC TECHNIQUE FOR THE TREATMENT OF HAGLUND’S DEFORMITY AND RETROCALCANEAL BURSITIS
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Todd D Bell, Charleston, SC, USA
USC School of Medicine, Columbia, SC, USA

The traditional surgical management of retrocalcaneal bursitis consists of an open excision of the inflamed bursa, resection of the posterosuperior calcaneal tuberosity, and debridement of the Achilles tendinopathy if chronic degenerative changes are present and accessible. In an effort to reduce the operative morbidity and speed recovery time, we have used an endoscopic technique for management of this condition. Medial and lateral paratendinous portals are created and a 5 mm shaver is introduced into the area of the retrocalcaneal bursa. The shaver is then used to perform a limited debridement and create a working space for insertion of a standard 30 degree arthroscope. Once the arthroscope is inserted, debridement of additional bursal tissue is carried out. This affords excellent visualization of the calcaneal tuberosity as well as the insertion of the Achilles tendon. Bony resection is performed with a round medium burr and a short sleeve. Degenerative changes of the tendon can be probed, visualized and usually debrided. Post-operatively, patients are allowed to bear weight in a removable cast boot for a variable amount of time based on the estimated extent of tendon debridement, which was performed. Since 1997, nineteen patients at the Medical University of South Carolina and the University of South Carolina School of Medicine have undergone this procedure. Preliminary results with AOFAS scores are encouraging. Patients experience improvement with eventual complete resolution of their symptoms. 90% have been satisfied or very satisfied with their outcome. There has been one major and one minor complication in the series i.e. a non-compliant patient with an Achilles tendon rupture three weeks after surgery and a transient sural neuropathy. Retrocalcaneal bursoscopy is an effective surgical technique for the treatment of retrocalcaneal bursitis. Patients must be monitored closely after surgery to prevent overuse of the healing Achilles tendon.

Paper #89
•EXTRACORPOREAL SHOCK WAVE THERAPY (ESWT) IN PATIENTS WITH PAINFUL, PROXIMAL PLANTAR FASCITIS
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Frank Adam, Homburg/Saar, GERMANY
Stefan Rupp, Homburg/Saar, GERMANY
Andreas K. Kreutz, Homburg-Saar, GERMANY, Presenter
Dieter M Kohn, Homburg-Saar, GERMANY
Romain Sel, Homburg/Saar, GERMANY
Orthopaedic University Hospital, Homburg/Saar, GERMANY

Objective
The aim of this study was to compare the effect of extracorporeal shock wave therapy (ESWT) in patients with chronically painful, proximal plantar fasciitis with a conventional conservative treatment.

Methods
Forty-seven patients (49 heels) with a previously unsuccessful conservative treatment of at least 6 months were prospectively randomized to two groups with a random list. Treatment of group 1 (25 heels) started immediately after enrollment with three sessions of ESWT (3000 shock waves/session of 0.2 mJ/mm2) at weekly intervals. No local anaesthesia was applied. In the patients of group 2 (24 heels) conservative treatment was continued for 12 weeks. After this period they were treated using the protocol of group 1. Patients were followed up at 6, 12 and 24 weeks and 2 years after ESWT. A clinical investigation was performed regarding pain on a visual analogue scale ranging from 0 (no pain) to 100 (maximal pain) and the comfortable walking time. Statistical analysis was done with the non-parametrical Wilcoxon test for paired samples and the non-parametrical Mann-Whitney test for unpaired samples.

Results
No significant difference of pain (70.2 ± 22.4 to 70.2 ± 22.2) and comfortable walking time (0.3h ± 0.5 to 0.3h ± 0.5) after further conservative treatment (3 months) was seen (group 2). Six months after ESWT pain during activities of daily living decreased by 83% on the visual analogue scale (VAS) and the comfortable walking time had increased significantly in both groups (p<0.01). Two years after ESWT pain during activities of daily living had decreased even more by 90% on the visual analogue scale compared to prior to ESWT and the comfortable walking time had increased significantly in both groups (p<0.01).

Conclusion
In our study we could not find any significant differences of pain and walking time after further conservative treatment of 3
months in patients with chronic proximal plantar fasciitis. After ESWT pain and walking time improved significantly.

**Paper #91**

**NORMALIZED TENDON STRUCTURE AND DECREASED THICKNESS AFTER ECCENTRIC TRAINING IN PATIENTS WITH CHRONIC PAINFUL ACHILLES TENDINOSIS**

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Ronny Lorentzon, Umeå, SWEDEN
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Bertil Alfredson, Umeå, SWEDEN
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Objective - To prospectively investigate tendon thickness and tendon structure by ultrasonography in patients treated with eccentric calf muscle training for painful chronic Achilles tendinosis located at the 2-6 cm level in the tendon.

Methods - The patients were examined with grey-scale ultrasonography before and after the 12-week eccentric training regimen. At follow-up, a questionnaire assessing present activity level and satisfaction with treatment was also used.

Results - Twenty-six tendons in twenty-five patients (19 men and 6 women) with a mean age of 50-years were followed for a mean of 38 years (range 1-6.7 years). All patients had a long duration of pain symptoms (mean 17 months) from chronic Achilles tendinosis. At follow-up, 22 out of 25 patients were satisfied with treatment and active in Achilles tendon loading activities at desired level. The results of the ultrasonographic examination showed that the tendon thickness (at the widest part) had decreased significantly (p<0.005) between the measurements before and after treatment (8.8 ± 3 mm and 7.6 ± 2.3 mm (mean ± SD), respectively), in the tendons with tendinosis. In the non-treated normal tendons, there was no significant difference in tendon thickness between the measurements 5.3 ± 1.3 mm and 5.9 ± 0.8 mm (mean ± SD), respectively. All tendons with tendinosis had structural abnormalities (hypo-echoic areas and irregular structure) before start of treatment. After treatment (at follow-up), the tendon structure was normalised in 19 of the 26 tendons. In 6 out of the 7 tendons with remaining structural tendon abnormalities, the patients experienced pain-symptoms in the tendon during loading.

Conclusions - For patients with painful chronic Achilles tendinosis, treatment with eccentric calf muscle training is associated with a localised decrease in tendon thickness, and a normalised tendon structure. Remaining structural tendon abnormalities seems to be associated with remaining pain-symptoms from the tendon.

**Method**
A prospective sample of 12 patients with a rupture of the Achilles tendon were managed non-operatively with a functional bracing protocol at one centre (University of Rochester Medical Centre) and a group of age, gender, time since injury, and activity-matched controls with the same injury were managed with a standardized surgical repair at another centre (University of Western Ontario). Both groups followed similar immobilization and rehabilitation protocols. Outcomes included subjective responses to a questionnaire, clinical measurements of the range of motion of the ankle, and ground-reaction forces and temporal data gathered during functional dynamic activities that included walking, a single-limb power hop, and a single-limb heel rise endurance test.

Results: Subjects were similar in both groups with respect to gender (11M, 1F), age (surgical=39.9 yrs, bracing=40.3 yrs), and time since injury (surgical=3.3 yrs, bracing=2.7 yrs). Subjective assessment of the treatment was rated as excellent (surgery=9, bracing=9), good (surgical=2, bracing=3), and fair (surgical=1). Passive ankle plantarflexion was found to be decreased in both groups in comparison to the contralateral leg (surgical 4.9o, bracing=1.7o). Passive ankle dorsiflexion was decreased in comparison to the contralateral leg by 4.6o in the surgical group and increased by 2.0o in the bracing group. This difference was found to be statistically significant (p=0.02). With the numbers available, we could detect no significant differences between the groups with regard to any of the kinetic or temporal variables that were measured during functional dynamic activities.

Conclusions: With the numbers available, surgical repair of the Achilles tendon demonstrates no difference in clinical or functional outcome compared to functional bracing with the exception of an increase in passive dorsiflexion in the non-operative group.

**Paper #93**

**JOHN JOYCE AWARD FINALIST**

**MECHANICAL AND HISTOLOGICAL ANALYSIS OF THE CHRONICALLY RELAXED ACL AFTER THERMAL RADIO-FREQUENCY SHRINKAGE IN A SHEEP MODEL**

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Veronika Schoenfelder, Berlin, GERMANY
Patrick Hunt, Berlin, GERMANY
Heike Chwastek, Berlin, GERMANY
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Purpose: Examination of radio frequency (RF) application for shrinkage of the chronically relaxed anterior cruciate ligament (ACL) and analysis of the mechanical and histological properties after such treatment.

Methods: The tibial insertion of the ACL of 16 Marino sheep was surgically elevated simulating ACL elongation. The eminencia intercondylaris was elevated by a rectangular osteotomy and fixed with a bicortical screw. Thermal shrinkage of the ACL was carried out in 8 specimens using a monopolar RF device (Karl Storz Endoscopy, Tuttlingen, Germany). This treatment was continued until manual anterior-posterior (A-P) drawer testing revealed no increase in knee laxity. An arthrotomotomy was performed to reduce load bearing and to simulate careful rehabilitation. At 24 weeks all animals were sacrificed and each knee underwent mechanical testing at 60° of flexion. First, A-P displacement under ± 50 N load was measured, followed by a load-to-failure test with measurements of stiffness and failure load. At time zero, mechanical properties were compared...
between the intact, chronically relaxed and the RF treated ACLs. Cell numbers and vascular density of the ACL in each group were also histologically examined. Statistical analysis was performed using the Mann-Whitney-U Test. Level of statistical significance was set at \( p < 0.05 \).

Results: A significant increase was found for A-P displacement (+202%) comparing the ACL relaxed untreated group with the ACL intact group (\( p < 0.001 \)). Following thermal shrinkage, A-P displacement of the RF treated group (2.94 ± 0.69 mm) was reduced to nearly the level of the intact ACL specimens (2.31 ± 0.52 mm). At 24 weeks, a significantly lower stiffness and failure load were observed for the RF treated group (105 ± 51 N/mm and 445 ± 203 N) when compared to the ACL relaxed untreated group (143 ± 31 N/mm and 788 ± 305 N). A significant difference for A-P displacement could not be found between these two groups (4.68 ± 1.99 mm vs. 4.19 ± 0.86 mm). At 24 weeks, cell numbers were significantly reduced in the midportion of the ACLs in the RF treated group compared to the relaxed untreated ACLs. The same relationship was found for vascularity with significantly lower vessel density in the RF treated group. Subsynovial hypervascularity was found in each group, with no differences between the RF treated and relaxed untreated ACLs.

Discussion: Thermal RF shrinkage of the ACL caused a substantial decrease of the mechanical properties and of this ligament and resulted into decreased vitality of the treated tissues at 24 weeks. The initial restoration of the A-P displacement at time zero could not be maintained after 24 weeks, even though only reduced load bearing was implemented by the achillotenotomy. Our data demonstrated that a clinical advantage through general thermal shrinkage of the chronically relaxed ACL is questionable and that precise indications for the application of RF shrinkage will have to be established. Moreover, this study suggests that appropriate rehabilitation protocols should be designed for patients, which underwent RF treatment.

Paper #94
JOHN JOYCE AWARD FINALIST
THE EFFECT OF ELECTROTHERMAL SHRINKAGE ON BIOMECHANICAL PROPERTIES OF THE ANTERIOR CRUCIATE LIGAMENT
Eiji Kondo, Sapporo, JAPAN, Presenter
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Harakatato Toyohama, Sapporo, JAPAN
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Introduction: Previous studies have shown that thermal energy produces significant capsular shortening (shrinkage). Therefore, this phenomenon has been clinically applied to arthroscopy-assisted shoulder joint stabilization. Recently a few clinical reports have dealt with an application of the electrothermal shrinkage to the chronically relaxed anterior cruciate ligament (ACL). However, no basic studies have been conducted to clarify the degree of reduction in biomechanical properties of the ACL after the thermal shrinkage. The purpose of this study is to determine the effect of thermal shrinkage on biomechanical properties of the ACL.

Materials and Methods: Fifty fresh femur-ACL-tibia complexes harvested from fully matured LWD pigs weighing approximately 100kg were used in this study. Previous studies demonstrated that the mechanical properties of the ACL are similar to the human ACL. In each specimen, the posterolateral bundle of the ACL was resected. The femur-anteromedial (AM) bundle-tibia complex specimens were randomly divided into 5 groups of 10 specimens each. In Groups I and II, an electrothermal power of 28 Watts (W) was applied to the AM bundle for 30 seconds and 60 seconds, respectively, using an electrothermal radiofrequency device (Arthrocure, Sunnyvale, CA). In Groups III and IV, a 45-W power was applied for 30 seconds and 60 seconds, respectively, using the same device. In Group V, no electrother- mal treatment was applied to the bundle in order to obtain the normal control data. For the electrothermal treatment, we hung each specimen from a testing jig, applying a constant load of 1 N in physiological saline solution of 37 degrees Celsius. A senior orthopaedic surgeon performed the shrinkage treatment while the specimen was fixed with a simple clamping device. The surgeon then selected a thermal treatment was applied to the anterior, medial, and lateral aspects of the AM bundle. In each group, 8 out of the 10 specimens were used for biomechanical evaluation, and the remaining 2 were used for histological observation with light and polarized light microscopy. In biomechanical evaluation, the cross-sectional area and the length of the ACL were measured with a video dimension analyzer (VDA) before and after the treatment. The structural properties of the femur-AM bundle-tibia complex were determined in tensile testing with a VDA at a cross-head speed of 50 mm/min. Statistical analyses were made using the ANOVA with the post-hoc Fisher PSLD test for multiple comparisons.

Results: After the electrothermal treatment, the length of the AM bundle significantly decreased into 92%, 82%, 86%, and 74% of the original length in Groups I, II, III, and IV, respectively (\( p<0.0001 \)). In tensile testing, the stiffness of the AM bundle failed at the treated portion in Groups I, II, III, and IV, respectively. The ANOVA demonstrated a significant difference among the groups (\( p<0.0008 \)). Groups II, III, and IV were significantly lower than Group V, respectively (\( p<0.02 \)). Concerning failure modes, each specimen was avulsed from the insertion in Group V, while 1, 4, 3, and 8 out of the 8 specimens failed at the treated portion within the bundle in Groups I, II, III, and IV, respectively. The maximum load of the femur-AM bundle-tibia complex was 894, 860, 840, 734, and 914 N in Groups I, II, III, IV, and V, respectively. The ANOVA showed a significant difference among the groups (\( p<0.0156 \)). Group IV was significantly lower than Group V (\( p<0.0017 \)). In the treated portion within the bundle, histologically, the normal ligament structure composed of regularly aligned collagen fascicles and fibrob- lasts completely disappeared.

Discussion: This study showed that electrothermal energy significantly reduces the length of the AM bundle of the ACL, dependent of its magnitude. This study also demonstrated that the energy drastically deteriorated the structural properties of the AM bundle, dependent of its magnitude. For example, when the AM bundle was shortened into 74% of the original length, the stiffness was reduced into 61% of the original value. Such magnitude of shortening is commonly required as a clinical treatment. Therefore, this study warned against too optimistic application of electrothermal shrinkage to the ACL as a clinical treatment. This study also suggested that further in vivo studies should be conducted to increase the database on the electrothermal treatment for the ACL.
Objective: This study was initiated to assess the long-term significance of MRI detected bone bruises associated with ACL injury. Previously, a group of 23 ACL-injured patients underwent MRI scans immediately post injury and again 6 years later. All underwent early ACL reconstruction, and had normal initial radiographs and arthritic cartilage on arthroscopic inspection. 6 year MRI scans demonstrated cartilage thinning in the areas of these bone bruises in 2/3, but no corresponding clinical differences. The current study was designed to assess the long-term effects of these bone bruises.

Methods: Twenty of the original 23 patients were contacted and consented to undergo repeat MRI scan, radiograph and clinical assessment. Average length of follow-up was 12 years and average age 43 years. All patients underwent IKDC assessment, Mohtadi Quality of Life score, KT-1000, plain radiography and MRI. Protocol reproduced the methods of the earlier investigation to allow direct comparison. MRI included exact sequences done at 6 years with an additional sequence. This allowed accurate assessment of articular cartilage and subchondral bone, and comparison with previous scans.

Results: 4 patients had undergone revision reconstruction and 6 undergone further arthroscopic surgery. The remaining 10 had no further intervention. When compared to previous scans the main finding was a general progression of arthritis. This largely involved the medial compartment with associated meniscal pathology, rather than being specifically associated with areas of previous bone bruising in the lateral compartment. In these areas no significant progression of cartilage thinning was seen, but persistent or new areas of fibrosis and cystic change were observed in the subchondral bone. The significance of these findings remains uncertain at this stage.

Conclusions: MRI detected bone bruising indicates significant injury to articular and subchondral bone in ACL injured knees. The findings of this study add to the understanding of the natural history of the bone bruise.

Paper #96
JOHN JOYCE AWARD FINALIST
INTRA-ARTICULAR HYALURONIC ACID SUPPLEMENTATION FOLLOWING AUTOGENOUS OSTEOCHONDRAL GRAFTING (MOSAICPLASTY) OF THE KNEE
Anthony Miniaci, Toronto, CANADA
Graham Tyler-Lee-Strong, Edinburgh, UK, Presenter
Mark Hartig, Guelph, CANADA
Toronto Western Hospital/University of Guelph, Toronto/Guelph, CANADA

Introduction: The surgical trauma following autogenous osteochondral grafting (mosaicplasty) creates a “hostile” intra-articular environment, which may have a detrimental effect on graft healing, incorporation and survival. Intra-articular hyaluronic acid (HA) is currently used as a viscosupplementation agent in osteoarthritic joints. Along with its viscoelastic properties HA also has a number of anti-inflammatory properties including steric hindrance, an inhibitory affect on macrophages and anti-oxidant activity. We have undertaken a prospective, randomized controlled study using an ovine model to investigate whether HA supplementation following a mosaicplasty procedure has a beneficial effect on graft healing and survival.

Experimental Methods: Twelve adult sheep were randomized to undergo a standardized mosaicplasty procedure on their right knee joint (stifle) followed by a 5 week course of intra-articular HA (Na Hyaluronate 25mg) (HA grp) or a 5 week course of intra-articular buffer solution (C grp) starting 1 week postoperatively. A standardized full thickness osteochondral defect was created on the medial femoral condyle and then reconstructed using three 4.5 mm diameter autogenous osteochondral grafts. The knees were aspirated immediately pre-operatively, weekly for the next 5 weeks prior to intra-articular injection, and then at 8 and 12 weeks. The synovial fluid was assessed for total leukocyte and total protein levels. At 12 weeks post-op the animals were sacrificed and the operated knee joint was photographed and scored for cartilage coverage and quality. Biomechanical creep indentation testing of the graft articular cartilage, the interstitial tissue between the grafts and the donor sites was photographed and scored for cartilage formation and cartilage flow. MRI included exact sequences done at 6 years with an additional sequence. This allowed accurate assessment of articular cartilage and subchondral bone, and comparison with previous scans.

Results: The synovial fluid inflammatory leukocyte and total protein levels were markedly raised post-op in both groups and had dropped considerably at 8 and 12 weeks but had not returned to normal. Creep testing showed a significant difference between the HA graft cartilage (81% of the contralateral) and the C graft cartilage (59%). Scoring of histology sections showed that the HA group had less new interstitial tissue between grafts but more cartilage flow around the experimental defect. Chondrocyte viability and the quality of the subchondral bone were better in the HA grp, but this was not significant. The mean GAG concentration for the HA graft cartilage was 0.024 mgGAG/mg wet wt compared to 0.017 for the C graft cartilage which was significant (P<.05, student’s t test).

Discussion: There are a vast number of factors that impact on potential graft survival following a mosaicplasty procedure. HA benefits the repair site by maintaining cartilage mass around the defect. This allows cartilage flow to fill in the defect perimeter. By contrast, in growth of new interstitial connective tissue appears to be inhibited, and this is consistent with HA’s ability to inhibit neovascularization and adhesions. Longer studies may determine if this effect is sustainable or transient, and whether HA is truly chondroprotective in this application or merely acting by suppressing inflammation or improving soft tissue lubrication.

Conclusion: This study suggests that intra-articular HA may convey a small beneficial effect on graft survival in the early stages following mosaicplasty. However, further work is required.
Introduction - Surgical intervention in the form of ligament reconstruction is often recommended for patients experiencing instability following rupture of the anterior cruciate ligament (ACL). The two most common tissues used for reconstruction of the ACL are the central third patellar tendon and the combined semitendinosus and gracilis hamstring tendons (ST&G). Although investigations into strength measurements for both graft sources report few significant differences in outcome for flexion and extension measurements, it has been suggested, due to the contributory role of the ST&G to internal rotation, that harvest of the semitendinosus and gracilis may contribute to internal tibial rotation weakness.

Objective - To compare internal and external tibial rotation peak torque between the ACL reconstructed and normal contralateral limb at least two years post ACL reconstruction with the use of autogenous semitendinosus and gracilis hamstring tendons.

Method - Subjects were eligible to participate in this study if they were at least 2 years post unilateral ACL reconstruction with the maximum potential of elbow function, and ensures satisfactory cosmesis.

METHODS: Fifty-five fresh frozen cadavers (mean age 78.8+25.3) were randomly assigned to five groups. The subpectoral bone tunnel technique served as the control. The four other groups were different combinations of reamer sizes (7-8mm) and bioabsorbable interference screws (7.8, and 9mmX23mm in length). These groups then underwent an axial load to failure test using an Instron testing device (Instron Corp, Model1321, Canton, MA) at a rate of 1mm/sec to a maximum displacement of 100mm. Fifty percent of the average ultimate failure load from these tests (100N) was then used to evaluate the amount of displacement of the tendon bone interface with 500cycles (1 Hertz). These groups then underwent an ultimate load to failure test in the same manner as the initial group after the cyclic loading test. Bone mineral density (DEXA Lunar, Madison, WI) at the biceps groove and diaphysis of proximal humerus were then obtained for all specimens for comparison purposes. All specimens also underwent an anatomical evaluation to measure intrarticular biceps distance (important for proper tensioning of the tenodesis), length and width of bicipital groove. A repeated measures ANOVA with significance set at p<0.05 and a Bonferroni post hoc comparison was used for data analysis.

RESULTS: Biomechanics- The maximum to minimum axial ultimate failure load per group was 8x9 (284 +/-65), 8x8 (272 +/-60), 7x8 (228 +/-39), 7x7 (220 +/-27), and bone tunnel group 181 (+/-36). There was no significant difference between axial ultimate failure load prior to and after cyclic loading. The maximum amount of displacement of 5,000 cycles was in the bone tunnel group (8.94 +/-3.1mm). The minimum displacement was in the 8x9 group (3.69 +/-1.8mm). Bone mineral density (g/cm^3) and bone mineral content (g) was not significantly different between groups. The ultimate failure strength of the 8x8 and 8x9 groups was significantly greater than the bone tunnel, 7x7 and 7x8 groups. The bone tunnel technique elicited the most displacement and this was significantly greater than the 8x9 group. There was no difference in the axial load to failure pre or post cyclic loading. Anatomy-The intraarticular biceps distance with the arm adducted was 34.5+4.4. The length of the groove was 30.6+5.6 and its width was 6.1+1.5. It was noted that the pectoralis major tendon was part of the biceps tendon sheath 36.7% of the time and the tendon was autotenodesed 10.2% and always associated with a rotator cuff tear.
CONCLUSION: The ultimate load to failure as well as the cyclic loading data indicates that the interference tenodesis method is stronger and has less displacement with repetitive submaximal load. Also, its ultimate failure did not significantly change after 5,000 cycles.

CLINICAL SIGNIFICANCE: The interference screw technique allows for immediate, secure fixation that is not compromised by repetitive loads. Adapting this technique to arthroscopic methods, in combination with an understanding of the proximal biceps tendon anatomy, provides the opportunity for successful arthroscopic biceps tenodesis. Furthermore, the immediate strength of the fixation will allow an accelerated rehabilitation.

Paper #99
RICHARD CASPARI AWARD FINALIST
THE RELATIVE RISK OF GLENOHUMERAL ARTHRITIS IN PATIENTS WITH SHOULDER INSTABILITY
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Purpose: The purpose of this study was to determine the relative risk of developing glenohumeral arthritis in patients with shoulder instability versus a control group.

Methods: For this study, data was prospectively collected in a database from 1993 to 2000. The control group was 83 patients with isolated shoulder impingement and no evidence or history of instability. The instability group consisted of 422 patients who were diagnosed with shoulder instability. At the time of surgical intervention, for all patients, the grade of arthrosis, presence/direction of instability, and associated pathologies were documented. Arthritis was operationally defined as arthritis of grade 3 or 4.

Results: The average age of the control group (42 years) was significantly higher than the instability group (30 years). (p<0.05). No difference was seen between groups in gender distribution and the average time from injury to surgery (control=1084.8; instability=893.1). (p<0.05) The overall prevalence of arthritis in the instability group was significantly higher (p=0.038) than the control group. Patients with Bankart lesion had a higher prevalence of arthritis (15%) than those instability patients without a Bankart (9%).

Compared to our control group, patients with instability had a 3 times greater risk of arthritis. In patients over 35 years of age, this risk increase to 4.6 times, while under 35 years of age risk increase was 2.2 times the control. Patients with Bankart lesions had a 3.5 times higher risk than the control, compared to those without who had a 1.9 times increased risk.

Conclusion: Patients with instability have a greater relative risk of arthritis than a control group of patients with isolated impingement. This risk increases with age and duration of symptoms.

Paper #100
RICHARD CASPARI AWARD FINALIST
DYNAMIC RADIOGRAPHIC EVALUATION OF ANTERIOR GLENOHUMERAL LAXITY
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Purpose of the study
Laxity of the Inferior GlenoHumeral ligament (IGHL) is a cause of poor functional results in arthroscopic shoulder stabilization. Clinical evaluation allows to have an idea of IGHL laxity. The purpose of this study was to objectively evaluate laxity of the IGHL using a dynamic radiographic test (AP view in passive abduction of the glenohumeral joint) and correlate it with arthroscopic findings.

Material and methods
The authors have conducted a prospective study on 21 patients undergoing arthroscopic stabilization for antero inferior instability of shoulder. Mean age was 24.6 years (17 males and 4 females). The radiographic test was performed in dorsal decubitus bilaterally and comparatively. A forced passive abduction was applied on the shoulder in neutral rotation eliminating motion in the scapulothoracic joint as described by Gagey. We measured the angle between the humeral shaft and the line drawn between the lateral part of the scapular tubercle and the lower edge of the glenoid fossa. This test has been proved to be reliable and reproducible in a previous study. During arthroscopy, capsulolabral lesions were assessed using Detrisac classification. The radiological test was considered as positive for difference superior to 15° between pathological and healthy side.

Results
For a difference of abduction of 15 degrees or more, the sensitivity of the test was 77% and the specificity 91%. In anterior shoulder instability, clinical evaluation and static imaging are enable to precisely evaluate ligamentous laxity. Results of open surgery are still better than arthroscopic technique in terms of recurrence. An important laxity of the IGHL was proven to be a cause of bad results in arthroscopic stabilization. Dynamic radiographic evaluation is more efficient. For a difference superior to 15° we have found 87% of Detrisac type 3 and 4 lesions.

Conclusion
We suggest to add to classical preoperative imaging, this dynamic radiographic test with hyper abduction of the glenohumeral joint. If the difference is superior to 15°, surgical treatment should not only refix the labrum but also perform a shortening or plication of the ligamentous complex or perform open surgery.

Paper #101
RICHARD CASPARI AWARD FINALIST
ANGIOGENIC MARKERS AND ROTATOR CUFF TEARS
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Introduction
Tendinosis is a common entity in the orthopedic field. There have been many theories on etiology and as many treatments.
Vascularity of the tendon has been proposed to be a factor involved in the tendon pathology. It has been hypothesized that the lack of vascularity can compromise the cells to synthesize extracellular matrix necessary for the repair and remodeling of damaged tendons. Ahmed et al has theorized that poor vascularity and lack of adequate repair leads to potential rupture. The integrins and the growth factor family of cytokines are two classes of proteins that are contributors to endothelial cell migration and angiogenesis, which are important in tissue healing. One subset of the integrin proteins, containing the alphav subunit, has been associated with endothelial cell migration and indirectly tied to angiogenesis. In the growth factor family of proteins, vascular endothelial growth factor (VEGF) has been reported to be involved in the regulation and induction of angiogenesis through its stimulatory effect on endothelial cells. The purpose of this study was to assess the relative expression levels of the alphav subunit and VEGF genes as potential markers of angiogenesis and test the hypothesis that a reduction in these markers may play a detrimental role in tendon healing. To achieve this goal, RNA was extracted from rotator cuff supraspinatus biopsy tissue from normal and abnormal specimens and subjected to reverse transcription polymerase chain reaction (RT-PCR) for the semi-quantitative determination of alphav and VEGF mRNA.

Material and Methods
Biopsy tissue of the supraspinatus tendon was obtained in fourteen individuals who were undergoing arthroscopic or open shoulder surgery. Biopsy samples were obtained from a similar site at or near the rotator cuff cable of the supraspinatus tendon. Six normal and eight abnormal samples were obtained. Abnormal samples consisted of rotator cuff tears; the main diagnosis and reason for operative intervention. Rotator cuff repair was performed in all patients either arthroscopically or with an open approach. No rotator cuff tear was acutely traumatic in origin. The average age was 61.5 years with a range of 47 to 71 years. The normal tissue was obtained from patients undergoing surgery consisting of shoulder replacement, intramedullary nailing of a humerus fracture, open reduction and internal fixation of a proximal humerus fracture and open anterior shoulder stabilization. The average age was 48 years with a range of 19 to 82 years. The biopsy was placed in a guanidum thiocyanate solution and then placed in the freezer until the RNA could be extracted. Analysis of the angiogenic markers, alphav integrin subunit and vascular endothelial growth factor (VEGF) by semi-quantitative reverse transcription polymerase chain reaction (RT-PCR) was carried out to determine evidence of angiogenesis. Statistical analysis was performed using paired T-test and a priority level of significance was set at p<0.1.

Results
The results of the semi-quantitative RT-PCR shows that VEGF was expressed at approximately 50% lower in the abnormal samples as compared to the normal samples with a p-value of 0.18. Vascular endothelial growth factor is known to be involved in the regulation and induction of angiogenesis. The alphav integrin, associated with endothelial cell migration and indirectly tied to angiogenesis, was approximately 30% lower in abnormal tissue compared to normal tissue with a p-value of 0.23. These results show a trend toward decreased expression in abnormal tissue.

Discussion
It has been hypothesized that poor vascularity may be a factor and it may also prevent adequate tissue repair leading to further weakening of the tendon and eventual tendon rupture. Kraus-Hansen et al showed experimentally that intratendinous ligations of blood vessels in the superficial digital flexor tendon of horses led to necrosis and fibrillation at the core of the tendon. VEGF has been shown to be decreased in abnormal rotator cuff tendons by 50%. Recognizing VEGF and alphav integrin as markers for angiogenesis, it may enhance our ability to treat this pathological condition of the rotator cuff with further therapeutic modalities enhancing blood supply and addressing the deficit of angiogenesis.
PAPER ABSTRACTS

INTRODUCTION

PCL reconstruction still present unpredictable and unreliable results. This is related to the lack of knowledge existing on PCL with respect to ACL and to the technical difficulties of the surgical technique is reproducing PCL structure. Recently 2 bundles reconstruction has been suggested to better reproduce the PCL biomechanics. The exact knowledge of PCL fibers bundles behaviour and their role on guiding knee kinematics should be helpful to guide PCL reconstruction. The purpose of this study was to numerically describe the PCL orientation during the whole ROM with respect to tibial plateau and lateral notch of medial femoral condyle, in order to obtain a comprehensive understanding of location and orientation of PCL.

MATERIALS AND METHODS

The experimental data about motion and anatomy were obtained using the FARO arm electrogoniometer (FARO arm, FARO Technologies, Lake Mary, USA), a six degrees of freedom device with 0.3 mm/0.3 degrees accuracy. These data were processed off-line by a dedicated software, in order to display the relative position of the bone structures and to measure the individual behaviour of the joints’ soft tissue. In particular the relationship of the spinoglenoid ligament of the entrapment neuropathy of the distal suprascapular nerve. Dynamic study showed increased pressure on the suprascapular nerve when the cadaveric arm is internally rotated. The greatest pressure change came from the combination of abduction and external rotation. Finally, a newly described technique, that is minimally invasive, was shown to release the spinoglenoid ligament arthroscopically and preserving the suprascapular nerve. This gives the athlete and surgeon another option in treating entrapment neuropathies of the suprascapular nerve.

RESULTS

Groups A and B, PCL reconstruction was performed with two randomly divided into four groups of 10 specimens each. In these animals were used as substitutes for the human hamstrings and gracilis tendons, respectively. In Group A, the doubled FT graft was fixed with 2 threads and an Endobutton, while the PM bundles reconstruction has been suggested to better reproduce the PCL structure. Recently 2 bundle reconstruction could guarantee a more physiologic behaviour of PCL reconstructed graft. Moreover our data could be helpful to improve tunnel orientation.

DISCUSSION

This study have quantitatively determined a significant different behaviour regarding elongation and orientation between the AL and PM bundle of PCL. These data increase anatomical knowledge of PCL and suggest that two bundle reconstruction procedures have not always been consistent. Recently, a few studies have advocated several advantages of PCL reconstruction procedures using the multi-strand flexor tendon (FT) graft. However, there have been no biomechanical studies to validate these procedures. Currently, cyclic loading tests have been established to evaluate ligament reconstruction procedures. However, studies have not been conducted using cyclic loading tests to compare the PCL reconstruction procedures using the FT graft to the procedures using the BTB graft. The purpose of this study is to biomechanically compare the two PCL reconstruction procedures with the multi-strand FT graft to the two standard PCL reconstruction procedures with the BTB graft, using the displacement-controlled cyclic testing of 5000 times.

Materials and Methods: Forty fresh-frozen hindlimbs from fully mature LWD pigs were used in this study. The flexor digitorum profundus tendon and the BTB preparation harvested from these animals were used as substitutes for the human hamstring and BTB grafts, respectively. The 40 knee specimens were mature hindlimbs to verify the intact branch of the suprascapular nerve to the infraspinatus muscle. Releasing the ligament diminished the increased pressure below the spinoglenoid ligament during shoulder range of motion.

Conclusions: This study, contrary to previous reports, revealed the spinoglenoid ligament to be present in all dissected cadaveric shoulders with some variation in size. Histology studies confirmed the presence of the spinoglenoid ligament originating from the lateral scapular spine and inserting into the posterior shoulder capsule and glenoid. These findings support the relationship of the spinoglenoid ligament of the entrapment neuropathy of the distal suprascapular nerve. Dynamic study showed increased pressure on the suprascapular nerve when the cadaveric arm is internally rotated. The greatest pressure change came from the combination of abduction and external rotation. Finally, a newly described technique, that is minimally invasive, was shown to release the spinoglenoid ligament arthroscopically and preserving the suprascapular nerve. This gives the athlete and surgeon another option in treating entrapment neuropathies of the suprascapular nerve.

RESULTS

The 3D orientation with respect to the tibial plateau was statistically significant. The posterior medial bundles makes a bigger angle with the tibial plateau in extension, but it changes less than AL bundles (13° vs. 25° average variation) during PROM. Also orientation of the two bundles was significantly different in the first 60° of the flexion.

During PROM the angle between the PCL fibres and the plane approximating the femoral notch at the ligament’s insertion area ranges from 36° to 52° (average of all specimens). The orientation of PCL with respect to this plane was quite homogeneous between the two bundles.

DISCUSSION

This study have quantitatively determined a significant different behaviour regarding elongation and orientation between the AL and PM bundle of PCL. These data increase anatomical knowledge of PCL and suggest that two bundle reconstruction procedures have not always been consistent. Recently, a few studies have advocated several advantages of PCL reconstruction procedures using the multi-strand flexor tendon (FT) graft. However, there have been no biomechanical studies to validate these procedures. Currently, cyclic loading tests have been established to evaluate ligament reconstruction procedures. However, studies have not been conducted using cyclic loading tests to compare the PCL reconstruction procedures using the FT graft to the procedures using the BTB graft. The purpose of this study is to biomechanically compare the two PCL reconstruction procedures with the multi-strand FT graft to the two standard PCL reconstruction procedures with the BTB graft, using the displacement-controlled cyclic testing of 5000 times.

Materials and Methods: Forty fresh-frozen hindlimbs from fully mature LWD pigs were used in this study. The flexor digitorum profundus tendon and the BTB preparation harvested from these animals were used as substitutes for the human hamstring and BTB grafts, respectively. The 40 knee specimens were randomly divided into four groups of 10 specimens each. In Groups A and B, PCL reconstruction was performed with two FTs, which were trimmed so that the cross-sectional area became 14 mm² and 7 mm² to simulate the human semitendinosus and gracilis tendons, respectively. In Group A, the doubled FT graft was fixed with 2 threads and an Endobutton,
proximally, and with 4 sutures and a screw post, distally (FT-Button procedure). In Group B, a polyester tape was firmly connected with each end of the doubled FT graft using the original technique, and the tape was fixed with two staples (FT-tape procedure). In Groups C and D, PCL reconstruction was performed with a 10-mm wide BTB graft with 25-mm long bone plugs. In Group C, each end was secured with an interference screw (BTB-tunnel procedure). In Group D, the femoral side was fixed with an interference screw, and the tibial bone plug was placed on the back of the tibia and secured with a 4.5-mm cortical screw and flat washer (BTB-inlay procedure). Each femur-graft-tibia complex specimen was mounted on a tensile tester at 90 degrees of knee flexion. Anterior-posterior displacement of the tibia to the femur was measured with a differential transformer type transducer attached to the femur and tibia. The load and the displacement were continuously recorded on an X-Y recorder. Each group underwent preconditioning (10 cycles of 50-N loads, and then 89-N load for 2 minutes), and was then divided into 2 sub-groups of 5 complexes each. One sub-group underwent 5000 times (0.28 Hz) of cyclic displacements with a constant peak value of 3 mm (Displacement-controlled cyclic testing). The remaining sub-group did not undergo any cyclic testing. These peak values were chosen to simulate mechanical conditions during continuous passive knee motion. Finally, each specimen underwent tensile failure testing after the complex was reduced to the zero-position. Statistical analyses were performed using ANOVA with Fischer’s PLSD test for post hoc multiple comparisons.

Results: (1) Cyclic testing: The peak load value decreased over time in each group (p<0.0001). At the 5000th cycle, the average peak load was 28.6 N, 32.9 N, 38.1 N, and 45.5 N in Groups A, B, C, and D, respectively. Group A was significantly lower than Groups C and D (p<0.05). Group B was significantly lower than the other groups (p<0.05). Group C was significantly lower than Group D (p=0.0448). (2) Tensile failure tests: The cyclic loading did not affect the ultimate load and the posterior laxity (the posterior displacement induced by a 134-N load). There were no significant differences in the average ultimate load and the posterior laxity among Groups B (823N and 3.1mm), C (835N and 2.4mm), and D (854N and 2.5mm), while these parameters of Group A (590N and 4.3mm) was significantly inferior to the other three groups (p<0.05).

Discussion: This study demonstrated that, in each procedure, cyclic loading significantly affects the biomechanical properties of the PCL-reconstructed knee. This result indicated that post-operative management involving cyclic loading on the reconstructed PCL should be performed very carefully in each procedure during the early phase after surgery, until the graft is fixed with granulation tissues within the bone tunnel. Concerning the procedures with the FT graft, this study suggested the FT-tape procedure is similar in effectiveness to the BTB-tunnel procedure from the biomechanical viewpoint, although it is inferior to the BTB-inlay procedure. However, the FT-Button procedure is inferior to the BTB procedures from the same viewpoint. Therefore, after this particular procedure, cyclic loading should be avoided for a longer period of time than after the other procedures.

Background: Posterior cruciate ligament reconstruction should include an accurate reproduction of the normal femoral footprint. Studies to date have not included the size, orientation, and overall contribution of the meniscofemoral ligaments at the PCL complex femoral footprint.

Methods: Eight cadaveric knees (five cadavers) were dissected to remove the posterior cruciate ligament complex from its distal attachment sites. Removal of the lateral femoral condyle allowed visualization of the posterior horn of the lateral meniscus and identification of the individual components of the PCL complex. Measurements of the anterior and posterior meniscofemoral ligaments as well as the PCL proper were completed using calipers and suture. Measurements were taken at mid-substance as well as the femoral footprint and the quantities were averaged. The angles of insertion relative to the epicondylar axis and femoral long axis were also recorded.

Results: The femoral attachments of the meniscofemoral ligaments and the PCL proper were each found to conform to a rounded rectangular shape. The anterior and posterior meniscofemoral ligaments (aMFL, pMFL) were present in each knee. The length of the PCL proper footprint in the major axis (top of notch to medial wall) was 17.4 mm. The minor axes dimensions at the top of the notch (N), mid section arch (A), and medial wall (W) were 8.1mm, 8.1mm, and 6.5mm, respectively. The major axes for the aMFL and pMFL were 9.5mm and 8.5mm. The minor axes of the aMFL were (N) 3.3mm, (A) 3.1mm, and (W) 3.0mm. The minor axes for the pMFL were (N) 3.3mm, (A) 3.8mm, and (W) 3.3mm. The femoral surface circumferences were 50.3mm (PCL), 22.9mm (aMFL), and 24.2 (pMFL). The insertion sites were quantified with regards to notch to arch (N-A) and arch to medial wall (A-W) ratios. The PCL proper was nearly equally divided with values of 10.3mm (N-A) and 9.1mm (A-W). The aMFL components measured 1.4mm (N-A) and 8.9mm (A-M) respectively. The pMFL was found exclusively on the medial wall measuring 8.25mm (A-M). The angles of insertion compared to the epicondylar axis for the PCL, aMFL, and pMFL were 83, 33, and 30 degrees respectively. The angles of insertion compared to long axis of the femur were 84, 77, and 61 degrees respectively. Also included were orientation measurements from cartilage reference points and qualitative analysis of the PCL fiber regions and tensioning patterns.

Conclusions: The meniscofemoral ligaments contribute significantly to the overall size at the femoral footprint of the PCL complex. These contributions may have been under appreciated in previous literature leading to over estimation of the size of the PCL proper footprint and miscalculations of its location. A thorough understanding of the size and location of each of the components of the PCL complex is beneficial when determining the correct position for femoral tunnel placement in PCL.
Paper #106
**EFFECTS OF BONE BLOCK POSITION AND ORIENTATION WITHIN THE TIBIAL TUNNEL FOR PCL GRAFT RECONSTRUCTIONS: A CYCLIC LOADING STUDY OF BONE-PATELLAR TENDON-BONE ALLOGRAFTS**

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Introduction: Excessive post-operative posterior laxity is often observed in patients who have undergone PCL reconstruction with a tibial tunnel. This residual laxity could be related to thinning and permanent elongation of the graft as it is cyclically loaded in vivo. The purpose of this study was to measure the mechanical responses of B-PT-B allografts to cyclic loading tests for different bone block positions and orientations within a tibial tunnel.

Methods: Fresh-frozen patella-patellar tendon-tibia specimens were divided into medial and lateral halves. 11 mm wide grafts were prepared for insertion into 11 mm tibial tunnels. Two variants of bone block placement were studied in two separate test series. In Series 1 (27 graft pairs), all bone blocks were placed flush with the posterior opening of the tibial tunnel; one graft was oriented with the bone block positioned posteriorly in the tunnel (posterior orientation) while its pair was oriented with the bone block position anteriorly in the tunnel (anterior). In Series 2 (20 graft pairs), all grafts were oriented with the bone block positioned posteriorly; one graft had the bone block flush with the posterior tunnel opening while its pair had the bone block recessed into the tunnel, 1.0 cm away from the posterior opening. All grafts were subjected to 2000 cycles of tensile force from 20 to 200 N. Measurements of graft thickness were taken at the region of maximum graft curvature (the “killer corner”). The total change in graft length at an applied force level of 200 N was recorded after cyclic loading. RANOVA was used to compare all measurements for each test series.

Results: In Series 1, 3/27 grafts with posterior bone block orientations failed at the killer corner before 2000 cycles of testing could be completed; all specimens with anterior bone block placements survived the testing intact. In Series 2, 3/20 grafts with recessed bone blocks failed at the killer corner while all those with flush bone blocks survived. Results for graft pairs which survived testing are as follows: In series 1 there was a 21.4% reduction in graft thickness in the posterior group and a 10.5% reduction in the anterior group (p<.05). There was a 6.67 mm increase in graft length in the posterior group and a 5.50 mm increase in the anterior group (p<.05). In series 2, there was a 23.9% reduction in graft thickness in both the flush and recessed groups. There was a 6.68 mm increase in graft length in the flush group and a 9.39 mm increase in the recessed group (p<.05).

Conclusions: With regards to the mechanical parameters measured in this study, the best position for the bone block of a B-PT-B graft is flush with the posterior tunnel opening with the bone block oriented anteriorly in the tibial tunnel.

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Paper #107
**ARTHROSCOPIC RELEASE OF THE LONG HEAD OF THE BICEPS TENDON: FUNCTIONAL OUTCOME AND CLINICAL RESULTS**

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The treatment of chronic, refractory biceps tendinitis remains controversial. The etiology of biceps tendinitis may involve pathology within the tendon, specifically along its course in the bicipital groove or at its insertion on the labrum. In specific cases where all other pathologies have been ruled out, site specific release of the long head of the biceps (LHBT) may yield relief of pain and symptoms. We sought to evaluate clinical and functional outcome in a cohort of patients who underwent arthroscopic release of the LHBT. 54 patients diagnosed with biceps tendinitis or biceps tendon instability underwent an arthroscopic release of the LHBT as either as isolated procedure or as part of another shoulder procedure over a 2 yr period. 36 pts were available for follow-up at a minimum of 18 months. Patients were not excluded for concomitant shoulder pathology that included DIT, rotator cuff tears (RCT), Bankart lesions, or instability. 11/36 had isolated arthroscopic release of the biceps tendon. Patients underwent a complete shoulder exam by one surgeon who was different than the surgeon performing the surgery at our institution and were scored based on ASES, UCLA, and L’Insalata functional shoulder questionnaires. In addition, ipsilateral and contralateral metrics were evaluated. Results of 36 pts (10F, 26M, 49yrs) were evaluated at 2.3 yrs post-op (range 18-42 mos). L’Insalata, UCLA, and ASES scores were 70 (1), 25 (8), and 37 (11) respectively. The Popeye sign (PS) at rest or during active elbow flexion, 17% had a +PS during rest and elbow flexion. 57% had no PS at rest, but a +PS during active elbow flexion. 17% had a +PS during active elbow flexion. Side to side strength difference was 2.5 reps (10 lbs weight). 57% were rated as good, very good, or excellent. 43% of pts were graded as fair (N=4) or poor (N=6). Of 6 pts with a poor result, 2 had DIT, 2 had RCT, 2 had an acromioplasty. None of the patients reported arm pain at rest or proximally. 36% of pts complained of fatigue discomfort (soreness) isolated to the biceps muscle following resisted elbow flexion. 96% had mild to no biceps tenderness upon palpation of the bicipital groove.

The conclusions based on our findings: arthroscopic release of the LHBT is an appropriate and reliable intervention for patients with chronic, refractory biceps tendinitis. The loss of strength for biceps curls was minimal. Cosmetic deformity presenting as a +PS and fatigue discomfort during biceps curls were the primary complaints. This procedure is not advocated for heavy lifters (i.e., physical laborers and football players) due to the 36% incidence of fatigue discomfort symptoms. 100% of patients reported no pain isolated to the biceps muscle at rest. 96% of patients report that their biceps pain had significantly decreased. Although this is not a perfect solution, this appears to be an acceptable surgical intervention especially in the light of the decreased incidence of biceps tenderness when compared to tenodesis (reported between 10-30%).

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*The FDA has not cleared the drug and/or medical device for the use described in this presentation (i.e., the drug or medical device is being discussed for an “off-label” use).*
Purpose - To investigate the relationships between vascular endothelial growth factor (VEGF), a proliferation marker (Ki-67) and the cell cycle inhibitor p27 (cyclin-dependent kinase inhibitor p27), in endothelial cells in chronic degeneration of the rotator cuff.

Background - The rotator cuff is subject to constant pressure from the head of the humerus. This tends to "wring out" the blood supply resulting in a functionally avascular critical zone, although microvessels can be identified. This zone is the site of degeneration and tears. Attempts at repair under these circumstances could be compromised by inadequate local function of the vascular system particularly sprouting of the capillaries to support the repair process.

Methods - Rotator cuff tissue was obtained from ten patients (age 40-80y) undergoing surgical repair. The size of tear was 1-4.5cm, time from presentation to surgery was 1 month (acute) to between 0.5-4y (chronic). Immunohistochemical staining with commercial monoclonal antibodies to VEGF, p27, Ki-67 was performed on formalin fixed paraffin embedded tissues. Endothelial cells were identified by CD31 and smooth muscle actin (SMA) positivity. Visualisation used a standard DAB chromagen technique.

Results - Microvessel distribution varied according to tissue location, being pronounced towards the muscle insertion and torn edges of tissue, but much reduced in areas of healthy tendon and absent from areas with clear signs of advanced matrix degeneration without tears. Widespread VEGF positivity was observed in fibroblast and endothelial cell populations and diffusely within the matrix. Strong P27 positivity was observed in many endothelial cells which consequently demonstrated little Ki-67 staining.

Conclusion - Thus the endothelial cells appear to be simultaneously under both a mitogenic, VEGF drive, and subject to an inhibition of proliferation i.e. p27 positivity.
Introduction: Epicondylitis or tennis elbow is a frequent pathology among the sports population. Its medical-physical treatment not always solves the problem and this pathology becomes chronic and recurrent. In this study, a series of 19 cases treated arthroscopically and their results is presented.

Method: Eleven cases were evaluated, 8 women and 11 men, who were treated arthroscopically for chronic or recurrent epicondylitis. Previously, all cases underwent a treatment consisting of anti-inflammatory drugs, physical therapy and in 6 cases a minimum of 3 infiltrations with corticoids. Patients were classified in four grades for the application of different arthroscopic techniques, according to their clinical evaluation, the MRI and the arthroscopic findings. The methodology consisted on the bursectomy, fasciectomy and release of the epicondyle muscles in each case. In 12 cases an intra-articular inspection of the elbow was performed, not finding a related pathology attributable to this lesion.

Results: An average follow-up of 16.3 months (6 to 28) was carried out. Owens classification in three arthroscopic types was used, performing in type I (12 cases) bursectomy and decompressive fasciectomy; in type II (7 cases) epicondyle muscles release, not finding in this series type III cases with exostosis. Results were excellent or very good in 73% of the cases but in all cases patients were satisfied with the result.

Discussion: The arthroscopic treatment is considered a good election for patients with chronic or recurrent epicondylitis, and where non-surgical treatments are not effective. Decompression of the fascia, together with the partial release of the epicondyle muscles is an effective method for the treatment of this pathology and has predictable results.

Paper #111
EPICONDYLITIS. ARTHROSCOPIC TREATMENT
Alberto Pienovi, San Isidro, ARGENTINA, Presenter
Eduardo Martin Otolongoi, San Isidro, ARGENTINA
Rafael Jose Tossi, Buenos Aires, ARGENTINA
CTO, San Isidro, ARGENTINA

Introduction: The removal of intra-articular loose bodies (LB) is an effective method for the treatment of this lesion. While the numbers in this study are yet too small for definitive statements "extension impingement" is described as internal impingement of the elbow and in our study proved to be the cause of symptoms in these overhead throwing athletes. Arthroscopic debridement alleviated the impingement and symptoms in all patients. The long-term prognosis is dominated by associated chondral lesions.
**Paper #114**

**THE ROLE OF ELBOW ARTHROSCOPY IN THE DEGENERATIVE, CONTRACTED ELBOW**

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Medical College of Ohio Hospital, Toledo, OH, USA

Purpose: To report the outcomes of arthroscopy in the treatment of the contracted, degenerative elbow.

Methods: Sixteen consecutive elbow arthroscopies performed in fifteen patients with contacture and degenerative changes were studied. There were eleven males and four females. One patient was lost to follow-up. Average age of patient, 46 years (range 29-69). The dominant arm was involved in ten patients. Eight patients had a specific traumatic episode with subsequent degenerative changes, and seven patients had no specific history of injury or trauma. Symptoms prior to surgery consisted of loss motion, locking or catching, and pain. Patients exhibited evidence of radiographic degenerative change pre-operatively with a pre-operative failure of conservative treatment. All elbows were debrided arthroscopically with removal of loose bodies, excision of osteophytes, and manipulation under anesthesia.

Results: Pre-operative range of motion averaged 23-123 degrees. Post arthroscopic debридement and manipulation yielded a range averaging 6-130 degrees. Extension and flexion gains were 17 and 7 degrees, respectively. Follow-up averaged 30 months. Post-operatively, two patients continued to have painless, periodic catching, although both were improved from their pre-operative state. No patients continued to have locking episodes nor pain within their improved arc of motion.

Conclusions: The results of this study demonstrate significantly improved range of motion and pain relief via elbow arthroscopy in all patients with elbow arthrofibrosis.

**Paper #115**

**ARTHROSCOPIC SUTURE OF TFCC LESIONS**

Luigi Pederzini, Modena, ITALY, Presenter
Giulio Pezzella, Tramaco Siscammore, ITALY
Marco Esposito, Modena, ITALY
Massimo Tosi, Campogalliano, ITALY
Mauro Prandini, Sassuolo, ITALY
Arthroscopic Center Villa Fiorita, Sassuolo, ITALY

Purpose: to show results about TFCC suture and to present a new method for suturing the articular disc

Materials and methods: from 1996 to 2001, 87 TFCC arthroscopic sutures were performed in 1B (66 cases) and 1C (21 cases) lesions of the articular disc. In 62 cases (group A) the suture was performed using two spinal needles in a out-in technique using 2.0 PDS (knot in the subcutaneous tissue). In 25 cases (group B) a new out-in method to suture was used (inarticular knot). In group A, 85% was sutured by 1n stich while 15% by 2 stiches. In group B, 70% was sutured by 2 stitches while 30% by 3 stiches. Both the groups were immobilized for 5 weeks in an above elbow fully plaster. Both the groups were followed clinically at 2-4-8 months post-op. X ray were taken at 4 months, 5 patients had a 5 months MRI control, 3 patients had an arthroscopic second look for different problems.

Results: 4 months x ray didn’t show any peculiar sign regarding ulnar head or first row possible problems. The clinical examination at 2 months evidenced 65% of group A complaining some pain in the ulnar side due to the knot positioned in the subcutaneous tissue. Only 5% of the group B presented some discomfort in the ulnar side. At 4 months follow up 45% of group A still had problems in the ulnar side, while all group B was pain free.

At 8 months post-op group A was pain free. In 3 patients a surgical removal of the knot was necessary at 5 months post-op.

5 patients (3 group A, 2 group B) had a 5 months control MRI in which a complete repair was showed.

3 patients had a second look arthroscopy in which a repaired TFCC was evidenced.

Grip strenght was similar to the controlateral as 5 months post-op.

Conclusion: TFCC suture is an excellent option in treating 1 B, and 1 C TFCC lesions. The high rate of ulnar pain (due to the extrarticular knot in group A), and the low rate of the ulnar pain in group B using the new out-in method with the intrarticular knots suggested us to choose this last technique in 1 B, 1 C TFCC repair

**Paper #116**

**SIGNIFICANCE OF ARTHROSCOPIC TREATMENT OF TFCC INJURIES IN WRIST FRATURES OUTCOME**

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Pablo Lacavere, Buenos Aires, ARGENTINA
Santiago Butler, Buenos Aires, ARGENTINA
Eduardo Diego Abalo, Capital, ARGENTINA
Juan Pablo Previgliano, Capital, ARGENTINA
Enrique Pereira, Capital, ARGENTINA
Roberto Valentini, Capital, ARGENTINA
Eduardo Humberto Costanza, Buenos Aires, ARGENTINA
IADT, Buenos Aires, ARGENTINA

Introduction: Distal radioulnar joint instability due to triangular fibrocartilage complex (TFCC) injury can develop after distal radius fractures. Arthroscopic assessment of associated soft tissue injuries can improve surgical results.

Purpose: To review the incidence of traumatic TFCC injuries in distal radius fractures and the results of the arthroscopic surgical treatment.

Method: Fourteen patients (fifteen wrists) who sustained a distal radius fracture and were treated by arthroscopic assisted reduction and percutaneous pinning were retrospectively reviewed. Selection criteria were, age under seventy years old, no previous wrist injury or concomitant ligament injury and minimum follow-up of twelve months. The average age at surgery was 45.8 years (range 23-70). Mean follow-up was 18.8 months (range 12-30). DRUJ lesions were classified according with Fernandez Classification. Five (33%) type II A (Unstable, TFCC tear) were found. Three were type 1 B and two were type 1 D of Palmer’s Classification. All three 1 B tears were arthroscopically repaired using outside-in technique with 2.0 PDS sutures, whereas the two 1 D lesions were debrided. Subjective and objective results were analyzed with the use of New York Orthopaedic Hospital Score and the Green-O’Brien Score.

Results: All patients were graded excellent to good using both scores. At late follow-up, 4 patients were pain free and a mild pain was seen in the other. The mean active forearm rotation ranged from 70° to 90° pronation (average 80°) and 60° to 90° supination (average 80°).

Conclusions and Significance: TFCC injuries and associated DRUJ instability are not unusual after distal radius fractures. Arthroscopic early recognition and management could reduce painful sequelae and functional deficit.
The purpose of this prospective study was to evaluate the results and clinical effectiveness of osteochondral autograft in treatment of traumatic and degenerative osteochondral defects of the talus.

Material and Methods: From September 1997 to March 2002, 61 consecutive patients with traumatic and degenerative full thickness chondral defects of the talus were operated according to an intra- and postoperative protocol. The study group consisted of 28 men and 33 women with a mean age at injury of 28.1 years (range, 14 to 46). The mean time between the onset of symptoms and operation was 8 months (1 to 18). Location of defect was lateral in 21 and medial in 40. The preoperative AOFAS score was 54 points (range, 45 to 67).

Results: All patients were available for an average 21 months follow-up (range, 6 to 52). All were improved and returned to increased levels of function. Sports activity level was unchanged in 47 patients (80%) and decreased in 12 cases (17%) respect to that prior injury. Two patients (3%) did not return to sports activities. 48 patients were painfree and 12 showed slight symptoms and swelling after full sports. The AOFAS score increased to 93 points (range, 79 to 100). Clinical data were statistically significant improved.

Conclusions: Osteochondral autografts transplantation seems to be an efficient technique to treat traumatic and degenerative osteochondral defects of the ankle joint as it permits to fill the defect with a viable tissue which has the same biological and mechanical properties of the native tissue.

Paper #118
AUTOLOGOUS OSTEochondral Grafting for Cartilage Defects of the TalAr DOME
Dov Kolker, Boston, MA, USA, Presenter
Michael Wilson, Boston, MA, USA
Harvard University, Boston, MA, USA

Purpose
We present a follow-up study including a standardized outcome analysis of both the recipient and donor sites to help further develop our understanding of both the management and prognosis of osteochondral defects of the talus treated with the use of autologous osteochondral grafting.

Methods
The cases of twenty-one patients surgically treated with open talar autologous osteochondral grafting for symptomatic focal cartilage defects of the talar dome between 1998 and 2000 were retrospectively reviewed. The mean age of men and women was 31.3 and 33.7 years, respectively, with a mean time to follow-up of 20.5 months. The talar lesions were preoperatively evaluated using plain radiographs, computerized tomography (CT), magnetic resonance imaging (MRI), and arthroscopy. The surgical management for all patients consisted of open debridement of the talar dome defect approached using either an oblique medial malleolar osteotomy for the medial talar dome lesion or a soft tissue takedown of the syndesmotic ligaments via an anterolateral approach for the lateral talar dome lesion. The donor osteochondral cylindrical grafts were then harvested using an open arthrotomy from the nonweightbearing trochlear border of the ipsilateral knee and consequently press-fitted into the respective sized recipient talar site to fill the defect. The medial malleolar osteotomy site was then rigidly internally fixed using two screws for the medial lesion or a modified Brostrom repair was performed to reconstruct the lateral ligaments for the lateral talar lesion. The postoperative regimen included an eight week course of nonweightbearing in a short leg cast with early range of motion of the knee followed by a foot and ankle and knee rehabilitation program. The mean size of the talar dome defects was 10mm x 15mm (range 70mm² to 390mm²).

Results
Functional outcome results were prospectively obtained, for both the ankle and the knee, using the MODEMS AAOS Foot and Ankle Follow-up questionnaire, the AOFAS (American Orthopedic Foot and Ankle Society) ankle-hindfoot score and Hannover scores for the ankle, and the International Knee Documentation Committee (IKDC) subjective knee evaluation form (a modification of the MODEMS Knee follow-up questionnaire), the IKDC subjective knee examination form, and the Hospital for Special Surgery (HSS) score for the knee. The mean AOFAS ankle-hindfoot score was 60.6 (range 42 to 72) preoperatively, 83.5 (range 60 to 100) at twelve months postoperatively (in nineteen patients), and 89 (range 65 to 100) at final follow-up. The Hannover ankle assessment revealed a mean score of 93.3 (range 73 to 104) at final follow-up, and the mean score for the MODEMS AAOS Foot and Ankle Follow-up questionnaire was 93.2 (range 77.5 to 100). Regarding donor site pathology, the IKDC subjective knee evaluation form revealed a mean score of 87.4 (range 61.4 to 100) at final follow-up. Using the IKDC objective evaluation form, the mean postoperative score for the knee was grade A (normal) in 14 (67%) and grade B (nearly normal) in seven (33%). Using the HSS score, the mean score was 95.3 (range 85 to 100). There was 90.5% overall patient satisfaction. Additionally, there was a statistically significant association between the presence of a bipolar ankle lesion (with a focal cartilage defect of the distal tibial plafond opposite the corresponding talar lesion) and less than excellent outcome results (p<0.05).

Conclusion
We believe that the technique of autologous osteochondral grafting presented is valuable and should be considered an option for the patient with a symptomatic focal osteochondral defect of the talus.

Paper #119
THE MICROFRACTURE TECHNIQUE FOR THE TREATMENT OF OSTEOCHONDRAL AND DEGENERATIVE CHONDRAL LESIONS OF THE TALUS.
Hajo Thiermann, Heidelberg, GERMANY
Christopher Becker, Heidelberg, GERMANY
Dimitrios Stylianos Mastrokalos, Leimen, GERMANY, Presenter
Robert Kilger, Heidelberg, GERMANY
Center for Knee and Foot Surgery, ATOS Clinic Cent, Heidelberg, GERMANY

Objective of Study: The microfracture technique has become an established marrow stimulation method in the knee. This study wants to determine its usefulness on the treatment of chondral lesions of the talus.

Material and Methods: In a prospective study, 22 patients with an osteochondral lesion (OCL, 12 patients) or degenerative chondral lesion (DCL, 10 patients) were operated arthroscopi-
RESULTS: We found that tunnel dimensions had to be modified compared to the antegrade insertion of osteochondral cylinders. In the coronal plane the angle between the canal and the talar dome surface ranged from 35 to 40 degrees. In the sagittal plane the tangent to the talar surface was hit at 90 degrees for a typical OCD location in the posterior half of the talus. The surface inaccuracies between cylinder and surrounding cartilage ranged between 0 and 2 mm. Cylinder protrusion could be avoided by pushing the talus against the distal tibia during insertion. Sufficient press fit fixation could be achieved. It was especially demanding to reconstruct the curvature of the talar dome in the coronal plane.

CONCLUSION: In the anatomic model appropriate accuracy could be reached for the retrograde placement of osteochondral cylinders in the medial talar dome.

Paper #121
OSTEOCHONDRAL LESIONS OF THE ANKLE: A RETROSPECTIVE CLINICAL AND RADIOMIC EVALUATION OF PRE AND POST OPERATIVE FACTORS INFLUENCING PROGNOSIS.
Ron Arbel, Had Haskaron, ISRAEL, Presenter
Isabelle Tachiykan, Tel Aviv, ISRAEL
Moshe Yanze, Ramat Gan, ISRAEL
Center of Sport Medicine Tel Aviv Surasky Med. Cen, Tel Aviv, ISRAEL

Study purpose: To evaluate the results of arthroscopic treatment of ankle osteochondral lesions and to define the clinical and arthroscopic factors influencing prognosis.

Material and methods: From 1993 to May 1999, a total of 44 patients underwent 54 arthroscopic procedures for diagnosis and treatment for osteochondral lesions of the ankle. Forty-three patients were available for follow up. The evaluation included a pre and postoperative clinical scoring, radiographic evaluation including pre and postoperative anterior-posterior, lateral and mortise view of the ankle, as well as CT scan and MRI of the ankle. Operative techniques included: diagnostic arthroscopy followed by cartilage lesion shaving (16 patients 29%), micro-fractures technique (16 patients 29%), fixation of the lesion using polyactic “Biofix” rods (10 patients 19%), drilling of the lesion to the subchondral bone, ante or retrograde(10 patients 19%), and bone graft filling of subchondral cysts (2 patients 4%).

Results: Traumatic etiology of the lesion was found to be associated with postero-medial talus lesions (p<0.012). Significant clinical and radiographic improvements were found comparing pre and post operative CT scoring (p<0.005), plain radiographs (p<0.01) and clinical score (p<0.003). No correlation was found between the XR, CT findings and arthroscopic grading. Clinical improvement was found to correlate directly with CT grade (P<0.05). Fixation technique with Biofix was found to be associated with post operative subchondral cyst formation detected on plain radiographs and on CT (P<0.0001). Tibial and talar “kissing lesions” correlated with poor preoperative clinical score (P<0.05).

Conclusions: Ankle X-ray and CT play a limited role in planning the intraoperative procedure. Findings like sclerosis and subchondral cysts

Paper #120
THE RETROGRADE MOSAICPLASTY OF TALAR OSTEochondritis DISSECANS
Christian Hoser, Innsbruck, AUSTRIA, Presenter
Oliver Bickler, Innsbruck, AUSTRIA
Reto Bale, Innsbruck, AUSTRIA
Ralf Rosenberger, Innsbruck, AUSTRIA
Thomas Popp, Innsbruck, AUSTRIA
Christian Fink, Innsbruck, AUSTRIA
University Hospital, Innsbruck, AUSTRIA

INTRODUCTION: One treatment option for symptomatic talar OCD is autologous osteochondral transplantation (mosaicplasty) through a medial malleolar osteotomy. It was our goal to develop a technique for retrograde mosaicplasty of the medial talar dome, avoiding the need for osteotomy.

MATERIAL AND METHODS: We placed a guide wire through the lateral talar process into the most common location of OCD in the posterior half on the medial talar dome in five lower limb specimens. This was performed minimally invasive using a stereotactic navigation system in combination with a scotchcast immobilization technique and a targeting device. The guide wire was overreamed with the appropriate reamer and the shape of the created defect was evaluated by arthroscopy. A 4.5mm osteochondral cylinder was harvested from the ipsilateral lateral femoral trochlea. Starting at the lateral talar process the osteochondral cylinder was inserted into the canal until the surface was reached. The position and accuracy was analyzed by anatomic dissection.

Conclusions: In a short term follow-up, the microfracture technique has proven to restore severe cartilage damage with a good functional outcome. Age seems not to be a limiting factor. However, longer-term results remain to be evaluated.

Paper #112
OSTEOCHONDRAL LESIONS OF THE ANKLE: A RETROSPECTIVE CLINICAL AND RADIOMIC EVALUATION OF PRE AND POST OPERATIVE FACTORS INFLUENCING PROGNOSIS.
Ron Arbel, Had Haskaron, ISRAEL, Presenter
Isabelle Tachiykan, Tel Aviv, ISRAEL
Moshe Yanze, Ramat Gan, ISRAEL
Center of Sport Medicine Tel Aviv Surasky Med. Cen, Tel Aviv, ISRAEL

Study purpose: To evaluate the results of arthroscopic treatment of ankle osteochondral lesions and to define the clinical and arthroscopic factors influencing prognosis.

Material and methods: From 1993 to May 1999, a total of 44 patients underwent 54 arthroscopic procedures for diagnosis and treatment for osteochondral lesions of the ankle. Forty-three patients were available for follow up. The evaluation included a pre and postoperative clinical scoring, radiographic evaluation including pre and postoperative anterior-posterior, lateral and mortise view of the ankle, as well as CT scan and MRI of the ankle. Operative techniques included: diagnostic arthroscopy followed by cartilage lesion shaving (16 patients 29%), micro-fractures technique (16 patients 29%), fixation of the lesion using polyactic “Biofix” rods (10 patients 19%), drilling of the lesion to the subchondral bone, ante or retrograde(10 patients 19%), and bone graft filling of subchondral cysts (2 patients 4%).

Results: Traumatic etiology of the lesion was found to be associated with postero-medial talus lesions (p<0.012). Significant clinical and radiographic improvements were found comparing pre and post operative CT scoring (p<0.005), plain radiographs (p<0.01) and clinical score (p<0.003). No correlation was found between the XR, CT findings and arthroscopic grading. Clinical improvement was found to correlate directly with CT grade (P<0.05). Fixation technique with Biofix was found to be associated with post operative subchondral cyst formation detected on plain radiographs and on CT (P<0.0001). Tibial and talar “kissing lesions” correlated with poor preoperative clinical score (P<0.05).

Conclusions: Ankle X-ray and CT play a limited role in planning the intraoperative procedure. Findings like sclerosis and subchondral cysts

RESULTS: We found that tunnel dimensions had to be modified compared to the antegrade insertion of osteochondral cylinders. In the coronal plane the angle between the canal and the talar dome surface ranged from 35 to 40 degrees. In the sagittal plane the tangent to the talar surface was hit at 90 degrees for a typical OCD location in the posterior half of the talus. The surface inaccuracies between cylinder and surrounding cartilage ranged between 0 and 2 mm. Cylinder protrusion could be avoided by pushing the talus against the distal tibia during insertion. Sufficient press fit fixation could be achieved. It was especially demanding to reconstruct the curvature of the talar dome in the coronal plane.

CONCLUSION: In the anatomic model appropriate accuracy could be reached for the retrograde placement of osteochondral cylinders in the medial talar dome.
carries a less favorable prognosis, a finding which is not reflected in the current classifications. Arthroscopy is a valuable tool for evaluation and treatment of talar osteochondral lesions. The operative technique should be selected according to arthroscopic findings – the surgeon should be prepared to tailor the different types of treatment to each lesion.

**Paper #122**

**ARTHROSCOPIC AUTOGENOUS OSTEochondral GRAFT Fixation (MOSAICPLASTY) OF UNSTABLE OSTEochondritis DISSEcANS LESIONS OF THE KNEE**

**Anthony Miniaci, Toronto, CANADA, Presenter**

**Graham Tyler-Smith-Strong, Edinburgh, UNITED KINGDOM**

**Toronto Western Hospital, Toronto, CANADA**

Aim: To assess the use of autogenous osteochondral graft fixation (mosaicplasty) in unstable osteochondritis disseccans (OCD) lesions (Clanton type 2 and 3) of the knee.

Materials & Methods: Twenty patients with x-ray and MRI confirmed OCD lesion in their femoral condyle, that had remained symptomatic despite adequate conservative treatment (average 36 months range 24-60), underwent arthroscopic mosaicplasty plug fixation of the lesion. The OCD lesions were all loose at operation and were all fixed rigidly in situ using a varying number of autogenous 4.5mm osteochondral plugs harvested from the edge of the trochlear groove. The average age at operation was 15.9 years (11 - 32 yrs). The patients were prospectively assessed clinically using the IKDC system and by MRI scan at 3, 6 and 12 months and then six monthly. Average follow up was 3 years.

Results: The pre-operative IKDC assessments scored the knees as 3 B(Nearby Normal), 6 C(Abnormal) and 11 D(Severely Abnormal), at 6 months this had risen to 16 A(Normal), 3 B and by 18 months to 20 A. Joint effusions were present pre-operatively in 17 knees which had all resolved by 6 months. Serial MRI scans documented healing of the osteochondral plugs and a continuous articular cartilage surface layer in all cases by 9 months.

Discussion: Using mosaicplasty plug fixation we were able to obtain healing in all 16 unstable OCD lesions. The benefits of this technique are the ability to obtain rigid stabilization of the fragment using multiple plugs, stimulation of the subchondral blood supply by drilling and autogenous cancellous bone grafting.

Conclusion: We present mosaicplasty plug fixation of unstable OCD lesions in the knee as a new technique. The results of fixation are healing in all cases including adolescent and adult cases and recommend its use for this difficult clinical problem.

**Paper #123**

**AUTOLOGOUS CHONDROCYTE IMPLANTATION VERSUS MICROFRACTURE**

**Tom Clement Ludvigsen, Oslo, NORWAY, Presenter**

**Gunnar Knutsen, Tromso, NORWAY**

**Lars Engbretsen, Oslo, NORWAY**

**Jon Olav Droget, Trondheim, NORWAY**

**Torbjorn Grontvedt, Trondheim, NORWAY**

**Eirik Solheim, Bergen, NORWAY**

**Torbjorn Strand, Bergen, NORWAY**

**Vidar Isaksen, Tromso, NORWAY**

**Oddmund Johansen, Tromso, NORWAY**

**University Hospital Tromso, University Hospital Tr, Oslo, Bergen, Trondheim and Tromso, NORWAY**

**Introduction**

New methods have been used with promising results to treat full-thickness cartilage defects. So far, no controlled randomised studies are available comparing the methods. The goal of the present study was to compare ACI to microfracture through a randomised controlled study.

**Method**

80 patients were included into the study from January 1999 to February 2000. 40 patients were treated with ACI and 40 with microfracture. The patients were randomised in the operating theatre after inclusion criteria were met. The age of the patients varied from 18 to 45 years, and only symptomatic single defects on the femoral condyle between 2-10 cm² were treated. They all had stable knees with no general osteoarthritis. Trauma was the etiology in 64.5% and 28% had OCD. All patients were included into an identical rehabilitation protocol after surgery. Follow up examination of an independent observer was done after 12 and 24 Months. We used the ICRS scoring system, Lysholm, Tegner and the Visual Analogue Scale (VAS-painscore). Two years after treatment second-look arthroscopy with biopsy for histological examination of an independent observer was done after 12 and 24 Months. We used the ICRS Cartilage Repair Assessment for macroscopic evaluation during arthroscopy was applied. Failures were defined as patients reoperated because of non-healing of the primary treated defect. Shaving or trimming were not defined as failures.

**Results**

There were four failures in the ACI-group, and two in the microfracture-group. Reoperations due to trimming and debridement were done in ten cases in the ACI-group and four in the microfracture-group. No serious complications like deep infections or thromboembolic events were reported. After one year both groups had significant clinical improvement (Lysholm and VAS painscore). The outcome was slightly, but not significantly, better in the microfracture than the ACI-group after one year. Histological results and the two-year clinical outcome will be presented.

**Discussion**

Both groups have acceptable short time results. Cartilage surgery is a major procedure with a significant morbidity and long rehabilitation and should only be performed when symptoms are severe. The quality of the repair cartilage is essential to the durability of the repair tissue. One goal for the repair of cartilage is to get hyalinelike repair tissue.

**Conclusion**

Microfracture results in acceptable short time results and have less failures and reoperations than ACI. Further conclusion will follow after analysing the two-year outcome including arthroscopy and histology.
Paper #124
ARTHROSCOPIC EVALUATION OF CARTILAGE REPAIR FOLLOWING AUTOLOGOUS CHONDROCYTE IMPLANTATION (ACI)
John A L Hart, Melbourne, AUSTRALIA, Presenter
Alfred Hospital, Monash University, Melbourne, AUSTRALIA

PURPOSE: To evaluate the repair of articular cartilage defects in the knee joint treated by ACI using arthroscopic assessment.

METHOD: 106 articular cartilage defects in 79 knees of 77 patients were treated by ACI. The autologous chondrocytes were injected beneath a peri-osteal flap (Brittberg et al, 1994). 43.5% of the lesions involved the patella, 35.2% the femoral condyles, 16.7% the trochlea, and 4.6% the tibial condyles. Average defect size was 254.65mm². 20% of knees had more than one defect. Associated biomechanical procedures were carried out in 88.7%. Patients were scheduled for review arthroscopy and removal of the metal implants at nine months following implantation. The ICRS rating score was used to assess articular cartilage repair.

RESULTS: 89 lesions in 68 knees have been assessed arthroscopically. 4 eligible patients have not been assessed.

The ICRS repair scores (Normal(N)12, nearly normal(NN) 8-11) were as follows; medial femoral condyle (21) N 16, NN 4; lateral femoral condyle (9) N 7, NN 1; tibial plateau (6) N 3, NN 2; patella (37) N 14, NN 23; trochlea (16) N 8, NN 7. Synovitis was markedly reduced in all knees with well healed defects. Eleven patients developed adhesions between the perioseal graft and the synovium. Ten of these occurred on the patella and caused a patellar click in some patients during flexion which was relieved by arthroscopic resection. Biopsies at arthroscopy showed predominantly hyaline cartilage. Contraindications are noncontained defects, violated subchondral bone plate and unsuitable patients.

CONCLUSION: ACI is an effective method of repairing articular cartilage defects. In this series the results for the patella have approached those for the medial femoral condyle. This is attributed to the simultaneous biomechanical correction of patello-femoral dysplasia. Stabilization of the articular surface results in resolution of synovitis.

Paper #125
MARROW STIMULATION TECHNIQUES VERSUS AUTOLOGOUS CHONDROCYTE IMPLANTATION FOR TREATMENT OF FULL-THICKNESS CHONDRA DEFECTS OF THE KNEE: COMPARISON OF PATIENT OUTCOMES AT 3-5 YEARS.
Jon E Browne, Kansas City, MO, USA
Bruce Maseley, Houston, TX, USA
Christoph Enggert, Freiburg, GERMANY
Freddie H Fu, Pittsburgh, PA, USA
Bert R. Mandelbaum, Santa Monica, CA, USA
Robert A. Arciero, Farmington, CT, USA
Lyke J Mickel, Boston, MA, USA
Allen F Anderson, Nashville, TN, USA, Presenter
Cartilage Repair Registry, Kansas City, MO, USA

INTRODUCTION: Autologous cultured chondrocyte implantation (ACI), for articular cartilage lesions of the distal femur, generally demonstrates effectiveness in 80-85% of cases. However, no studies have compared these results to those of marrow stimulation techniques (MST): abrasion, drilling, or microfracture. The purpose of this multicenter, prospective study was to compare patient reported outcomes at a minimum of three years between patients treated with autologous chondrocyte implantation and marrow stimulation techniques.

METHODS: Based on a prospectively designed protocol, outcomes were compared between eligible patients treated with MST or ACI. The first consecutive eligible patients in each cohort met the following criteria: at least one femoral defect ≥ 2cm², no treated patella or tibia defects, and the index operation performed in the past 3-5 years. Information on adverse events and treatment failures were captured using standardized data collection forms or spontaneous report by patients or treating surgeons. Treatment outcomes were measured using the modified Cincinnati Knee Rating System and were evaluated at baseline and at a minimum of 3-years follow-up. Treatment failures were included in the analysis and scored as a ‘2’ with all symptoms present.

RESULTS: At baseline, MST and ACI patients were similar with respect to age, body mass index, gender, lesion etiology, lesion size, location of defects, and number of defects. However, ACI patients were more impaired and symptomatic than patients treated with MST were. Baseline mean overall condition scores were 3.1 for ACI patients and 4.1 for MST patients (p=0.012). In addition, a greater number of ACI patients (70% vs. 36%, p=0.007) underwent at least one surgery prior to the index cartilage harvest procedure, and were more likely to be on worker’s compensation (38% vs. 9%, p=0.008) when compared to those of the MST cohort. At follow-up, ACI patients reported greater improvement in their overall condition score (3.8 vs. 1.2 points, p=0.001), pain scores (3.9 vs. 1.5 points, p=0.019) and swelling scores (4.1 vs. 1.1 points, p=0.002) when compared to MST patients, respectively. These changes from baseline to follow-up were statistically significant and clinically relevant.

CONCLUSION: ACI patients reported greater functional improvements and significantly reduced symptoms at 3-5 years than MST patients even though they were characterized at baseline by lower overall condition scores, were more likely to have had at least one prior surgery and be on worker’s compensation. Results from this prospective comparative study demonstrate that ACI may be more effective than MST for carefully selected patients.

Paper #126
PROSPECTIVE CLINICAL STUDY OF AUTOLOGOUS CHONDROCYTE IMPLANTATION (ACI) AND CORRELATION WITH MRI AT 3 AND 12 MONTHS
Ian Henderson, Presenter
Werner Hettwer
Benjamin Tuy
David Connell

INTRODUCTION: ACI produces good clinical results due to production of hyaline articular cartilage. This study aims to determine the usefulness of MRI in assessing graft maturation after ACI and to correlate this with clinical outcome.

MATERIALS AND METHODS
A consecutive series of the first 57 patients with 81 chondral lesions having a 12-month review after ACI were included. Follow-up protocol consisted of IKDC scoring, patient subjective rating and knee function assessment at pre-op, 3 and 12 months, and MRI using cartilage-specific techniques at 3 and 12 months. MRI scans were assessed for fill, signal, underlying bone marrow edema (BME) at the repair sites, and joint effusion.
RESULTS

Improvement from pre-op to 12 months was found subjectively (37.6 to 51.9) and in knee function levels (from 85% ICRS III to IV to 61% I & II). IKDC scores showed initial deterioration at 3 months (only 56% IKDC A or B) but marked improvement at 12 months (88% A or B).

MRI at 3 months showed: 82% with at least 50% fill; 99% normal or near normal signals; 71% mild to no effusion; and 80% mild to no underlying BME, these improved at 12 months to 93%, 93%, 94% and 91%, respectively. No linear correlation was found between each MRI parameter and objective and subjective scores. Overall 12-month MRI score indicated normal or near normal cartilage in 82%.

Second-look surgery (at an average of 11.5 months) and biopsies in 15 patients (22 lesions) showed moderate correlation of MRI scores with ICRS visual scoring and core biopsies of 13 grafts showed 70% were hyaline or hyaline-like cartilage.

CONCLUSIONS

Although no linear correlation could be found between MRI parameters assessed and clinical scores, our MRI scoring suggests production of normal or near normal cartilage at 12 months in 82% of lesions, corresponding to the subjective improvement of 81% of patients and 82% IKDC A or B scores. Furthermore, MRI corresponded with visual scoring and core biopsy results. MRI at 12 months may be a reasonable non-invasive means of graft assessment after ACI.

Paper #127

PATIENT SATISFACTION AND FUNCTIONAL OUTCOME AFTER MICROFRACTURE OF THE DEGENERATIVE KNEE

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Purpose: In this study, we measured satisfaction and functional outcome of patients treated arthroscopically with microfracture for isolated degenerative lesions of the knee.

Type of Study: A case series of patients with two to five year follow-up.

Methods: Our study group included patients over the age of forty with Outerbridge grade IV degenerative lesions and no evidence of concomitant ligament or meniscus injury or varus/valgus malalignment. Preoperative and postoperative subjective data were collected and compared, and functional outcome scores (Lysholm, Tegner) were calculated. Results: Eighty-one patients with mean age of 49.4 years (range 40-70 years) and degenerative lesion size of 229.5 mm² (range 25-2000 mm²) were evaluated at a mean follow-up of 2.6 years (range 2-5 years). All subjective parameters measured (pain, swelling, limping, walking, stairs, level of sport, and activities of daily living) demonstrated significant improvement over preoperative status (P<0.003). Similarly, functional outcome scores demonstrated significant improvement: mean Lysholm score improved from 53.8 to 83.1 (P<0.001), and mean Tegner Activity Scale score improved from 2.9 to 4.5 (P<0.05). There was no significant difference in Lysholm improvement by gender, and no significant association between Lysholm improvement and age. Significant improvement in mean Lysholm score was seen for lesions in all three compartments of the knee, with no significant difference in Lysholm improvement between compartments. There was a trend towards lesser Lysholm improvement in bipolar or "kissing lesions", as well as in lesions greater than 400mm² in area. Five patients (5.9%), required either revision microfracture to a previously treated lesion or total knee replacement at an average of 23 months (range 5-36 months) from the initial microfracture procedure. Thirteen patients (15.5%) required repeat arthroscopy within five years of the initial microfracture procedure for lysis of adhesions.

Conclusions: The microfracture technique is an efficacious surgical option for the treatment of degenerative chondral lesions of the knee. Patient satisfaction scores as well as subjective and functional outcome scores demonstrate the success of this procedure. The modest rate of failure and need for arthroscopic lysis of adhesions reflects the challenge of joint-sparing arthroscopic surgery in the degenerative knee.

Paper #128

AN OPTIMAL DONOR SITE FOR THE WEIGHT BEARING AREA OF THE FEMORAL CONDYLE IN AN AUTOLOGOUS OSTEochondRAL TRANSPlANTATION

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Localized articular cartilaginous lesions present a challenging clinical problem. To relieve pain and resume joint function, the articular cartilage should be repaired with hyaline cartilage of good congruity. Autologous osteochondral transplantation, which is one of the useful techniques to repair cartilaginous lesion, has several advantages including the initial stabilization of the osteochondral graft followed by a bony union at the subchondral area and the elimination of the risk of disease transmission. However, there are few reports regarding the selection of the donor site in autologous osteochondral transplantation. Therefore, we have measured the cartilage thickness and the surface curvature of the femoral condyle taken from cadavers and attempted to determine the optimal location of the donor site for the chondral lesion in the weight bearing area of both medial and lateral femoral condyles. Eight cadaveric femoral condyles were sectioned sagittally. To analyze the thickness and surface curvature of the cartilage, photographs of the sliced condyles were taken. The film was digitized and a morphological analysis was performed using an NIH image program. As a unit of analysis, the cartilage layer of the sliced condyle was divided into 1-cm-long compartment on both sides of the sulcus terminals. The thickness was measured at the center of each compartment and the curvature of the surface of each compartment was calculated as the reciprocal of the curvature radius. The curvature radius of the cartilage surface was measured as the radius of a circle passing three points that divided each compartment equally. Thereafter, because chondral lesion is predominantly observed in the weight bearing area of the medial and lateral femoral condyles located 2 to 3cm posterior to the sulcus terminals, the cartilage in this area was assumed as a recipient site. To determine the optimal donor site of this presumptive chondral lesion, we compared the thickness and curvature of the recipient sites with those of each compartment. The differences in thickness and curvature between each compartment and the recipient sites were calculated and mapped schematically on the femoral condyle. The average thickness of the cartilage was 1.69 mm (range 0.22 to 3.65 mm), with the maximum curvature 27.2 m-1 and the minimum ~0 m-1. When the recipient site was assumed to be the weight bearing area of the medial and lateral condyles, the most com-
patible donor site in terms of the cartilage thickness and curva-
ture was located anterior to the sulcus terminalis in the middle
portion of the lateral condyle with a thickness difference of
less than 0.07 mm and a curvature difference less than 2.22 m-1. The
anterior portion of the lateral femoral condyle can be an opti-
mal donor site for the chondral lesion in the weight bearing
area of both medial and lateral femoral condyles.

Paper #129
DEGREE OF DEGENERATION AND CHONDROITINASE
ABC TREATMENT OF HUMAN ARTICULAR CARTILAGE
AFFECTS THE ADHESION OF TRANSPPLANTED
CHONDROCYTES
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INTRODUCTION
Chondrocytes transplantation can be a treatment modality for
cartilage repair in osteoarthritis. However, Transplanted cells
may have difficulties attaching to the surface of chondral
lesions because of the antiadhesive properties of the proteo-
glycan rich matrix.[3] The removal of the proteoglycans at a car-
tilage surface may expose underlying collagen molecules,
removing proteins that are known to have antiadhesiveness.[2]
The propose of this study was to determine if transplanted chondrocytes adhere differentially to cartilage surface accord-
ing to the degree of degeneration and to determine the effects
of chondroitinase ABC on chondrocytes adhesiveness.

EXPERIMENTAL METHOD
Human cartilage explant and chondrocytes were harvested from
patients underwent knee replacement arthroplasties for osteo-
arthritis. The articlar cartilage surface was cut into a disc (0.5-
0.8 mm thick, 3.75 mm diameter). Cartilage discs were grouped
by grade of degeneration: normal (G0), superficial fissures (G1)
and deep fissures (G2)[1] and stored at -70° before use. Human
chondrocytes were transferred onto cartilage discs pretreated
with 0, 1 U/ml chondroitinase ABC (Sigma, USA) for 15 min at
37 degrees. Transplanted chondrocytes were cultured on cartilage
discs at 37 degrees with constant gentle shaking for 14 days.

RESULTS AND DISCUSSION
The transplanted chondrocytes continued to proliferate and
synthesize matrix on the surface of cartilage disc. At 14 days
after transplantation, the degenerated surface of G1 or G2 car-
tilage disc was covered with the matrix synthesized by the
transplanted chondrocytes. The degenerated surface of cartil-
gage disc became very similar with normal articular cartilage
surface with the new matrix made by transplanted chondro-
cytes under SEM. The number of cells attached to G1 and G2
cartilage disc was greater than that of cells attached to G0
disc. The difference in the number of cells attached on G0, G1,
and G2 cartilage disc seems to correspond to the fact that the
amount of proteoglycan on the surface of degenerated cartilage
is smaller than that of normal cartilage. Chondroitinase ABC
treatment of cartilage surface resulted in the increase of colla-
gen fibrils exposed. One day after cell transplantation, the
number of cells attached to cartilage disc was greater in chon-
droitinase ABC treatment group(G0, G1, G2) compared with
control group. Through this experiment, the amount of proteo-
glycan synthesized by transplanted chondrocytes was greater in
G2 with or without chondroitinase ABC treatment.

CONCLUSION
In this in vitro study, the transplanted chondrocytes onto
osteoarthritic cartilage could repair the defects on the surface
of osteoarthritic cartilage. The transplanted chondrocytes
attached better on the surface of degenerated cartilage com-
pared with that of normal cartilage and chondroitinase ABC
treatment of cartilage surface enhanced the cell attachment.
These findings may be applied to developing a new method of
intraarticular chondrocytes injection for osteoarthritis treat-
ment.

REFERENCES

Paper #130
RE-OPERATION AFTER AUTOLOGOUS CHONDROCYTE
IMPLANTATION: INDICATIONS AND FINDINGS
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Ian Henderson, FRACS, FAOrthA, AUSTRALIA, Presenter

Objectives
This study characterizes patients undergoing re-operation after
autologous chondrocyte implantation (ACI) and reports surgi-
cal findings and interventions, cartilage repair assessment,
clinical outcome and biopsy results.

Materials and Methods
Of 135 patients treated with ACI for chondral knee lesions, 22
(16.3%) who underwent re-operation at mean 10.5 months were
reviewed. Clinical outcome and cartilage repair were assessed
using the ICRS cartilage injury evaluation package. Central and
marginal core biopsies (2mm) of the repair sites were obtained.

Results
Indications for re-operation were knee pain (3) and
placing/catching, which was either painful (5) or painless (12).
Two asymptomatic patients were arthroscoped at removal of
internal fixation. Surgical findings were hypertrophic grafts in
26/31 lesions (85.2%), lifted-off patches (7) and detached
patches (3). Shaving of hypertrophic areas (26/31) and patch
removal (7) were carried out. Other procedures were chon-
droplasty of new lesions (2), meniscal trimming (1) and one ACI
to a new lesion. All mechanical symptoms resolved rapidly and
at 6-12 months, only 3 patients had pain but these had new
chondral lesions (2) and progressive arthritis (1). Thirty (96.8%)
lesions had normal or nearly normal ICRS repair assessment.
Sixty-eight percent were subjectively improved and 81.8% had
normal or nearly normal IKDC scores. Central core biopsies
revealed good integration to subchondral bone in all speci-
mens. Repair tissues found were hyaline cartilage (7), hyaline-
like cartilage (6), mixed hyaline and fibro-cartilage (3) and
fibrocartilage (2). Marginal Biopsies revealed an excellent inter-
face with adjacent normal cartilage.

Conclusion
Bothesome mechanical symptoms required surgery in 12.6% of
ACI-treated patients 6-17 months. These were attributed to
hypertrophic grafts or detached periosteal patches; simple
shaving and/or patch removal was curative. Ninety-seven percent of grafts had normal or nearly normal appearances at mean 10.5 months and were mostly filled with hyaline or hyaline-like cartilage (72%). All had good subchondral bone and marginal interface integration.

**Paper #131**  
**THE EFFECT OF INCREASING TIBIAL SLOPE ON THE STABILITY OF THE PCL-DEFICIENT KNEE**  
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Sarah L. Yao, Pittsburgh, PA, USA  
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**INTRODUCTION:** Injury to the posterior cruciate ligament (PCL) results in increased posterior tibial translation, leading to increased articular cartilage wear and degeneration. Previous studies have shown that increasing tibial slope can shift the resting position of the tibia anteriorly with respect to the femur. Thus sagittal osteotomies that alter the tibia slope may have role in the treatment algorithms of PCL injuries.

**OBJECTIVE:** The objective of this study was to evaluate the effects of increasing the tibial slope on knee kinematics in the PCL-deficient knee under anterior-posterior tibial and axial compressive loads.

**MATERIALS AND METHODS:** Ten fresh frozen human cadaveric knees were tested with a robotic/universal force moment sensor testing system. The path of passive flexion-extension (F-E) of the intact knee was established from 0° to 120° and served as reference position for the application of external loads. 134N anterior-posterior (A-P) load and 200N axial compression were applied at 0°, 30°, 60°, 90°, and 120° of knee flexion. The 5 degree of freedom knee kinematics were obtained for the intact. The PCL was transected and the loading conditions repeated.

**RESULTS:** PCL-deficiency resulted in a posterior shift of the resting position of the intact knee to 13.8±0.9°. After an osteotomy was performed, tibial slope increased from 9.2±1.0° in the intact knee to 13.8±0.9°. This increase in slope caused a reduction in the posterior sag of the PCL-deficient knee, shifting the resting position anteriorly by up to 4.5±2.2 mm at 90°. Under the 200N axial compressive load, anterior tibial translation was further increased up to 3.8±2.8 mm at 90° of knee flexion.

**CONCLUSION:** Increasing tibial slope in a PCL-deficient knee causes a relative decrease in posterior tibial sag by shifting the resting position of the tibia anteriorly. Additionally, this tibial sag is further reduced with the application of an axial compressive load in combination with increased tibial slope. These data suggest that increasing tibial slope may be beneficial for the patient with a PCL-deficient knee.
High tibial valgus osteotomy (HTO) was performed for medial compartmental osteoarthritides of the knee and the fragments were fixed with Koshino blade plate. Approximately total 1,250 high tibial osteotomies were performed up to now in our university hospital. The plates were removed and the parapatellar release procedures were added to increase ROM. The series included 1,460 knees with medial compartmental osteoarthritides of 18 men and 97 women with aged age of 65 (47-80). At the time of plate removal, regeneration of the articular cartilage was observed through arthroscopy and rated by a staging system. And the biopsy specimen of regenerated cartilage were taken from the medial femoral condyle in 28 knees, which were decalcified and stained with Safranin-O, anti-type-I, type-II, collagen and anti-s100 protein. The averaged interval between these two operations was 24 months (3-36). The preoperative average standing femoro-tibial angle was 185°±6° (5° of varus angulation) with the medial joint space being 1.1 mm and after osteotomy it improved to 167°±5° (12° of valgus angulation) with the medial joint space being 2.3 mm at the time of plate removal. At the plate removal, regeneration of the articular cartilage in the medial femoral condyle showed no regenerative change (Stage 0) in 13, pink and yellowish fibrillation (Stage 1) in 2, scattering small islands of white fibrocartilage (Stage 2) in 35, partial coverage with white cartilage (Stage 3) in 50, full coverage with overgrown white cartilage (Stage 4) in 30, even coverage with white cartilage (Stage 5) in 16 knees. The biopsy specimens showed different cell types and staining pattern. Between superficial zone with spindle shaped fibrocartilage-like cells and middle to deep zone with round shape distributed hyaline cartilage-like cells. Regeneration of the articular cartilage was more advanced in the cases with medial joint space opened after osteotomy (p<0.05).

INTRODUCTION: The lateral unicompartamental knee replacement (lateral UKR) can be used in the management of the lateral femorotibial osteoarthritides compartment. We analyse our results according to etiology, operative data, pre- and post-operative clinical and radiographic data.

MATERIAL AND METHODS: Between January 1985 and December 1999, a consecutive series of 77 patients (81 knees) with lateral osteoarthritides were treated by lateral UKR arthroplasty using the HLS prosthesis. 87% were reviewed clinically and radiologically, we obtained notes in 13% of cases. Mean age at time of operation was 71.5 years. Mean follow-up was 6.5 years (minimum 2 years).

RESULTS: Knee score was improved: mean post-op score: 90.2 (pre-op 49). This improvement was due to greater pain relief and to enhanced mobility: 63% of the knees were completely pain-free. Function score was 73.3 points after lateral UKR (pre-op 59). In the frontal plane the mean mechanical femoral angle was 183.3°±3° (190°±5° in pre-operative), with a mean mechanical tibial angle of 90.6°±1° and a mean mechanical femoral angle of 91.1°±3°. The survival curves plotted using the Kaplan-Meier technique showed 97.15% of the unicompartmental prosthesis to be present after 5 years, and 93.3% at 10 years. 93% of the patients were very satisfied or satisfied with their operated knee.

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A POLYURETHANE SPACER: A NEW TECHNIQUE

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Unicondylar arthroplasty (UKA), an almost forgotten option for the arthritic knee, has experienced a resurgence of interest with the introduction of minimally invasive surgery (ENGH 2002). SCULCO (1994) described UKA as treatment of choice in unicompartmental arthritis of the knee, when arthroplasty is indicated. Advantages over total knee arthroplasty (TKA) are preservation of cruciate ligaments as well as other undamaged structures along with possible restoration of knee function to nearly normal. Patellar dislocation is not necessary as part of the procedure, and hospitalisation can be avoided. We report an extension of UKA using an even less invasive surgical technique to insert a spacer between the femur and tibia for treatment of medial compartment osteoarthritis.

TESTING

In our technique, the polyurethane implant is formed at the time of surgery. The formed implant is then inserted through a mini-medial arthrotomy into the patient’s arthroscopically-prepared medial compartment and shaped to the femoral-tibial articulating surfaces to provide a custom fit. The procedure does not entail any alteration of the femoral or tibial joint surfaces. The elastomeric, custom fit implant provides an articulating surface with a low coefficient of friction and excellent impact absorption, while correcting angular deformity. Multiple biocompatibility tests have been performed (ISO 10993 battery). In a sheep model the response of adjacent bone and cartilage was evaluated and confirmed the biocompatibility of the polymer.

SURGICAL TECHNIQUE

The procedure begins with a standard diagnostic arthroscopy and debridement of the knee. The medial meniscus is removed. The medial portal is extended to a mini-medial arthrotomy of about 3.5 cm in length. Ridges of the femoral articulating surfaces and femoral osteophytes in the medial gutter are smoothed. A test implant is then inserted to determine the preparation as complete, check correct restoration of alignment and full range of motion. The implant is now formed in a mold and inserted into the medial compartment. The knee is extended and varus stress is applied to shape the implant to the articulating surfaces of the tibia and femur. The patient is allowed immediate full weight bearing as tolerated; a brace is advised for the first weeks.

RESULTS

First clinical results on 12 patients (the oldest implant being in place for 10 months) show encouraging improvements for WOMAC pain scores (357 reduced to 76 - avg.) and WOMAC function scores (1074 improved to 119 - avg) as well as global assessment (avg improvement 77%). Two patients had the procedure successfully performed as outpatients. No complications directly related to the procedure have been noted.

CONCLUSION

A high level of patient acceptance and good first clinical results encourage us to continue the research.

A RADIOLOGICAL ASSESSMENT OF BEARING DISLOCATION OF THE OXFORD LATERAL UNICOMPARTMENTAL ARTHROPLASTY

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When the Oxford unicompartmental meniscal bearing arthroplasty (UCA) is used in the lateral compartment 10% of the bearings dislocate. A radiological review was performed to investigate if surgical implantation was related to bearing dislocation.
The post-operative radiographs of 46 lateral Oxford UCA's were analysed. Five variables relating to the position and alignment of the components were measured. Bearing dislocations have occurred in six knees.

Only one of the five variables, the proximal tibial varus angle, had a statistically significant relationship with dislocation. This variable quantifies the height of the lateral tibial joint surface. In the knees that dislocated the mean proximal tibial varus for dislocators and non-dislocators was 9° and 5° respectively. In both groups the variable was greater than would be expected in the normal knee (3°).

This study suggests that a high proximal tibial varus is associated with dislocation. Implantation procedures should be modified to account for this. In particular, care should be taken to avoid damage to or over-distraction of the lateral soft tissues.

**Paper #140**
**UNICOMPARTMENTAL KNEE PROSTHESIS IMPLANTATION WITH A NON IMAGE BASED NAVIGATION SYSTEM. A MATCHED-PAIRED COMPARATIVE STUDY OF THE QUALITY OF IMPLANTATION WITH A CLASSICAL TECHNIQUE.**

Jean-Yves Jenny, Illkirch, FRANCE, Presenter Cyril Boeri, Illkirch, FRANCE Centre de Traumatologie et d’Orthopédie, Illkirch, FRANCE

**INTRODUCTION:** The quality of implantation is an accepted prognostic factor for long term survival of a unicompartmental knee prosthesis. Most classical, surgeon controlled instrumentations mainly rely on the surgeon’s skill, and could have low accuracy and reproducibility. Navigation systems should allow a higher precision of implantation for such implants. The authors have studied the quality of the navigated-implantation of an unicondylar knee prosthesis with a non image based infrared navigation system in comparison with a classical, surgeon-controlled instrumentation.

**MATERIAL & METHODS:** The authors implanted a consecutive series of 60 unicompartmental knee prostheses (SEARCH® prosthesis, Aesculap, Tuttingen, FRG), operated by the same surgical team with the help of an adapted software of the ORTHOPilot® non image based navigation system (Aesculap, Tuttingen, FRG), which allows to define with a kinematic analysis the mechanical axes of the femur and the tibia, and to track relevant anatomical points with a stylus. The quality of implantation was assessed on postoperative long leg coronal and sagittal standing X-rays according to the Knee Society recommendations. The control group of 30 cases was selected in a consecutive series of 250 patients operated by the same surgical team with the same implant, but with a classical, surgeon controlled instrumentation with intramedullary femoral and extramedullary tibial guiding devices. Both navigated (group A) and classical implanted (group B) groups were matched according to age, sex, pre-operative coronal femoro-tibial deformation and severity of the degenerative changes. The rate of optimally implanted prostheses was compared in both groups with a Chi-square test at a 0.05 level of significance.

**RESULTS:** The coronal femoro-tibial mechanical angle was in the desired range (177°±3°) by 52 patients of the group A and 40 patients of the group B. The coronal orientation of the femoral component was in the desired range (90°±2°) by 52 patients of the group A and 42 patients of the group B (p<0.02). The sagittal orientation of the tibial component was in the desired range (0 to 5° of posterior slope) by 56 patients of the group A and 42 patients of the group B (p<0.02). The original level of the joint space was reconstructed in the desired range (±2 mm in comparison to the non replaced joint) by 58 patients of the group A and 48 patients of the group B (p<0.05). In 37 patients in group A and 8 patients in group B had an optimal implantation for all studied criteria (p<0.001).

**CONCLUSION:** The used navigation system allowed a significant improvement of the quality of implantation of an unicompartmental knee prosthesis in comparison to a classical, surgeon controlled instrumentation. Pre-operative dedicated imaging was not necessary. The long term survival of such implanted prostheses could be improved in comparison to the manually implanted prostheses.

**Paper #141**
**INTERMEDIATE TERM FUNCTIONAL OUTCOMES AFTER ARTHROSCOPIC KNEE SURGERY**

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**OBJECTIVE:** Traditionally, assessment of patient function has been based on symptoms, clinical exam findings and radiographs. The use of patient-oriented questionnaires validated for outcome measures has only recently been employed. This study investigated demographic, intraarticular (IA) pathology and arthroscopic treatment as positive outcome predictors in 4 to 7 years after knee arthroscopy. Our hypothesis was initial IA pathology at the time of arthroscopic surgery was a significant variable in intermediate outcomes.

**METHODS:** The analysis consisted of 218 patients with minimum 4-year follow-up with single unilateral knee arthroscopy (single surgeon) in a ligamentously stable knee without other major lower extremity problems. Intraarticular knee pathology and treatment were recorded on scale diagrams and forms with clinical follow-up by self-administered questionnaires, which included SF-36, WOMAC, KOOS, Lysholm, and IKDC. Both univariate and multivariate statistical analyses were performed to determine statistically significant intraarticular and demographic variables at intermediate follow-up with the outcomes questionnaires, global scores, subscale scores, and functional status.

**RESULTS:** Multivariable modeling revealed gender (male) and patellar/trochlear degenerative pathology as the only consistent statistically significant (p<0.05) independent predictors of poor outcome with the KOOS, the IKDC, and the WOMAC scores. Other factors found to be significant were: age (p=0.037) in the KOOS symptoms/stiffness model, complete meniscus tear in the WOMAC stiffness (p=0.006, medial) and SF-36 Mental Health (p=0.046, lateral) models. Articular cartilage degeneration was significant only in the MFC with advanced models. Articular cartilage degeneration was significant only in the MFC with advanced (Grade IV) arthritis vs early (Grade I-III) changes in the KOOS model, and for the LFC was significant in both early and advanced in the KOOS model and in sports/recreation function, quality of life and overall scores.

**CONCLUSIONS:** The overall functional outcome after operative knee arthroscopy as assessed by validated questionnaires is...
most highly correlated by articular cartilage status, especially patellofemoral arthritis, as well as gender with males having statistically significant worse outcomes scores than females. Meniscal treatment did not significantly affect scores at follow-up. The results of this study may assist the counseling of patients regarding expectations of functional outcomes following knee arthroscopy.

Paper #142
EARLY COMPLICATIONS AFTER HIGH TIBIAL OSTEOTOMY – A COMPARISON OF TWO TECHNIQUES (OPEN VS. CLOSED WEDGE)
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Ziekenhuis Hilversum, Hilversum, NETHERLANDS

Aim of the study
To compare two different techniques of high tibial osteotomy (HTO) (open wedge - PUDDU vs. closed wedge AO-L-plate), with special interest in complications (rate of pseudoarthrosis, infections, re-operations, loss of correction angle).

Material & Methods
Between March 2000 and December 2000 we treated 40 consecutive patients suffering from med. gonarthrosis with valg. high tibial osteotomy (HTO) and followed them prospectively. Out of this group in 50% the open wedge technique (PUDDU) was used, the other patients were treated with the “conventional” technique (AO-L-plate) in the open wedge group the wedge defect was filled with tricalciumphosphate. There were 21 female and 19 male patients with an average of 52 years of age (range 30-75). AP and lateral x-rays were taken preoperatively (P: 52.2, range 30-75, T: 51.9, range 32-63) 16 right (P: 7 / T: 9) and 24 left knees (P: 13 / T: 11) were treated. At an average of 11 months (range 3 - 24 mths) all patients were followed. A visual analog scale was noted (pain and quality of living), standard x-rays (ap and lateral) were taken preoperatively as well as at follow-up and complications were noted.

Results
In total 25 complications in 15 patients were noted. In the PUDDU group 11 patients (55%) suffered from 19 complications, versus four patients (20%) from six complications in the AO-group. Eight tibial non unions (P: 35% / T: 5%), three fibular non unions (P: 0 / T: 15%) and three infections (P: 10% / T: 5%) occurred. Furthermore three times loss of correction (P: 15% / T: 0) and six times material failure (P: 30% / T: 0) complicated the post-operative period, as well as loosening of material which was found in two cases (P: 5% / T: 5%). These complications led to re-operations in 15% of the total patient group (P: 15% / T: 15%). Despite the fact, that most of the patients had improved postoperatively regarding pain and quality of living, the percentage of complications in the group of patients treated with the open wedge technique (PUDDU) was significantly higher regarding tibial non union, loss of correction and material failure.

Conclusion
Even though both techniques (conventional L-plate and PUDDU open wedge) are well established, the substitution of the wedge defect with tricalciumphosphate bone in the PUDDU group seems to lead to a higher complication rate. We will adapt our surgical technique in the future and look for a different bone substitute. Further studies have to proof, whether this will lead to satisfactory results.

Paper #143
CT EVALUATION OF FEMORAL COMPONENT ROTATION IN TKA: COMPARISON OF TIBIAL AXIS METHOD TO TRANSEPICONDYULAR LINE.
Jens Boldt, Zürich, SWITZERLAND, Presenter
Urs Muntzinger, Zürich, SWITZERLAND
Schulthess Klinik, Zürich, SWITZERLAND

Purpose: Accepted landmarks for determining femoral component rotation in total knee arthroplasty (TKA) include the posterior condyles, Whiteside's line, arbitrary three to four degrees of external rotation, and transepicondylar axis (TEA). All methods require anatomical identification, which may be variable. The purpose of this study was to radiologically evaluate femoral component rotation (CT analysis) based on a method that references to the tibial shaft axis and balanced flexion tension without identification of femoral anatomical landmarks.

Methods: Out of a cohort of 3058 mobile bearing low contact stress TKA, CT scans of 38 randomly selected well functioning TKA were evaluated to determine femoral component positioning. Spiral CT scans of the femoral epicondylar region with four mm cuts were performed to accurately identify medial and lateral femoral epicondyles. Rotational alignment was measured in relation to the transepicondylar axis using CT-implemented software by two independent radiologists.

Results: Mean femoral rotational alignment was parallel to the TEA (average 0.3 degrees internal rotation) ranging from six degrees internal to four degrees external rotation. All thirty-eight cases had satisfactory clinical results, range of motion of over 90º, and showed perfect patello-femoral tracking and patellar congruency on axial views.

Conclusions: Femoral rotation position based on tibial shaft axis and balanced flexion tension gap is patient specific, reproducible and results in predictable femoral rotational positioning and patella tracking. CT analysis in this study confirms that the tibial shaft axis method produces a consistent femoral component positioning that relates accurately to the TEA. Tibial shaft axis method avoids the need for arbitrary landmark identification, placing the femoral component predictably in an optimum position in relation to the tibia and patella.

Paper #144
THE USE OF THE KNEE JOINT-LINE BALANCER TO CONTROL PATELLA POSITION IN REVISION TOTAL KNEE ARTHROPLASTY
Anna M. ten Ham, NETHERLANDS
Ate Wymenga, Nijmegen, NETHERLANDS, Presenter
Wilco Jacobs, Nijmegen, NETHERLANDS
Sint Maartenskliniek, Nijmegen, NETHERLANDS

Purpose: The goal of this study is to evaluate the use of custom-made device to control patellar height and joint-line during revision total knee surgery.

Materials and Methods: Following revision total knee arthroplasty the joint-line is often elevated that results in a patella baja. The normal spacer blocks are inadequate to indicate what the joint-line will be. We developed an adjustable flexion-extension spacer, the knee joint-line balancer (KJB). This device simulates femur component sizes, polyethylene sizes, the joint-line level and distal femur wedges. The subjects of the study were the first ten consecutive patients who had undergone revision of a primary total knee arthroplasty where the KJB was used. A reference group composed of the last ten patients treated without the use of the KJB was also evaluated. The
joint-line position and the patellar height were determined
before and after revision total knee arthroplasty. The method
described by Figgle et al. was used.

Results: In the reference group the average joint-line change
was 3.1 mm (range -6.7 mm to +5.3 mm). In the KJB group the
joint-line change averaged 3.8 mm (range -7.3 mm to +6 mm).
The patellar height in the reference group averaged 7.7 mm.
Seven patients had a patella baja, and two of these seven
patients had patellar impingement. One patient needed a prox-
imalisation of the tuberositas. The patellar height in the KJB
group averaged 14.6 mm after revision. Only one patient had a
patella baja.

Conclusion: The Knee Joint-line Balancer device provides better
control of the patella position in total knee revision.

Paper #145
CLINICAL RESULTS OF CRUCIATE-RETYAINING TOTAL KNEE ARTHROPLASTY WITH ALUMINA CERAMIC CONDYLAR PROSTHESIS – COMPARISON TO THE CO-CR ALLOY PROSTHESIS
Tokifumi Majima, Sapporo, JAPAN, Presenter
Hirotaka Azuma, Sapporo, JAPAN
Hiroyoshi Nakajima, Sapporo, JAPAN
Yoshinari Aoki, Sapporo, JAPAN
Akio Minami, Sapporo, JAPAN
Kazunori Yasuda, Sapporo, JAPAN
Dept. of Orthopedic Surgery, Hokkaido Univ. School, Sapporo, JAPAN

Introduction: In 1992, Yasuda et al. originally developed a
unique cruciate ligament-retaining total knee prosthesis com-
posed of an alumina ceramic femoral component having the
same thickness as the standard metal component, a titanium-
alloy tibial component, and UHMWPE insert. In wear tests with
a knee simulator (106 gait cycles), the depth of wear on the
UHMWPE insert surface in the alumina ceramic knee was 20 %
of that in the standard Co-Cr alloy knee. However, no studies
have been conducted to compare clinical results between the
two types of total knee prosthesis. The purpose of this study is
to compare the mid-term clinical results of cruciate-retaining
total knee arthroplasty between the alumina ceramic prosthe-
sis and the Co-Cr alloy prosthesis.

Materials and Methods: In a prospective study, 218 patients
with osteoarthritic and rheumatoid arthritic knees underwent
arthroplasty with PCL-retaining total knee prostheses in two
hospitals. Under the same inclusion criteria, the alumina
ceramic total knee prosthesis (LFA-I, Kyocera, Japan) was used in
one hospital, and the Co-Cr alloy total knee prosthesis (Kinemax, Howmedica, USA) was used in the other hospital.

Discussion: For the condylar knee prosthesis, a problem men-
tioned in the previous literature was fragility against impact
loading. In this study, we did not experience any case of ceramic
component breakage. This fact suggested that the problem of
the ceramic knee fragility has been solved by material improve-
ment of the alumina ceramics. This study demonstrated that, in
the mid-term follow-up evaluations, there were no significant
differences in the clinical results between the patients with the
ceramic total knee prosthesis and the standard Co-Cr alloy
total knee prosthesis. In addition, the ceramic prosthesis
showed some statistical tendency of superiority to the Co-Cr
prosthesis concerning the lucent line found in radiological
evaluation. In the basic scientific literature, the alumina
ceramic knee has been shown to have excellent wear proper-
ties. Although we could not conclude the superiority of the
ceramic prosthesis concerning UHMWPE wear and long-term
survivorship of the knee at the present time, the results encour-
gaged us to conduct a long-term follow-up study on the ceramic
total knee prosthesis.

Paper #146
INTRA-ARTICULAR OSTEOTOMIES FOR MALUNITED TIBIAL HEAD FRACTURES: OPERATIVE TECHNIQUE AND LONG-TERM FOLLOW-UP RESULTS.
Mark Altena, Woudenberg, NETHERLANDS, Presenter
Academical Medical Centre, Amsterdam, NETHERLANDS

Background
The outcome of corrective surgical interventions for posttrau-
matic deformities of the knee is seldom reported in literature.
Reconstructive osteotomies present a challenging alternative
treatment to total knee arthroplasties for posttraumatic intra-
articular malunions. The goal of this study was to present the
results after five to twenty-four years of follow-up.

Patients and Methods
We analysed the outcome of 20 intra-articular osteotomies per-
formed at an average of 24 months (range 7 months to 40
months) after primary tibial plateau fracture treatment. End-
point of the follow up was a total knee arthroplasty or an
arthrodese. The average age of the patients at reconstruction
was 42 years (range 22 to 64 years). All primary tibial fractures
were analyzed according to the AO/ASIF prospective documen-
tation system. The outcomes were evaluated on the basis of the
Hospital for Special Surgery (HSS) knee score, the Neer score,
the Lysholm score and the Ahlbäck radiological score.

Results: In the ceramic prosthesis group, 2 revision surgeries
were performed because of breakage of the tibial tray and late
infection, respectively. In the Co-Cr prosthesis group, 2 revi-
sions were carried out due to loosening and late infection,
respectively. In clinical evaluation of the remaining patients,
the HSS knee score averaged 86 points in the ceramic prosthete-
sis group and 85 points in the Co-Cr alloy prosthesis group. The
average knee flexion angle was 112 degrees in the former group
and 113 degrees in the latter group. There were no significant
differences in these clinical parameters between the two
groups. In radiological evaluation, we could not find any radi-
olucent lines around the ceramic femoral component, while
radioluency was present in 2 knees (2.3 %) around the Co-Cr
alloy femoral component. Beneath the tibial tray, however, we
found a radiolucent line in 8 knees (9.5 %) of the Co-Cr alloy
prosthesis group, while it was found in 3 knees (2.7 %) of the
ceramic prosthesis group. There was a significant difference in
the radioluency between the two groups (p<0.05).

Discussion: For the condylar knee prosthesis, a problem men-
tioned in the previous literature was fragility against impact
loading. In this study, we did not experience any case of ceramic
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ties. Although we could not conclude the superiority of the
ceramic prosthesis concerning UHMWPE wear and long-term
survivorship of the knee at the present time, the results encour-
gaged us to conduct a long-term follow-up study on the ceramic
total knee prosthesis.
Results
Two patient were excluded of the follow up because of a total knee arthroplasty after 6 years and a knee arthrodesis after 2 years. We evaluated 18 patients. The average duration of follow-up after the reconstructive osteotomies was 12 years (range 5 to 24 years). The average Hospital for Special Surgery knee score was 87.6 at the latest follow up 9 knees were scored as excellent, 5 had a good result, 3 scored fair and 1 had a poor result. The average Lysholm score was 88.7, the average Neer score was 85 points. The Ahlbach radiographic score pre-operatively showed no osteoarthritis in 3 knees and in 17 knees grade one of osteoarthritis was seen. At the latest follow up the Ahlbach score showed no osteoarthritis in 1 knee, in 16 knees grade one of osteoarthritis and in 3 knees grade two of osteoarthritis was seen. The average valgus deformity pre-operatively was 13.5° (anatomical axial alignment) which was corrected to a 5.2° valgus. An impressive remodelling of the articular surface was seen. Only minor complications were seen in three cases.

Conclusions
In active patients with a painful and disabling intra-articular malunion of the knee joint, a reconstructive osteotomy provides an adequate alternative to a total knee arthroplasty or an arthrodesis, that allows heavy functional activities.

Paper #147
LONG-TERM RESULTS AFTER HIGH TIBIAL OSTEOTOMY FOR THE TREATMENT OF VARUS GONARTHROSIS. A RETROSPECTIVE 10 TO 15 YEARS FOLLOW-UP STUDY.
Philipp Frey, Zürich, SWITZERLAND
Wolfgang Marilke, Zürich, SWITZERLAND, Presenter
Urs Munzinger, Zürich, SWITZERLAND
Martin Hudler, Zürich, SWITZERLAND
Maria Bizzini, Zürich, SWITZERLAND
Schulthess Clinic, Zürich, SWITZERLAND

PURPOSE. Despite the widened indication for TKA and further development of unicompartment arthroplasty, proximal tibial osteotomy is still indicated for the treatment of symptomatic varus deformity of the knee. The purpose of our retrospective case-series study was to determine factors (level of activity, age at time of surgery, alignment, stability, previous meniscectomy, wedge-size, etc.) that influence the long-term outcome after ten to 15 years.

METHOD/RESULTS. Between 1984-1990 331 HTO have been performed at the Schulthess-Klinik. We selected 143 patients (164 knees) with no other problems than the affected knee. Finally we could assess 41 knees in 35 patients after 10-15 years. The evaluation has been based on the dual rating system (164 knees) with no other problems than the affected knee. We selected 143 patients (164 knees) with no other problems than the affected knee. Finally we could assess 41 knees in 35 patients after 10-15 years. The evaluation has been based on the dual rating system (164 knees) that made the subsequent procedure for TKA more technically demanding. Excellent and good clinical results that were obtained from this series were not as high as those that were obtained from primary TKA.

CONCLUSION. We conclude that although permanent relief of pain is not to be expected, HTO is still a good procedure for the treatment of varus-gonarthrosis, since TKA can be postponed for at least ten years. It should therefore be the treatment of choice in a young and active population.

Paper #148
TOTAL KNEE ARTHROPLASTY AFTER FAILED HIGH TIBIAL OSTEOTOMY
Andrea Baldini, Florence, ITALY, Presenter
Paola Aglietti, Florence, ITALY
Luca Maria Vena, Florence, ITALY
Domenico Lup, Florence, ITALY
Giovanni Gianbalvo Del Ben, Florence, ITALY
First Orthopaedic Clinic, University of Florence, Florence, ITALY

Objective: A total of 85 consecutive Total Knee Arthroplasties (TKA) in 77 patients who had undergone previous closing wedge high tibial osteotomies (HTO) have been reviewed. The authors assessed technical difficulties, effect of HTO on results of TKA compared with a control group of primary TKAs matched for age, sex, implant type and follow up.

Methods: All procedures were performed using the Insall-Burstein I and II (57%), the Meniscal Bearing Knee (14%), the Legacy PS (12%) and the Constraint Condylar Knee prostheses (2%). Technical problems encountered in the study group were significantly higher. Exposure of the joint required a modified V-Y quadricepsplasty in 11 knees. A significant metaphyseal tibial off-set was present in 17%, and 29% had a tibial plateau bone defect that required bone grafting in 5 knees and wedges in 3 knees. Modular tibial stem extensions were necessary in 17 knees to enhance implant fixation.

Results. At a follow up of 7 years on average (range: 2-19) 9 patients (10 knees) had died for unrelated reasons and 4 (6 knees) were lost leaving 64 patients (69 knees) for clinical (Knee Society rating system) and radiological evaluation. The Knee Score of the control group averaged 92 points, 83 points for the study group. Excellent and good results were significantly inferior in the study group (39% vs 77%, p=0.02). The control group had greater average range of motion (110° vs 100°) after arthroplasty. Residual mild knee pain was significantly higher in the study group (58% vs 10%). Function score was 71 and 83 points. Revision rate was 5.3% for TKA post-HTO (one septic and three aseptic loosening) and 1.1% for primary TKA (one aseptic loosening). Of the study group we also analyzed TKA performed after HTO that where done with (group A: 30 knees) or without (group B: 55 knees) restricted indications (grade 1-2 OA; good ROM, stable knees, etc.) and proper surgical technique. Results of these two subgroups were comparable but technical difficulties were higher for group B.

Comments: The previous osteotomy introduces deformities that made the subsequent procedure for TKA more technically demanding. Excellent and good clinical results that were obtained from this series were not as high as those that were obtained from primary TKA.

Paper #149
ANATOMICAL REALIGNMENT MODIFIES MUSCULAR RESPONSE
Michael Lewek, Newark, DE, USA, Presenter
Katherine Rudolph, Newark, DE, USA
William A Newcomb, Newark, DE, USA
Lynn Snyder-Mackler, Newark, DE, USA
University of Delaware, Newark, DE, USA

Introduction: Knee osteoarthritis (OA), prevalent in many older adults, leads to joint space narrowing and disabling pain. Genu varum, a form of knee malalignment, contributes to excessive joint laxity and the progression of knee OA. Joint laxity might delay the neuromuscular responses at the knee, which are thought to provide a measure of protection. The reflexive
response may reduce excessive shear and compressive forces on the joint surfaces that could contribute to further joint damage. The progressive opening wedge high tibial osteotomy has been proposed as a method to restore correct anatomical alignment of the knee while eliminating the medial joint laxity. The purpose of the study was to determine the effect of joint realignment via an opening wedge-high tibial osteotomy on the timing of the muscular response to a rapid valgus motion at the knee during standing.

Methods: Six subjects were tested prior to a scheduled opening wedge-high tibial osteotomy by one surgeon, and then returned 6 months later for follow-up testing. Ten healthy age-matched control subjects were also recruited for comparison. Subjects stood with the tested foot on a custom designed movable platform that was flush with the floor. The plate translated laterally 5 cm at a velocity of 40 cm/sec, while the electromyographic activity of the vastus medialis, semitendinosus, gracilis, sartorius, and the medial head of the gastrocnemius was assessed. Onset latency was defined from the initiation of plate movement to the time at which a linear envelope of the muscle activity exceeded 3SD above the baseline muscle activity (100 msec prior to plate movement).

Results: The medial gastrocnemius, semitendinosis, and sartorius exhibited the most consistent response prior to realignment, with activity exceeding 3SD above the baseline in 48-93% of the trials for those particular muscles. Following realignment through an opening wedge-high tibial osteotomy, the onset latency was decreased in the semitendinosis, and medial gastrocnemius (p < 0.05) and was comparable to the control subjects, who had onset latencies of 98±22 msec, and 114±10 msec, for those muscles respectively.

Discussion: The medial gastrocnemius, semitendinosis, and sartorius seem to play the largest role in resisting a rapid valgus motion at the knee. Moderate varus alignment appears to contribute to a delay in reflexive response times at the knee in frontal plane motion. The opening wedge-high tibial osteotomy, however, appears to restore the timing of the reflexive response, thus providing the knee joint with early protection against potentially damaging movements.

Paper #150
IS FULL POLYETHYLENE TIBIAL COMPONENT STILL A RELIABLE OPTION IN TKA?
Laurent Jacquot, Communay, FRANCE, Presenter
Philippe Neyret, Caluire, FRANCE
T. Aït Si Selmi, Lyon, FRANCE
Centre Livet, Caluire, FRANCE

Introduction:
The aim of this study is to report the results of 162 Total Knee Arthroplasties with full polyethylene tibial component.

Material and method:
Between 1989 and 1995, 162 HLS posterior stabilized cemented TKR with full polyethylene tibial component were carried out under supervision of one senior surgeon. 142 prostheses have been reviewed at more than one year, 3 patients died, and 17 patients were lost to follow-up (10%). The clinical datas have been analyzed according to the I.K.S criteria, radiological data with complete assessment including long legs films. The mean follow-up was 4.5 years.

Results:
At the final assessment, 96% of the patients were satisfied or very satisfied, 95% had no or little pain. The mean post operative flexion was 114°. The mean knee score at follow-up was 81/100, the function score 64/100. The radiological results showed a good positioning of the implant, a mean mechanical femoro tibial axis of 178.6°, a mean mechanical femoral axis of 89.1°, and a mean mechanical tibial axis of 89°. 8 failures (4.9%) occurred (change of component), 2 frontal instabilities, 3 patellar fractures, 1 infection, 1 aseptic loosening, 1 severe pain (too large tibial component). 2 revisions without change of component have been performed, 1 for stiffness (arthrolysis), and 1 for pain (arthrotomy). The survival rate of the implants was 95% at 4.5 years.

Discussion:
These 162 prostheses belong to a continuous serie of 893 HLS prostheses and we compare the results with those of prostheses with metal back tibial component (survival rate 98.6% at 3 years). There are more revisions with change of component in the group of Full poly prostheses, but not due to the type of tibial implant (Patellar fracture, infection). We found significative correlation between radio lucencies and post operative femoro tibial axis in the group of full poly tibial component. We found no clinical symptom in relation with theses lucent lines which are stable with time.

Conclusion:
The clinical and radiological results of theses 162 prostheses with full polyethylene tibial component are good. We analyse the advantages and disadvantages of full polyethylene and metal back tibial component in HLS TKA.

Paper #151
INTEREST OF A SPECIFIC DEVICE FOR AUTOMATIC PATELLAR CENTERING IN TKA: A BIOMECHANICAL STUDY.
Philippe Boisrenoult, Le Chesnay, FRANCE
Philippe Beaufils, Le Chesnay, FRANCE, Presenter
Amadou Diop, Paris, FRANCE
Department of Orthopaedic Surgery, André Magnol Ho, Le Chesnay, FRANCE

Introduction:
The aim of this work was to compare in an in vitro study, the patellofemoral loads in TKR by using or not a specific patellar-centering device.

Material and methods: 10 pairs of knees were instrumented with a TKA (Cedior posterostabilized, Sulzer®). For each pair, one patellar button was positioned with a specific automatic device (group 1), and the other without (group 2). A Harding’s knee simulator was used. Patellofemoral loads were measured at flexion of 0°, 15°, 30°, 45°, 90° with a 3D load cell (Scaime®, compression forces 600N, shear forces 300N). A Wilcoxon’s test was used for statistical study.

Results: Measures were reproducible (+/-1%). Total patellofemoral loads were the same in group 1 and 2. On the other hand, lateral shear forces were statistically less in group 1 than in group 2 (p<0.05).

Discussion: In our study, using an automatic device to centering the patellar button during TKR showed no changes in total patellofemoral loads, but allowed a better loads distribution, in decreasing shear forces. For us, using this device during TKR allows a better patellofemoral result.
Paper #152
P.C.L. RECONSTRUCTION USING DOUBLE BAND QUADRICEPS TENDON
Rene Abdalla, MD, BRAZIL, Presenter
Gilberto Camanho, MD, BRAZIL
Benno Ejnisman, MD, BRAZIL
CORE - Centro de Ortopedia e Reabilitacao, Sao Paulo, BRAZIL

Objective: The aim of this study was the evaluation of 14 patients (12 primary and 2 revisions) of P.C.L. reconstruction using quadriceps tendon double band.

Methods: 14 patients underwent surgery (12 male and 2 female) using double band quadriceps tendon with 12 months minimum and 28 maximum (average 18 months).

Results: The final analysis showed absence of posterior drawer (negative or “traces”) as to the clinical examination as to arthrometer (KT 1000™) in 11 and 1 + in 5. The I.K.D.C. evaluation showed: normal 2, subnormal 10 and abnormal 2.

Conclusion and Significance: The P.C.L. reconstruction still remains controversial in the literature. The surgical techniques variety and the lack of long-term follow-up evaluation take to a lot of doubt and speculations. Our study subjective and objective results (KT 1000™) showed satisfactory results related to function and posterior knee stabilization. In conclusion we believe that quadriceps double band is effective and should be used.

Paper #153
THE ENVELOPE OF FUNCTION – A SIMPLE METHOD TO REPRESENT THE FUNCTIONAL CAPACITY OF HUMAN JOINTS.
Scott F Dye, San Francisco, CA, USA, Presenter
45 Castro Street, Suite 117, San Francisco, CA, USA

Objective: In 1996, this author developed a new method to represent the functional capacity of the human knee – the Envelope of Function. Evidence suggests that it may work equally well for all joints and musculoskeletal systems.

Methods: Based on the concepts of Menschik (of Vienna) this author has come to view all joints as living biologic transmissors whose purpose is to accept, transmit, and ultimately disperse a range of biomechanical loads and yet maintain tissue homeostasis of all components while doing so. The Envelope of Function, in its simplest two-dimensional form, is a load/frequency distribution that defines this range of painless loading that is inductive of tissue homeostasis of a given joint. Too little loading over time results in loss of tissue homeostasis exemplified by atrophy of muscle and calcium loss from bone. Application of a sufficiently great load results in macrostructural failure, while supraphysiologic loading, insufficient to cause overt structural damage, can result in symptomatic loss of tissue homeostasis, exemplified by the early stages of a stress fracture or chronic patellofemoral synovitis. All overuse syndromes, including tennis elbow and chronic ankle sprains, can be represented by this zone of supraphysiologic overload. Homeostasis of living osseous structures (bones) can be represented by this zone of supraphysiologic overload.

Conclusion: With the development of better methods of dynamically and geographically tracking the homeostasis of all musculoskeletal tissues (e.g., PET scans) future orthopedic therapies might be more exactly and rationally evaluated and ultimately improved.

Paper #154
• CT-SCAN EVALUATION OF FEMORAL COMPONENT ROTATION IN TOTAL KNEE ARTHROPLASTY PERFORMED WITH TWO DIFFERENT TECHNIQUES: EPICONDYLAR VS. POSTERIOR CONDYLAR REFERENCE
Andrea Baldini, Florence, ITALY, Presenter
Paolo Aglietti, Florence, ITALY
Piergiuseppe Zampetti, Florence, ITALY
Giuseppe Caracchini, Florence, ITALY
Giovanni Bert, Florence, ITALY
Daniele Di Fede, Florence, ITALY
Andrea Masi, Florence, ITALY
First Orthopaedic Clinic, University of Florence, Florence, ITALY

Objective: Proper femoral component rotational alignment in total knee arthroplasty (TKA) is crucial for successful stability as well as patello-femoral mechanics. We evaluated two different techniques to obtain the correct femoral component rotational alignment relatively to the surgical transepicondylar axis (TEA).

Methods: We evaluated at an average follow-up of twelve months (range: 6-19 months) one hundred patients (females 83%, males 17%) that underwent unilateral TKA for gonarthrosis for varus (85%) and valgus (15%) deformities. All procedures were performed by the same surgeon using the Meniscal Bearing Knee prosthesis. Fifty of these procedures were performed using epicondylar referencing instruments (group I). For the other fifty patients instruments that automatically align 3° (varus knees) or 5° (valgus knees) off the posterior femoral condyles were used (group II). There were no significant differences in the two groups for age, gender, body mass index, axial deformity and degree of osteoarthritis. Rotational alignment of the femoral component using TEA as reference was performed at FU with CT-scan. Positives angular values defined external rotation, and negatives values defined internal rotation. All patients were also evaluated clinically and radiologically with standard w.b AP, LL and axial views.

Results: Femoral component rotation on average was 1.50° ± 0.25° (range 0.75° - 5.0°) for group I and 0.75° ± 0.75° (range 0.0° - 3.0°) for group II. Only two patients in group I showed 2.5° of internal rotation while in group II five patients had 4°, two had 3° and two had 2° of internal rotation. Clinical and radiological parameters did not significantly differ in the two groups at FU.

Conclusions: Referencing off the posterior femoral condyles is simple to use and with differential angulation for varus or valgus knees may limit errors in excessive internal rotation. Epicondylar referencing instruments are more accurate but need more skill to find the anatomical landmarks.
Bone morphogenetic proteins (BMPs) are a family of proteins that can induce bone and cartilage formation during embryogenesis and tissue repair. Human recombinant (hr) BMP13 has been recently cloned and proved to promote the formation of tendon and ligament tissues in in vivo experiments. But the gene expression of decorin could increase cell proliferation and the gene expression of pro-collagen 1 and biglycan, but the gene expression of decorin was not affected. Our findings suggest that BMP13 may play a role in tendon healing.

CONCLUSION:
Restricted range of motion in the knee joint is a disabling problem with varying underlying causes in underdeveloped countries like India, unlike Western countries where stiffness following ACL reconstruction surgery is probably the commonest cause. We have neglected knee intraarticular fractures which have been immobilized for prolonged period, post-infection restricted knee range of motion etc. Arthroscopic arthrofibrosis presents a technical challenge to surgeon. Results have gratifying for surgeon and patient. Regaining complete extension has been difficult than improving the range of flexion as shown in our series.

RESULTS: Results of 28 patients are reviewed. Despite prolonged physiotherapy to improve Range of Motion, mean pre-operative flexion contracture was 14 degree. Mean pre-operative range of motion was 81.4 degree and mean pre-operative Lysholm Knee Score was 62. After average post-operative follow up of 23 months, mean flexion contracture improved to 4.8 degree (gain of 9.2 degree). Total range of motion post-operatively improved to an average of 122 degree (average gain of 40.6 degree) and mean Lysholm functional score improved to 91.

CONCLUSION:
Bone morphogenetic proteins (BMPs) are a family of proteins that can induce bone and cartilage formation during embryogenesis and tissue repair. Human recombinant (hr) BMP13 has been recently cloned and proved to promote the formation of tendon and ligament tissues in in vivo experiments. But the roles of BMP13 on tissue regeneration in tendons remain unexamined. In the present study, human patellar tendon samples were collected for histological examination and preparation of tendon fibroblast culture. Immunohistochemical staining showed that BMP12 was detected on healthy patellar tendon samples, chiefly located on active tenoblasts and perivascular mesenchymal cells, with a similar distribution as proliferation cell nuclear antigens (PCNA), pro-collagen I and decorin. In vitro studies on tendon fibroblast culture showed that hrBMP13 could increase cell proliferation and the gene expression of pro-collagen 1 and biglycan, but the gene expression of decorin was not affected. Our findings suggest that BMP13 may play a role in tendon healing.

MATERIAL AND METHODS: There were 24 patients in the study. Each had chronic tendinosis of the patellar tendon, Achilles tendon, or lateral or medial epicondyly. They all had symptoms for more than 6 months (average 16 months), and failed at least 3 conservative treatments. A pre-operative MRI and pain and function scores were recorded. The patients had open radiofrequency stimulation of the tendons involved using a bipolar Radiofrequency Topaz Wand TM (Arthrocare Corp., Sunnyvale, CA). The generator was set to power level of 4 (175V RMS). The wand was placed on the surface of the tendon and activated for 0.5 seconds at 5mm distance intervals around the symptomatic area. The tendon involved was stimulated 15-20 times over an area of 3.0 square cm. Post-operative pain and function scores were recorded at 7-10 days, 4 weeks, and 6 months. Post-operative MRI's were performed at 4 weeks and 6 months.

RESULTS: Ninety two percent of patients had significant improvement in their pain and function at 6 months. The post-operative VAS pain scores were decreased by 55% at 7-10 days post operative, 75% at 4 weeks, and 85% at the 6 month evaluation. There was significant improvement (p<0.05) in the SF-36, IKDC, Upper Limb DASH, and the AOFAS scores. Seventy-five percent of the pre-operative MRI's had changes consistent with tendinosis. Post surgical and tendinosis changes were observed in 96% of patients at 4 weeks. At 6 months, only 21% had tendinosis changes on their MRI.

CONCLUSION: Bipolar radiofrequency stimulation appears to be a safe and effective treatment of chronic tendinosis. Further research is needed in this area to better understand the biochemical processes by which bipolar radiofrequency stimulation leads to pain relief and potential tendon repair.
Achilles and patellar tendinopathy shows similarity

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Tudor Cozma, Iasi, ROMANIA
Eva Samnegård, Stockholm, SWEDEN
Per Lindblom, Stockholm, SWEDEN
Chirister G Rolf, Sheffield, UNITED KINGDOM
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We evaluated three histopathological parameters quantitatively (glycosaminoglycan (GAG) content, vessel density and cellularity), by using computer-assisted histomorphometry of surgical biopsies from patients with long-standing pain located to the mid-portion of the Achilles tendon and at the apex patella in the patellar tendon. The surgical result was evaluated with a pain and disability score.

Patients and Methods
The patients with Achilles tendinopathy (n=42), all with pain 3 to 7 cm proximal to the tendon insertion, had a median age of 40 years (range 24 - 65 years). The patellar tendinopathy patients (n=12), all with pain at apex patellae, had a median age of 28 years (range 18 - 45 years). Tendon biopsies were obtained at surgery. Autopsy specimens from the Achilles tendon (n=10) and open biopsies from asymptomatic patellar tendons obtained at anterior cruciate ligament reconstructions with patellar bone-tendon-bone autografts (n=11) served as controls. The histomorphometric evaluation was blinded for the examiner and a computer-assisted histomorphometric technique was used to randomly quantify the assessed parameters GAG-content, cellularity and vascularity. A clinical follow up after in median 18 months used the same tendon evaluation protocol.

Results
The GAG-content, cellularity and vascularity were significantly increased in tendinopathy tissue compared to the control tissue. The study could not demonstrate significant pathological differences of the three quantified histological parameters in Achilles versus patellar tendinopathy. The mean GAG-content (GAG to collagen ratio) was 0.44 (SD 0.31) in Achilles and 0.36 (SD 0.24) in patellar tendinopathy. The control values were 0.07 (SD 0.10) and 0.05 (SD 0.06), respectively. The mean cellularity in a standardized high power field was 5.8 (SD 3.1) in Achilles and 4.7 (SD 5.4) in patellar tendinopathy. The frequencies in the control material were 2.3 (SD 1.7) and 2.8 (SD 1.7). The mean vessel density was 14.6*10^-3 (SD 25*10^-3) in Achilles and 13.1*10^-3 (SD 10.6*10^-3) in patellar tendinopathy. The control tissue had mean vessel density values of 2.6*10^-3 (SD 3.0*10^-3) and 5.3*10^-3 (SD 5.4*10^-3). The outcome following surgical treatment after a median time of 18 months was categorized as satisfactory (excellent and good) in 82% of the Achilles tendinopathy patients and in 50% (6/12) in patellar tendinopathy patients.

Discussion and Conclusion
The pathological tissue in painful tendinosis has been described having changes in fiber structure and arrangement, variation in cellularity, rounding of nuclei, increased non-collagen extracellular matrix (GAGs) and increased vascularity. In this study, we chose to evaluate the GAG content, the cellularity and vascularity because these parameters could be quantified. The study compared two common sport medicine tendon disorders with blinded unbiased methodology without significant differences of the studied histomorphometric parameters. However, the outcome following open surgical treatment was better in Achilles tendinopathy.

Overuse soft tissue injuries as related to the body mass index (BMI) of infantry recruits

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Joseph Lowe, Jerusalem, ISRAEL
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Introduction:
Overuse injuries comprise the major cause of disability and loss of training days both in the athletic as in the military population. In this study, we evaluated in a prospective manner the effect of BMI on the occurrence of injuries in border police infantry recruits.

Material and Methods:
BMI is calculated by dividing a person's weight by the square of his height. When using kg and centimeters the normal ("athletic") male BMI is in the range of 20 to 25. In this study the BMI of 201 infantry recruits was prospectively compared to soft tissue overuse injuries during a 4 month course of basic training.

Results:
16% of the recruits were “underweight”, 7% were “overweight” and 77% were “normal”. Foot injuries showed a trend for more injuries in the underweight and overweight groups (p=0.1). Achilles overuse injuries were also higher in the under and over weight groups (0.09). Shin splints were again lowest in the “normal” weight, slightly higher in the “underweight” and higher in the “overweight” (p=0.04). PFJ pain showed the same tendency (p=0.12). When calculating the total soft tissue overuse injuries it was shown that the “normal” or the “athletic” population was injured significantly less than the “under” or “over” weight groups (p=0.006).

Conclusions:
The “athletic” build or the “Mesomorph” population seems to have a lower tendency to suffer overuse soft tissue injuries than both the “Endomorph” with a higher BMI or the “Ectomorph” with a lower BMI than that accepted as normal.

The treatment of suppurative arthritis with debridement

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Objective: To investigate the treatment of suppurative arthritis with debridement under arthroscopy and persistent irrigation after operation. Method: 36 patients with suppurative arthritis were treated by debridement under arthroscopy and persistently irrigated after operation. Result: All cases follow-up (range 3 to 18 months) results were cured, 31 of the cases were excellent, while 5 was fair. No patient relapsed. The average treatment time was 15.8 day. Conclusion: Debridement under arthroscopy and persistent irrigation after operation has better therapeutic effect than surgery during which the joint cavity was washed but not irrigated.
opened. It is less invasive, has better recovery, costs less time. So it is an ideal therapeutic method.

Paper #161
CAN SPORT MASSAGE REDUCE PAIN AND LOSS OF FUNCTION
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Tonu Saartok, Vishi, SWEDEN
Per A Renstrom, Stockholm, SWEDEN
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The use of sports massage is increasing in the athletic community. The purpose with this study was to evaluate the effect of massage treatment on pain, muscular strength and function following hard eccentric exercise. We also studied if calcitonine gene-related peptide (CGRP) and neuropeptide Y (NPY), measured by microdialysis, were affected by sports massage. These peptides are involved in the modulation of pain.

Method: 16 subjects performed 300 eccentric exercises of both quadriceps. Sports massage was given on one leg, and the other leg served as a control. Subjects were treated once a day for three days. The maximal strength tests were done on a KinCom dynamometer. Three eccentric and concentric maximal contractions at a speed of 180 degrees per second were tested. Maximal torque between 10 and 90 degrees was noted. Each subject also made three maximal one-leg long-jumps on each leg. The best performance of each leg was measured. The subjects valued the pain and discomfort of both legs on a visual analogue scale (VAS).

Results: There was a marked loss of strength and function of the quadriceps directly after exercise and also after two days. The massage treatment did not affect any of the modalities studied. We could not find any effect on the level or duration of pain, or on the loss of strength or function following exercise. The amounts of CGRP and NPY were not affected.

Paper #162
INTRAARTICULAR TEMPERATURE CHANGES: ICE VS CRYOTHERY
Todd A. Warren, Nashville, TN, USA, Presenter
Kurt P. Spindler, Nashville, TN, USA
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OBJECTIVE: Ice and cryotherapy devices are ubiquitous in the treatment of knee injuries, yet no studies to date have evaluated intraarticular (IA) temperature changes in normal knees. This study investigated the IA temperature of normal knees comparing ice vs. a cryotherapy device. We were interested in the effect of application of cryotherapy. Our hypothesis was there would be no IA differences in temperature or pain between the two methods of treatment.

METHODS: After IRB approval and consent, twelve subjects had thermocouple probes placed in the suprapatellar pouch (SP) and on the skin of bilateral normal knees. Subjects were treated for one hour with crushed ice to the left knee and a cryotherapy device (Cryocuff™) filled with ice water to the right knee. Both methods of cryotherapy were removed for the second hour. Temperatures were recorded every two minutes for a total of two hours. Subjects were asked to indicate discomfort levels of both knees through the use of a 10 cm visual analog scale (VAS).

RESULTS: Ice showed a significantly lower skin temperature (30, 60, 90 min, p<0.001) when compared to the cryotherapy device. IA temperatures were significantly lowered from baseline with both treatment methods. However, ice showed a significantly greater decrease in median IA temperature at 60 min (20.9°C, p = 0.001), 90 min (18.1°C, p = <0.001), and 120 min (22.3°C, p = 0.013) than the cryotherapy device 60 min (31.4°C), 90 min (23.9°C), and 120 (25.3°C). VAS pain scores showed ice to be significantly more painful than 30 (2.3, p = 0.01) and 60 minutes (4.0, p = 0.013) than the cryotherapy device at the same time (30 min = 1.4, 60 min = 1.6). Pain was inversely correlated with IA temperature in the ice group at 120 minutes (rho = -0.65, p = 0.02).

CONCLUSION: Both methods of cryotherapy cause significant declines in temperature when compared to the cryotherapy device. Ice produced significantly greater declines in IA temperature compared to the cryotherapy device. Although ice showed significantly higher pain scores at 30 and 60 min, this was only clinically meaningful (>2 cm difference) at 60 min. Pain was inversely correlated with IA temperature in the ice group. We hypothesize a critical pain threshold may exist in the normal knee.

Paper #163
GENERALIZED JOINT LAXITY INFLUENCES THE APPROPRIATENESS OF SPECIFIC SPORTS ACTIVITY FOR ATHLETES.
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Hirotoshi Higuchi, Maebashi-shi, JAPAN
Mitsuhito Takekada, Maebashi, JAPAN
Shigeru Morikawa, Maebashi, JAPAN
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Discriminant analysis was carried out to investigate the influence of generalized joint laxity (GJL) to aptitude for athletic performance. Subjects were 34 succor players and 28 gymnasts. They were male high school student with a mean age of 17 years who gained a place on representative athletes of Gunma Prefecture. 23 values were obtained based upon anthropometric examination and detecting GJL. Discriminant analysis was performed with the succor and gymnastic groups as the objective variable and the 23 measured values as explanatory variables. The discriminant analysis successfully distinguished the 2 groups (F=12.5854, p<0.001). Partial F values indicated that reiterating side step (Partial F=9.1217), bench press up power (8.6036) and GJL (7.4400) contributed significantly to the discriminant function. And GJL was favorable to the gymnasts. Succor players were exposed to athletic movements encountered during play with opponents. Gymnasts were exposed to a similar set of exertions in a non-opponent setting. These findings suggested that GJL influenced the aptitude for athletic performance.

Paper #164
PERCUTANEOUS VS. OPEN SURGICAL ACHILLES TENDON REPAIR – A COMPARATIVE STUDY
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Milos Kosanovic, Celje, SLOVENIA
Teaching Hospital, Maribor, SLOVENIA

237 consecutive patients with a closed acute rupture of the Achilles tendon were included in the multicentre study. There were 132 prospectively followed patients in the first hospital, where all the patients were operated on with the percutaneous
sutting under local anesthesia and 105 patients in the second hospital where all the patients were treated with the open operative repair under general or spinal anesthesia. Functional outcome and the complication rate were assessed with the follow-up of minimally two years.

The results showed significantly more major complications in the group of open operative repair in comparison with the group of percutaneous repair (12.4% versus 4.5%; p = 0.03), particularly necrosis (5.6% versus 0%; p = 0.019), as well as greater total number of the complications (23% versus 11%; p = 0.013). There were slightly more reruptures (3.7% versus 2.8%) and suralis nerve disturbances (4.5% versus 2.8%) in the group of percutaneous repair with no statistical significance. Functional score assessment showed no statistical significance with good result in 91% patients in the group of percutaneous repair and in 88% patients in the group of open operative repair. Patients in the group of open operative repair had finally significantly greater thickness of the operated Achilles tendon (p = 0.0005) and greater loss of dorsiflexion of the ankle (p = 0.003). Patients in the group of percutaneous repair were more satisfied in their subjective assessment (p = 0.024). The average costs in the group of percutaneous repair were about one third of those in open operative group.

### Paper #165

**SONOGRAPHIC EVALUATION OF PLANTAR FASCITIS AFTER**

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Frank Adam, Homburg/Saar, GERMANY  
Stefan Rapp, Homburg/Saar, GERMANY  
Andreas K. Kreutz, Homburg-Saar, GERMANY  
Dieter M Kohn, Homburg-Saar, GERMANY  
Romain Seif, Homburg/Saar, GERMANY, Presenter  
Orthopaedic University Hospital, Homburg/Saar, GERMANY

**Objective**  
The aim of this study was to investigate the effect of extracorporeal shock wave therapy (ESWT) on the sonographic appearance of chronically painful, proximal plantar fasciitis.

**Methods**  
Twenty-two patients with a unilateral proximal plantar fasciitis and a previously unsuccessful conservative treatment of at least 6 months were prospectively enrolled. The pain-free contralateral plantar fascia was used as the control. Prior to ESWT the thickness of the plantar fascia was measured sonographically 3 cm distal of the origin at the medial calcaneal tuberosity and the pain estimation on a visual analogue scale (VAS) ranging from 0 (no pain) to 100 (maximal pain) along with the comfortable walking time was recorded. The decrease in thickness of the plantar fasciitis was significant (5.2 ± 1.5 to 4.3 ± 1.1 mm; p < 0.05) whereas 6 months after ESWT the thickness of the fascia was no more significantly different. The decrease in thickness of the plantar fasciitis was significant (5.2 ± 1.5 to 4.4 ± 1.0; p < 0.05). Six months after ESWT those patients with less pain (VAS < 30) had significantly thinner plantar fascias (p < 0.01).

### Conclusion

In our study we found the chronically painful proximal plantar fascia to be sonographically significantly thicker than the pain-free control side. After ESWT the plantar fasciitis thinned and pain and walking time improved significantly. Patients with less pain (VAS < 30) had significantly thinner plantar fascias.

### Paper #166

**OUTCOMES FOR DECOMPRESSION OF TRAUMATIC VS NON-TRAUMATIC COMMON PERONEAL NEUROPATHY**

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**Purpose:** Common peroneal neuropathy is associated with significant functional deficits including foot drop, numbness, and pain. The outcomes of operative intervention comparing neuropathies from traumatic versus atraumatic etiologies have not been well studied and are needed to determine the potential benefit.

**Methods:** A 6 year (1994-1999) retrospective review of a single surgeon’s results of operative decompression for common peroneal neuropathy in 10 consecutive patients (6M/4F) was performed. Etiologies included knee dislocation (3), ganglion (2), and idiopathic (4). Each patient had an EMG and MRI and/or US preoperatively. Time from onset to surgery ranged from 18 days to 15 years. Average patient age was 42 (range 22 to 58 years). Each patient had complete decompression and epineurolysis of the common peroneal nerve from its origin to its distal divisions. All patients with knee dislocations also had lateral collateral ligament repair performed. One of these also had an ACL reconstruction.

**Results:** Four patients with idiopathic peroneal neuropathy (2 with foot drop and numbness; 2 with pain/sensation changes only) had complete resolution of symptoms within an average of 6 weeks (range immediately postoperative to 4 months). Three patients with a ganglion compressing the nerve (all with foot drop, numbness, and pain) had complete resolution of foot drop and numbness within 2 months with only mild pain persisting in one. Three patients with knee dislocations (all with foot drop and numbness; 1 with severe pain also) showed no change in the foot drop. The patient with severe pain had resolution of the pain and another had some improvement in sensation.

**Discussion/Conclusion:** Common peroneal neuropathy due to atraumatic etiologies appears to consistently respond very favorably to operative decompression with resolution of symptoms within an average of 6 weeks. Neuropathy associated with knee dislocation does not improve significantly; however, operative decompression may improve sensation or pain symptoms.
MOVEMENT OF THE LATERAL DISCOID MENISCUS

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Tsutsuya Matsuura, Tokushima, JAPAN
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Purpose
To investigate the movement of the symptomatic and non-symptomatic lateral discoid menisci from full extension to 90 degrees of flexion with MRI.

Subjects and Methods
Five patients (all male, 12 to 17 years old) with symptomatic and contralateral non-symptomatic lateral discoid menisci participated in the study. A 0.2 Tesla open magnet MR scanner was used to generate the images. Sagittal and coronal T1-weighted images were taken at 0, 45 and 90 degrees of flexion. Movement of the lateral and medial menisci was measured in the line of their greatest diameter. In the sagittal plane, the perpendicular distance from the outer inferior edge of the meniscus to the outermost edge of the articular cartilage of the tibial plateau was measured for both the anterior and posterior horns. In the coronal plane, the distance from the outer inferior edge of each meniscus to the outermost edge of the tibial plateau was measured. The heights of the anterior and posterior horns were also measured.

Results
In the sagittal plane, anterior and posterior horns of the medial meniscus in the symptomatic (Sy) and non-symptomatic (NS) knees moved posteriorly as the knee was flexed (Sy: ant 7.7 mm, post 5.3 mm, NS ant 6.6 mm, post 3.7 mm). The results were compatible with the previous studies (Thompson, Vedi). By contrast, the lateral discoid menisci in the symptomatic and non-symptomatic knees showed an abnormal movement. During knee flexion from 0 to 45 degrees, the discoid menisci in both knees moved anteriorly (Sy: ant 0.8 mm, post 5.1 mm, NS ant 3.0 mm, post 3.5 mm), then they moved posteriorly from 45 to 90 degrees (Sy: ant 4.8 mm, post 4.1 mm, NS ant 4.1 mm, post 2.6 mm). Height of the anterior and posterior horns of the lateral discoid meniscus increased as the knee flexed. Height of the anterior horn increased more than that of the posterior horn (Sy: ant 3.8 mm, post 1.1 mm, NS ant 3.5 mm, post 0.6 mm).

Conclusion
This is the first study to demonstrate the abnormal movement of the lateral discoid meniscus during the knee flexion. The abnormal movement of the discoid meniscus is a potential mechanism for the osteochondral lesion of the lateral femoral condyle which is frequently associated with the discoid meniscus.

Paper #168
MENISCUS STABILIZING FUNCTION OF THE MENISCOFEMORAL LIGAMENT – AN EXPERIMENTAL STUDY USING THE KNEE JOINT OF THE PIG

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Purpose
To prove experimentally whether the posterior meniscofemoral ligament (PML) has stabilizing function for the lateral meniscus (LM) using the knee joint of the pig.

Type of Study: Biomechanical animal study

Materials and Methods: Amputated stumps with the knee joints of the pig (Yorkshire), which have similar anatomy to the human knee joints, were used. The experiment was performed under 6 conditions: 1) intact PML with intact LM, 2) intact PML with radial tear of posterior horn of LM, 3) intact PML with total lateral meniscectomy, 4) cut PML with intact LM, 5) cut PML with radial tear of posterior horn of LM, and 6) cut PML with total lateral meniscectomy. The pressure-sensitive film (Prescale, Fuji) was inserted under the lateral femoral condyle and the axial load was transmitted to the knee joint with Universal testing machine (Instron, Model No.4469, USA). The pressured area, maximum pressure and average pressure were measured by the Prescale imaging analysis system FDP-901E series.

Results
With intact PML, the pressured area and maximum and average pressures showed little difference between the conditions of intact meniscus and radial tear of posterior horn of LM. With cut PML, regardless of the states of the LM, pressure concentration (much decreased pressured area, and increased maximum and average pressures) occurred, which had similar results to the condition of intact PML with total lateral meniscectomy. Conclusions: The PML of the pig had stabilizing function for the LM under the axial load. Clinically, tears of the posterior horn of LM, commonly seen in conjunction with ACL tear, are rarely symptomatic. This is thought to be due to the meniscus stabilizing function of the PML after tear of the posterior horn of LM.

Paper #169
RADIAL TEARS OF THE LATERAL MENISCUS: THE CASE FOR REPAIR

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Keith Sheldon Heckman, Coral Gables, FL, USA
Allene Martinez, Coral Gables, FL, USA
Matthew Rolf Scharhoff, Coral Gables, FL, USA
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John William Uribe, Coral Gables, FL, USA, Presenter
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INTRODUCTION
Lateral meniscal radial tears have been previously judged as difficult to treat due to technical difficulties associated with their repair, as well as their low healing potential. Radial tears of the lateral meniscus have been clinically treated by resection or neglect with satisfactory short-term results. We believe that tears of this pattern, including those adjacent to the popliteal bridge have the ability to heal. We present our series of repairs of radial tears of the lateral meniscus in order to evaluate this theory.
PAPER ABSTRACTS

MATERIALS & METHODS
We retrospectively reviewed all patients that underwent an arthroscopic meniscal repair from 1992-2001. Eighteen patients with radial tears of the lateral meniscus underwent an arthroscopic repair. Sixteen were contacted for follow-up and had either a second-look arthroscopy or a Magnetic Resonance Imaging examination to assess healing. Patients were also evaluated with the Lysholm and IKDC clinical outcome forms.

RESULTS
Ten (56%) repairs were done with an inside-out technique with 2-0 braided polyethylene sutures. Five (27.8%) were done with an all-inside technique, and 3 (16.7%) with outside-in sutures. All patients had an acute traumatic tear and 14/18 (77.8%) lateral meniscal pathologies were associated with anterior cruciate ligament tears treated concomitantly. Eleven of the 18 patients (61.1%) had tears adjacent to the popliteal bridge and all of these occurred at the same time as anterior cruciate ligament tears. Two patients were lost to follow-up. Twelve of 16 (75%) patients demonstrated satisfactory healing on second-look arthroscopy or on magnetic resonance imaging. The average Lysholm score was 90. According to IKDC, 14 (87.5%) knees were rated as normal and 2 (12.5%) as nearly normal.

DISCUSSION
Our results suggest that radial tears of the lateral meniscus do have the potential to heal. Whether the quality of the healed tissue provides any biomechanical function remains to be proven. We do believe that clinical outcome is not a reliable measure of meniscal healing, and second-look arthroscopy and/or magnetic resonance imaging are valuable to determine the presence of healed tissue in the repaired segment.

Paper #170
• ARTHROSCOPIC REPAIR OF OSTEOCHONDRAL LESIONS IN THE KNEE WITH A NEW BIOABSORBABLE SR-PLLA FIXATION DEVICE

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Russell F Warren, New York, NY, USA
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Purpose: Osteochondritis dissecans is a frequent problem encountered in young, athletic patients. We sought to evaluate the functional and radiographic outcome of osteochondral lesions involving the femoral condyle that were arthroscopically repaired using a bioabsorbable fixation device made of self-reinforced poly-1-lactic acid (SR-PLLA).

Methods: A retrospective clinical and radiographic evaluation of 9 patients (8M, 1F) with a mean age of 18 yrs at the time of surgery was carried out. 8 patients were diagnosed with osteochondritis dissecans. I had a traumatic chondral fracture. All patients underwent arthroscopic repair of a discrete osteochondral lesion involving the femoral condyle with a bioabsorbable fixation device (SmartNail, Bionx Inc., Blue Bell, PA) made of SR-PLLA. In all cases a bleeding bony bed was created before the fragment was fixed. All patients were evaluated at an average of 2 years post-operatively. All patients had pre-operative MRI's documenting the size, integrity, and location of the fragment. Patients were evaluated at follow-up with physical examination, Lysholm questionnaire, and repeated MRI with second-look arthroscopy.

Results: All patients had arthroscopic repair of an osteochondral fragment with a bioabsorbable fixation device. The average size of the fragment was 2x2cm. An average of 4 SmartNails were used in each case (range 2-10). All patients were treated with a post-op rehab protocol of non-weightbearing for a minimum of 6 weeks. Mean post-op Lysholm score was 94 (range 78-100). Subjectively, 6 patients graded themselves as having an excellent outcome, 3 as good. Clinically, all patients were rated as excellent or good. MRI evaluation of the osteochondral lesion and overlying cartilage was graded as healed in 7 patients, and of questionable integrity in 2 patients.

Conclusions: Osteochondral lesions involving the femoral condyle can be safely and reliably repaired arthroscopically. This is the first report that we are aware of documenting the efficacy of a SR-PLLA nail to internally fix an osteochondral lesion. Repeat MRI at an average of 2 years post-operatively reveals incorporation of the bioabsorbable nails and healing of the osteochondral fragment.

Paper #171
TORN DISCOID LATERAL MENISCUS TREATED BY PARTIAL CENTRAL MENISCECTOMY AND SUTURE OF THE PERIPHERAL TEAR

Nobuo Adachi, Izumo, JAPAN, Presenter
Mitsuo Ochi, Izumo-shi, JAPAN
Yuji Uchio, Izumo, JAPAN
MasaKazu Kuriwaka, Izumo, JAPAN
Rikuo Shinomiya, Izumo, JAPAN
Department of Orthopaedics, Shimane Medical Univ, Izumo, JAPAN

PURPOSE: The purpose of this study was to report 5 patients with torn complete or incomplete discoid meniscus treated by partial central meniscectomy and suture repair of the tear.

METHOD: From September 1995 to October 1999, we performed 53 partial central meniscectomy for patients of symptomatic discoid lateral meniscus who did not respond to several conservative treatments. Among them, 5 patients underwent the partial central meniscectomy and suture repair of the peripheral tear in the vascular zone and were followed for 2 years. They were 4 males and 1 female with mean age of 15.4 (11-17) years at the time of surgery. There were 4 complete and 1 incomplete discoid meniscus according to Watanabe's classification. There was no Wrisberg type of discoid meniscus. The average interval from injury to operation was 5.5 months (2.5-8.5). The average follow-up periods after surgery were 2 years and 7 months (2-3 years and 6 months). The clinical results were graded with the scale of Ikeuchi and Lysholm score. Three patients accepted the second and third look arthroscopy.

RESULTS: At the final follow-up over 2 years, 4 patients were graded as excellent and 1 patient was graded as fair according to the Ikeuchi's grading scale. The average Lysholm score improved from 83.4 (70-90) to 95.8 (89-100) points post-operatively. In the 3 patients who underwent second-look arthroscopy, complete healing was observed in 2 patients. One patient had severe degenerative changes in the meniscus, and the repaired site was not united requiring an additional partial menisectomy along the tear.

CONCLUSION: With the current advancement in arthroscopic meniscal repair techniques, a partial central meniscectomy in conjunction with the suture repair of the peripheral tear can be a good treatment for the patients with a torn complete or incomplete discoid meniscus.

SIGNIFICANCE: This is the first study to clarify the effectiveness of the partial central meniscectomy in conjunction with the suture repair of the peripheral tear of torn discoid meniscus. Because this procedure provides nearly normal meniscal mor-
phology, it may contribute to the prevention of osteoarthritic changes during post-operative periods.

Paper #172
CLINICAL RESULTS AFTER ARTHROSCOPIC MENISCETOMY FOR DISCOID LATERAL MENISCI
Sung-Jae Kim, Seoul, KOREA
Jae-Hoon Jeong, Kayng-shi, KOREA, Presenter
Su-chan Lee, Inchon City, SOUTH KOREA
Yong-Su Lee, Seoul, KOREA
Yong-Kan Ko, Seoul, KOREA
Yonsei College of Medicine, Seoul, KOREA

The clinical results after meniscectomy for the discoid meniscus have been variable especially in the long term follow up. We reviewed the cases of one hundred nineteen knees with symptomatic discoid lateral meniscus who underwent total, subtotal or partial arthroscopic meniscectomy between January 1990 and December 1999. The mean age at surgery was 30.5 years old (range: three to sixty years) at the time of operation. Preoperative duration of symptoms was 16.8 months and average duration of follow up was 60.1 months. At arthroscopy, 91 menisci were complete, 28 menisci were incomplete type. Patients were divided into three groups based on the type of surgery. Arthroscopic total meniscectomy was undergone in 47 cases of knee, subtotal meniscectomy in 21 cases and partial meniscectomy in 51 cases. On the basis of Ikeuchi grading system, 34 knees were graded as excellent, 62 knees were rated as good, 22 knees were rated as fair and 1 knee as poor. Longer duration of symptom and older age had a statistically significant higher risk of developing chondromalacia in knee joint (P=0.001). But no correlation was found between symptom duration and type of meniscal lesion. In patients who had had total meniscectomy for the complete type of lesion and partial meniscectomy for the incomplete type, results were satisfactory respectively in cases of less than 5 years follow-up. We found unsatisfactory results with significant preoperative chondromalacia and longer follow up.

Paper #173
LARGE OSTEochondRAL DEFECTS OF THE FEMORAL CONDYLE, THE MEGA-OATs TECHNIQUE
Erik Hofmann, Rockhampton, AUSTRALIA, Presenter
Iorgy Beyerlein, Munich, GERMANY
Peter Brucker, Munich, GERMANY
Andreas B Imhoff, Munich, GERMANY
Department of Orthopaedic Sportsmedicine, Munich, GERMANY

Large osteochondral defects are difficult to treat but several treatment options are available. The posterior condyle transfer technique described by Wagner in 1964 and Imhoff in 1990 has been developed further and is now used for coverage of large osteochondral defects in the weight bearing zone. This new technique has been called Mega-Oats. From July 1999, 25 patients of a mean age of 33.3, years (17-60) were treated with Mega-Oats. 13 patients additionally underwent high tibial osteotomy and two bone grafting using bone harvested from the proximal tibia. The mean follow up was 27.7 months. The technique calls for excision of the posterior femoral condyle which is placed in a specially designed work station. A Mega-Oats cylinder of diameter 20mm to 35mm is prepared and, using the press-fit technique, grafted into the prepared defect zone. The Lysholm score increased postoperatively from 66.33 (49-71) to 87.8 (72-97). Three months postoperatively control MRI showed incorporation of all cylinders. Between six and twelve weeks postoperatively patients attained a full range of motion and became fully weight-bearing. To date one superficial infection resolving on oral antibiotics and two cases of arthofibrosis four months postoperatively that required arthroscopic release were seen. No postoperative meniscal lesions of the posterior horn have been observed. Mega-Oats achieves a congruent reconstruction of the articular surface in the load-bearing zone of the femoral condyle. We consider it a good alternative in the treatment of large osteochondral defects of the femoral condyle in young patients.

Paper #174
PROSPECTIVE ANALYSIS OF HIP ARTHROSCOPY WITH FIVE YEAR FOLLOW UP
J.W. Thomas Byrd, Nashville, TN, USA, Presenter
Kay S Jones, Nashville, TN, USA
Nashville Sports Medicine & Orthopaedic Center, Nashville, TN, USA

Introduction: Hip arthroscopy is a well accepted technique, yet little outcome data has been reported and none with extended follow-up. The purpose of this prospective study is to report the results of arthroscopy in a consecutive series of patients with five year follow-up.

Methods: 55 procedures were performed on 50 patients who had achieved 5 year follow-up. All patients were assessed with a modified Harris hip score (100 point max) preoperatively and postoperatively at 1, 3, 6, 12, 24, and 60 months or until a subsequent procedure was performed. Variables studied included age, sex, diagnosis, duration of symptoms, onset of symptoms, center edge angle, workers compensation, and pending litigation.

Results: There was 100% follow-up. The median preoperative score was 56. Median postoperative results for the various intervals were as follows: 1 month (74), 3 month (81), 6 month (82), 12 month (85), 24 month (85) and 60 month (75). These results included 10 patients who underwent a subsequent procedure (7 THA, 1 core decompression, 3 repeat arthroscopy). Median improvement for the following diagnoses was: Loose bodies (28), Labral pathology (20), Chondral injury (17), Synovitis (18), Arthritis (1), and Avascular necrosis (nil). Median improvement based on the onset of symptoms was: Traumatic (28), Acute (11), and Insidious (15). Median improvement among workers compensation cases was 8. There was no correlation with duration of symptoms, center edge angle, or pending litigation. Two complications occurred in one patient including a focal area of myositis ossificans along one portal tract and partial neuropraxia of the lateral femoral cutaneous nerve.

Discussion and Conclusions: Hip arthroscopy can be performed for a variety of conditions (except end stage avascular necrosis and arthritis) with reasonable expectations of success and an acceptably low complication rate. More favorable results are seen when there is a specific history of significant trauma. Results seem to be poorer among workers compensation cases. Following arthroscopy, the greatest increase is noted within the first month with gradual improvement throughout the first year. This improvement is maintained at two years post op, but diminishes slightly with five year follow-up.
**Paper #175**

**COMPLICATIONS IN 1054 HIP ARTHROSCopies**

Michael Thomas Clarke, Cambridge, UNITED KINGDOM, Presenter
Arvin Arora, Cambridge, UNITED KINGDOM
Richard N Villar, Cambridge, UNITED KINGDOM
BUPA Cambridge Lea & Addenbrooke's Hospitals, Cambridge, UK

**Background**

Although hip arthroscopy is becoming more frequently performed, there is relatively little data in the literature regarding the frequency of complications. This study summarises the complications encountered in over 1000 prospectively recorded hip arthroscopies at a single institution.

**Methods**

Over a 12 year period we prospectively recorded data on all hip arthroscopies performed at our institution. Inpatient complications were recorded on a dedicated proforma. Outpatient complications were identified during clinic consultations in addition to regular patient follow-up questionnaires. Indications for surgery were undiagnosed hip pain (41%), osteoarthritis (21%), labral tears (18%), removal of loose bodies (7%) and other miscellaneous conditions (13%). The patient population included 458 males and 596 females with a mean age of 37 years (range 6 to 80). 599 procedures were performed on the right side and 455 on the left side. 53 procedures were staged bilateral cases.

We performed all arthroscopies under general anaesthesia in the lateral position using specialised joint distraction equipment. A ‘trial of traction’ was initially performed to identify the lowest force needed for access (typically 200–300N). This was evaluated by observation of the ‘radiolucent arc’ on an image intensifier. Two or three lateral/antero-lateral portals were used. Anterior portals were not used. Joint assessment utilised a 4.5mm diameter 70 degree arthroscope.

**Results**

We identified 15 complications (1.4%) in 1054 hip arthroscopies (95% CI <2.4%). The only major complication was one septic arthritis. Other complications included transient sciatic (3) and femoral (1) nerve palsies, vaginal tearing (1), trochanteric bursitis (1), excessive portal bleeding (2), haematoma (2), instrument breakage (2) and the need for arthrotomy (2). Additionally, in 194 cases (18%) access was considered difficult but adequate. In 30 cases (2.8%) access failed or was inadequate.

**Discussion**

The low incidence of early complications would suggest that hip arthroscopy can be performed safely if specialised distraction equipment is available and meticulous care is taken over patient preparation and positioning.

**Paper #176**

**DISC DEGENERATION AND ABNORMALITIES OF THE SPINE IN TOP ATHLETES.**

Leif Sward, Göteborg, SWEDEN, Presenter
Mikael Hellström, Göteborg, SWEDEN
Olof Lundin, Göteborg, SWEDEN
Richard Nyman, Uppsala, SWEDEN
Department of Orthopaedics and Radiology, Sahlgren, Göteborg, SWEDEN

**Study Design.** Prospective, blinded study of MRI-findings in randomly selected, active athletes at national top-level in four different sports with different demands on the back, including a blinded comparison with non-athletes. The abnormalities were related to back pain graded by self-assessed, structured questionnaires.

**Objectives.** To determine the occurrence of abnormalities on MRI of the lower thoracic and the lumbar spine of athletes in four sports with different demands on the back, and to compare the results with a group of non-athletes. Another objective was to investigate, by means of a questionnaire, the frequency and extent of back pain and its relation to the MRI findings.

**Summary of Background Data.** To reach elite level many sports require training with high intensity and with high loads, often from low age. Athletes participating in sports with great demands on the back have been shown to have a higher frequency of radiological abnormalities in the spine than non-athletes and more back pain than other athletes. Conventional radiological techniques primarily show injuries of the bony elements of the spine. Injuries of the intervertebral discs resulting in disc degeneration are detected as disc height reduction, this is however a late sign. Several studies have reported that magnetic resonance imaging (MRI) is the most sensitive method in detecting spine injuries in athletes.

**Methods.** The lower thoracic and the entire lumbar spine of 71 Swedish top male athletes, 18-37 years of age, were examined with MRI. The participants were active at National elite level in four different sports, 21 weight lifters, 13 wrestlers, 18 orienteers and 19 ice-hockey players. We also examined a reference group of 21 non-athletes (22-36 years of age). All participants also answered a self-assessed, structured questionnaire regarding back pain.

**Results.** Signs of disc degeneration were more common among athletes (92%) than non-athletes (48%), and were most common among weight lifters (100%) and ice-hockey players (100%). Discs with severely reduced disc signal intensity were found in all four groups of athletes but not in any of the non-athletes. 13 % of the discs with reduced signal intensity in athletes were classified as severe. The most frequent sites of reduced disc signal intensity in athletes was in the thoraco-lumbar junction and especially in the lumbo-sacral junction, while the distribution was more uniform among the non-athletes.

**Conclusions.** Athletes in sports with severe or moderate demands on the back run a higher risk of developing disc degeneration and other abnormalities of the spine than non-athletes. The abnormalities have been related to back pain.

**Paper #177**

**EFFECT OF PRE-EXISTING BACK PAIN ON THE INCIDENCE AND SEVERITY OF BACK PAIN IN COLLEGIATE ROWERS.**

John O'Kane, Seattle, WA, USA
Carol C. Teitz, Seattle, WA, USA, Presenter
Bonnie K. Lind, Boise, ID, USA
University of Washington, Seattle, WA, USA

In a previous study, Teitz et al found a 32% incidence of back pain in intercollegiate rowers. They questioned whether athletes with pre-existing back pain should be prohibited from participating in intercollegiate rowing. This study examines the effect of pre-rowing back pain on back pain during college rowing. Surveys were sent to 4680 former intercollegiate rowing athletes. 2165 surveys were returned (46%). 156 (8.5 %) of the respondents reported back pain before rowing. 57.1% of subjects with pain before rowing had back pain during college rowing.
The text provided is a mix of fragments from different sources, not forming a coherent paragraph. It appears to cover various medical and sports-related topics, including the incidence of injuries in military recruits, the effectiveness of preventive measures, and the diagnostic challenges related to ligamentum teres trauma.

**Paper #178**

**OVERUSE INJURIES AS RELATED TO THE AGE OF COMMENCING ORGANIZED PHYSICAL ACTIVITY**

Gideon Mann, Givat Shaul, ISRAEL, Presenter
Shay Shabat, Kfar Saba, ISRAEL
Yonatan Matan, Jerusalem, ISRAEL
Y Barak, Jerusalem, ISRAEL
Joseph Lowe, Jerusalem, ISRAEL
Alex Fishtenbusch, Jerusalem, ISRAEL
Meir Nyska, Kfar Saba, ISRAEL
Alex Borowski, Jerusalem, ISRAEL
Naama Constantini, Netanya, ISRAEL
M Perez, Jerusalem, ISRAEL
R Goldschmidt, Jerusalem, ISRAEL
Y Herzoni, Jerusalem, ISRAEL
Moshe Saderer, Jerusalem, ISRAEL
David Morgensztern, Kfar Saba, ISRAEL
Wingate Institute, Netanya, ISRAEL

**Introduction:**

Overuse injuries comprise the major cause of disability and loss of training days both in the athletic as in the military population. Though it is logical that commencing serious activity at an earlier age would prevent overuse injuries, the difficulty in organizing longitudinal, prospective, randomized trials make confirmation of this assumption extremely difficult.

**Material and Methods:**

224 border police infantry recruits were questioned concerning their previous physical activity prior to commencing a 4 month course of basic military training. Soft tissue overuse injuries and stress fractures were prospectively recorded during the basic training and separately compared for recruits who started organized physical activity at the age of 16-18 over those who started serious practice at the age of 17-18. “Dangerous” stress fracture (fracture of the shaft of long bones, the navicular and femoral neck) were also compared for recruits starting physical activity under the age of 16 as compared to age 16-18.

**Results:**

For overuse soft tissue injures a clear reduction of injury rate was noted for recruits who commenced physical activity at a younger age. This was significant for the Achilles tendon (p=0.03), the PFJ (p=0.04) and the total overuse soft tissue injuries (p=0.04).

For stress fractures a clear reduction was observed in recruits who commenced serious physical activity at a younger age. This showed a trend for metatarsal fractures (p=0.09), thigh fractures (p=0.09) tibial fractures (p=0.07) and all “dangerous” fractures (p=0.07). The reduction was significant for the total number of stress fractures (p=0.01).

**Conclusions:**

Commencing physical activity at a younger age may have a positive effect in preventing both soft tissue overuse injuries and the occurrence of stress fractures.

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**Paper #179**

**TRAUMATIC RUPTURE OF THE LIGAMENTUM TERES AS A SOURCE OF HIP PAIN**

J.W. Thomas Byrd, Nashville, TN, USA, Presenter
Kay S Jones, Nashville, TN, USA
Nashville Sports Medicine & Orthopaedic Center, Nashville, TN, USA

**Introduction:**

Lesions of the ligamentum teres have only occasionally been reported in the literature. However, with arthroscopy, pathology of the ligamentum teres has been increasingly recognized. The purpose of this study is to report the clinical characteristics associated with rupture of the ligamentum teres and the results of arthroscopic treatment.

**Methods:**

271 consecutive cases undergoing hip arthroscopy have been prospectively assessed using a modified Harris hip score (100 point max) preop and postop at 3, 12, 24, & 60 months. From this population, 41 patients were identified with lesions of the ligamentum teres. 23 of these were traumatic in origin and represent the substance of this study. The remainder (18) were hypertrophic or degenerative.

**Results:**

There was 100% follow up at an average of 18 months. There were 13 females and 10 males with an average age of 28 years. Duration of symptoms prior to surgery averaged 28 months. All patients experienced deep anterior groin pain. 19 patients experienced mechanical symptoms (catching, locking, popping, giving way), while 4 patients described simply pain with activities. 15 patients sustained major trauma (7 MVA, 3 falls from height, 3 football, 1 snow skiing, 1 ice hockey) including 6 dislocations. The remaining 8 patients sustained a twisting injury. Evaluation included 20 MRIs, 7 MR arthrograms, 7 CT scans, and 3 bone scans. The diagnosis of a lesion of the ligamentum teres was made preoperatively in only 2 cases. Rupture of the ligament was complete in 12 cases and partial in 11. Ligament injury was an isolated finding in 8 cases, and there was associated pathology in 15 cases (labrum 9, loose bodies 5, chondral damage 5). The average preop score was 48 and post op 89. There was no statistical difference between complete and partial ruptures or presence of coexistent pathology.

**Discussion and Conclusions:**

Rupture of the ligamentum teres is increasingly recognized as a source of persistent hip pain. The diagnosis remains elusive to various imaging techniques. An index of suspicion should be maintained, especially in the presence of mechanical symptoms and a history of significant trauma. However, rupture may occur simply from a twisting injury in absence of major trauma. These lesions can be diagnosed by arthroscopy and, based on these results, may respond remarkably well to arthroscopic debridement.
Background: Adequate joint distraction is one of the most important prerequisites for arthroscopy of the central compartment of the hip. More space will improve the intraarticular maneuverability of the arthroscope and additional instruments and may reduce the risk of intraarticular complications, such as damage to the acetabular labrum and articular cartilage.

Purpose: To quantify the effects of distension and progressive release of the Zona orbicularis and iliofemoral ligament on distraction of the hip joint.

Type of Study: Experimental cadaver study.

Material and method: Five whole pelves and proximal femora with 7 intact hip joints were obtained from formalin fixed human cadavers. The specimen were cleaned of soft tissues, leaving the pelvic ligaments and capsules of the hip joints intact. Both the symphysis and the iliosacral joints were transfixed with screws. The whole pelvis was then mounted to a rectangular metal plate connecting the anterior superior iliac spines and the pubic symphysis parallel to the ischial tuberosities. Thus, the vertical plane and horizontal axis were defined. The pelvis was then mounted onto a load cell in the crosshead of a materials testing machine. The hip joint was aligned in neutral position. The direction of the femoral distraction force was parallel to the vertical plane and perpendicular to the horizontal axis. Preconditioning, preload of 50 N, strain rate 10 mm/min. At a hip distraction of 5 mm the distraction force was recorded (Butler’s flexibility approach). Measurements were performed with the specimen in 7 different conditions: intact specimen (1), intact specimen after ventilation of the joint with air (distension, 2), incision of the Zona orbicularis (ZO, 3), release of the iliofemoral ligament (IFL) by a circular incision (4), 75% (5), 100% (7).

Results: Ventilation of the hip joint (distension with air, condition 2) showed a mean reduction of the distraction force by 41.5% (condition 4), 54.3 N (12.4%, condition 5), 68.5 N (15.6 %, condition 6) and 58.2 N (13.3 %, condition 7).

Conclusions: Distension and release of the Zona orbicularis and iliofemoral ligament present effective techniques to increase distraction of the cadaveric hip joint. Whereas the significant effect of distension has already been demonstrated in in-vivo studies, the indications and the effect of a release of the Zona orbicularis and iliofemoral ligament have to be investigated in vivo and discussed.

Purpose: Little outcome data have been reported for operative hip arthroscopy, especially for hip osteonecrosis before and after free vascularised fibula graft. The purpose of this retrospective study is to report our five-year experience of hip arthroscopy performed on a consecutive series of patients for a variety of hip disorders, as well as in cases of hip osteonecrosis.

Materials and Methods: Hip arthroscopy was performed in 12 patients (13 hips mean age 34.4 years range 16-50 years). Eight patients were men and three women with the same proportion for the right and left hip. Indications for hip arthroscopy were osteonecrosis of the femoral head treated with free vascularised fibula grafts (6 patients-7 hips), osteonecrosis of the femoral head (one patient), osteochondritis of the femoral head (2 hips), synovial chondromatosis (2 hips) and pipkin fracture (one patient). All the patients had hip pain with restricted range of motion. They were evaluated using a Harris hip score. The arthroscopy was performed in the supine position, using a standard traction table, 30° arthroscopes and anterior and peritrochanteric portals. Arthroscopic debridement was performed in all cases.

Results: No complications were reported. The mean follow up was 24 months (6-61 months). There was substantial improvement of clinical symptoms with satisfactory results for all cases. A second arthroscopic debridement was performed in one patient with osteonecrosis of the femoral head treated with a free vascularised fibula graft one year later. The median score improved from 50 to 85 points two months postoperatively. None of the osteonecrosis cases were converted to total hip arthroplasty until now.

Conclusions: Hip arthroscopy can be performed for a variety of hip disorders with reasonable expectations of success. Although operative hip arthroscopy is a technically demanding procedure, the indications for hip arthroscopy will increase and hip arthroscopy will be an alternative to conventional operations. Furthermore for osteonecrosis cases can extend the time for conversion to total hip arthroplasty.

Purpose: The FDA has not cleared the drug and/or medical device for the use described in this presentation (i.e., the drug or medical device is being discussed for an "off-label" use).

Methods
A retrospective study was carried out of 53 patients with a diagnosis of chronic compartment syndrome, treated by fasciotomy.
between 1995 and 1999; 37 responded. The history was of activity related calf pain. Diagnosis was confirmed by compartment pressure studies following an exercise specific protocol. After the failure of non-surgical management including orthotics a total of 72 limbs were treated surgically. Subjects were placed into two groups according to the compartments involved. Group I (12 subjects) underwent decompression of the anterior compartment alone. Group 2 (25 subjects) underwent anterior, and deep posterior compartment surgery. Subjective outcome measurement was by postal and telephone survey with a grading system of good, fair, no change or poor.

Results
There was an overall satisfaction rate (good or fair) of 73% at a mean follow-up of 19 months. Group I had 7 out 12 subjects (58%) and Group 2 had 20 of 24 subjects (80%) with satisfactory outcomes.

Discussion
Some poor results were simply due to failure to comply with the strict immediate post-op exercise protocol. The preponderance of poor results in group 1 were associated with a change in symptoms; there was pain more typical of Medial Tibial Stress Syndrome. Group 2 demonstrated a trend towards shorter duration of symptoms, which may have had an influence on the results. We now believe that single compartment release may lead to imbalance of the loads on the tibia, producing a late stress phenomenon and present bone scan data to support this view. Our clinical practice has changed as a result of this study.

Paper #183
THE HAMSTRING SYNDROME IN ENDURANCE ATHLETES.
Marco Merlo, Busto Arsizio, ITALY. Presenter
Migliorini Sergio, Cameri, ITALY
Busto Arsizio General Hospital, Busto Arsizio, ITALY

Hamstring syndrome is a gluteal pain located at the area of ischial tuberosity. Traction, mechanical compression and impingement of the sciatic nerve may occur in certain anatomo-pathological situations at the origin of the hamstrings on the ischial tuberosity. The nerve, in fact, passes through a crossway formed of the quadratus femoris, the gluteus maximus and the common tendon origin of the long head of the biceps femoris, the semitendinosus and the semimembranosus. The symptoms include sciatic pain irradiating from the lower gluteal area to the posterior aspect of the thigh which appears when running and ceases after the effort. Pain is also exacerbated by stretching of the hamstrings and typically with the direct compression when sitting. Differentiation is required from radiculopathies, the piriformis syndrome, exertional compartment syndromes, ischial bursitis and muscle disorders. CT and MRI of the ischiadic crossway is also an important means of diagnosis. This paper describes the results of the surgical management during the last five years of a personal series of eleven endurance athletes engaged in track and field and triathlon refractory to nonoperative treatments for periods of one to six years. Total resumption of competitive sports was achieved in six months. An account is also given of the surgical technique employed, consisting of sciatic neurolysis coupled with partial section of the taut and fibrotic hamstring tendons.

Paper #184
THE COMPUTER NAVIGATION SYSTEM IN TOTAL KNEE REPLACEMENT
Norberto Confalonieri, Seregno, ITALY
Pietro Cerea, Milan, ITALY. Presenter
Kourosh Motavalli, Milan, ITALY
Clinical Institute Orthopaedic Center (CTO), Milan, ITALY

INTRODUCTION
The aim of this work is to present the results of our experience after three years with the Orthopilot navigation system in TKR. This computer-assisted system, right in the operating room and without using any CAT or NMR reconstructions, enables to acquire data on the lower limb where the prosthesis is to be implanted, process the data and any information on the size of the prosthesis, and then serves as a guide for bone incision and for correct implantation of prosthesis components, according to the biomechanical coordinates for that patient, thus avoiding the use of intra and extra-medullary instruments.

MATERIALS AND METHODS
From January 1999, at the Orthopaedic Center of Milan, we have been using the Orthopilot system in more than 100 knee implants. We have experienced some initial problems, paying the price for the learning process with the replacement of three Orthopilot systems and a six-month halt. Now, with the latest version, the clinical radiographic results finally seem to confirm our prefixed objectives. We performe a comparison study to evaluate the results obtained with navigation system (group A, Search Aesculap) against intramedullary (group B, Tri CCC Genius) and extramedullary (group C, Mitab Scan) alignment. The X-ray results showed that the mean femoral-tibial angle (HKA) was 181.2° for group A, 178.5° for group B and 177.5° for the group C. The difference versus the other two groups was better for the Orthopilot system and with a statistical significance (p<0.001) calculated by the Student T test. If one takes as normal a range between 3° varus and 3° valgus, 90% of group A, 80% of group B, with no statistical significance. We had a low significant difference between group A versus group B, for the poor result s. We found HKA >3° and <5° in three cases (10%) for group A versus two cases for group C (13%) with a significance (p=0.05) at Chi-Square test. At the same, had a low significant difference between group A versus group B and C for the bad result s (HKA >5°). We found HKA >5° in zero cases for group A, in one case for group B (0.7%) and in five cases for group C with a statistical significance for group A versus group C (p=0.05) calculated by a Ficher exact test. For the femoral mechanical axis in anteroposterior (FM A-P), we observed a mean value of 91.12° in group A with a standard deviation (SD) of 1.5. FM A-P was 87.3° (SD=1.9) in group B and 88.5 (SD=2.00) in group C. The difference between the mean values was significant (p<0.001) with the Student T test. The same is for the femoral mechanical axis in lateral view (femoral slope). We obtained a mean value of 90.2° in group A with a standard deviation of 1. The femoral mechanical axis in lateral view was 86.3° (SD=1.9) in group B and 88.5 (SD=2.00) in group C. Also this difference was significant (p<0.001) with the Student T test (Tab 5). The femoral slope, obtained with a lateral X-ray photograph, within a range of +1° and -1°, was 90% of the cases from group A, 70% of the cases from group B, and 50% for group C with a statistical significance for group A versus group B (p=0.05). The Tibial mechanical axis in anteroposterior (TM A-P), we observed a mean value of 89.3° in group A (SD=1.1). TM A-P was 88.3° (SD=1.9) in group B and 88.5 (SD=2.00) in group C. The difference between the mean values was significant (p<0.001) with the Student T test (Tab 6). The optimal value for the tibial slope is different for group A (90°) than group B or C where the relative tibial component requires 5° of posterior slope (85°). Within a
range of $+2^\circ$ and $-2^\circ$, came 90% of the cases from group A, 80% of the cases from group B and C without statistical significance.

In a more recent study, the aim was to evaluate the correlation of data obtained with computer, about alignment versus clinical and X-ray data. We studied 35 cases, 15 men and 20 women, with a mean age of 69.5 (47-81). We compared the computer-form, obtained during the operation, with the X-ray and clinical parameters with the objective to positioning the femoro-tibial angle of $180^\circ$, a femoral and tibial angle of $90^\circ$ relative to the mechanical axis in antero-posterior, and a tibial slop at $0^\circ$ in profile. We think it is very important to esteem this correlation. We found infact, in some cases, how a little variation of the incidence angle in X-ray make a considerable variation of the mechanical axis. At the same, an acquisition obtained with the bad movement (ex. stress varus-valgus in laxity) can make some mistakes in computer.

**CONCLUSIONS**

As of today, our results confirming that the computer-assisted system for the implantation of total knee prosthesis is reliable. In many cases the results are better, regarding about alignment, than the standard technique using intra or extramedullary system even though the numbers are such that a statistically significant difference has not yet been achieved. The positioning of the screws for the transmitters does not cause an increase in morbidity, and the duration of the operation is within acceptable limits (about $15^\circ$).

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**Paper #185**

**COMPUTER ASSISTED TOTAL KNEE PROSTHESIS IMPLANTATION WITH A NON IMAGE BASED SYSTEM. A PROSPECTIVE, COMPARATIVE, MULTICENTER STUDY ABOUT 821 CASES.**

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Hartmut Kiefer, Bünde, GERMANY
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Ulrich Clemens, Sendenhorst, GERMANY
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**INTRODUCTION**: Accuracy of lower limb axial correction is a definite prognostic factor for long term survival of total knee prostheses. Manual instruments do not always allow an optimal prosthetic implantation. Computer guided technique could improve the quality of implantation of a total knee prosthesis. The objective of this study was to assess the effectiveness of a non image based navigation system for total knee prosthesis implantation.

**MATERIAL - METHODS**: The authors conducted a prospective, comparative study in five European centers. 555 patients were operated on with the same implant (Search® prosthesis, Aesculap, Tuttingen, FRG) and a non image based navigation system (OrthoPilot®, Aesculap, Tuttingen, FRG - group 1) and were compared with a historical control of 266 cases operated with the same prosthesis and a conventional, manual instrument (group 2). The radiographic results were analysed by an independent observer on hip-knee-ankle X-rays at the 3rd post-operative month.

**RESULTS**: Coronal mechanical femoro-tibial axis was within the desired range (3° of coronal deformation) in 89% (group 1) and 72% (group 2) of the cases ($p < 0.001$). Coronal orientation of the femoral component was within the desired range in 89% (group 1) and 77% (group 2) of the cases. Sagittal orientation of the femoral component was within the desired range in 76% (group 1) and 71% (group 2) of the cases. Coronal orientation of the tibial component was within the desired range in 92% (group 1) and 84% (group 2) of the cases. Sagittal orientation of the tibial component was within the desired range in 81% (group 1) and 70% (group 2) of the cases. 275 patients in group 1 (50%) and 82 patients in group 2 (31%) had an optimal implantation for all the studied items ($p < 0.001$). No significant difference between the different centers was observed.

**CONCLUSION**: The navigation system allowed a more consistent implantation of the total knee prosthesis within the desired angular range in comparison with the conventional, manual instrumentation. The rate of unacceptable implantations was dramatically decreased. Learning curve was short in all centers. As no significant difference was observed between all centers, this technique should be easily usable on large basis.

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**Paper #186**

**THE BRAZILIAN INITIAL EXPERIENCE WITH THE USE OF COMPUTER ASSISTED NAVIGATION IN TOTAL KNEE REPLACEMENT (TKR): 72 CASES**

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The purpose of this paper is to report the first 72 cases submitted to primary TKR with the aid of a Computer Assisted Infrared Navigation System (OrthoPilot) at the Instituto de Ortopedia e Traumatologia, Universidade de Sao Paulo, Brazil. The system was used to determine the coronal mechanical axis of the lower limb both preoperatively and postoperatively, as well as it guided the orientation of femoral and tibial bone cuts. In that manner it provided not only the initial assessment and the bone cuts orientation, but also the results of limb alignment after the cementation of all the components.

**RESULTS**: The coronal mechanical axis before TKR was deviated from neutral alignment in 9.25 degrees (deg) (+5.2 deg), ranging from 17.3 deg of varus to 22.5 deg of valgus. After cementation, the mean deviation from neutral was 0.66 deg (+0.77 deg) ranging from 3.4 deg of varus to 2.7 deg of valgus. More than that only one case (1.39%) exceeded 3 deg from neutral and 57 patients (78.26%) had its alignment deviated less than 1 deg. We did not experience any complication related to the use of the system.

**CONCLUSION**: The use of this Navigation System was considered: 1) safe; 2) accurate; 3) a valuable tool in obtaining good lower limb alignment in TKR.
COMPARISON OF INTRAARTICULAR INJECTION OF
EPINEPHRINE-ADDED SALINE AND POSTOPERATIVE
BLOOD SALVAGE IN REDUCING BLOOD LOSS AFTER
TOTAL KNEE ARTHROPLASTY

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Objective: In order to avoid allogenic blood transfusion, it is important to minimize postoperative blood loss in total knee arthroplasty (TKA). Consequently, different postoperative management regimens have been proposed. In this study, intraarticular injection of saline with epinephrine was compared with postoperative collection and reinfusion of unwashed shed blood in terms of effects on the reduction of blood loss after TKA.

Materials and methods: This study was conducted as a prospective study. Two hundred and twelve consecutively operated knees were randomly divided into one of two groups. In 106 knees, intraarticular injection of saline with epinephrine was given immediately after surgery (ISE group). In this group, 30 ml of epinephrine-added saline (1/500,000) was injected through Port-VAC drain (Howmedica) after wound closure. Drain tube was clamped for 30 minutes, then opened for drainage of blood. Shed blood was not reinfused. In the other 106 knees (CBC group), postoperative blood salvage using ConstaVac blood conservation system (Stryker) was applied. In this group, shed blood was collected with filter and infused back to the patient. The ISE group comprised of 18 males and 88 females. The average age at operation was 72.6 years ranging from 58 to 87 years. The CBC group was composed of 10 males and 96 females. The average age at operation was 72.8 years ranging from 57 to 92 years. The CBC group was composed of 10 males and 96 females. The average age at operation was 72.6 years ranging from 58 to 87 years. For analysis of the results, the amount of drained blood in each group was assessed. Moreover, pre and postoperative hemoglobin level and requirement of allogenic blood transfusion were compared between the groups.

Results: The amount of drained blood in the ISE group averaged 350.3 ml (range: 100–770 ml), whereas the mean value of drained blood in the CBC group was 662.3 ml (range: 15–1540 ml). Thus, significantly less blood was drained postoperatively in the ISE group than in the CBC group (p<0.0001). Hemoglobin levels in the ISE group and the CBC group were 12.8 and 12.7 g/dl before operation. When examined postoperatively, the average value in both groups were 10.5 and 10.5 g/dl on the first postoperative day, 9.6 and 9.8 g/dl at one week, and 10.7 and 10.9 g/dl at one month respectively. Thus, no significant difference was observed between the two groups. Allogenic blood transfusion was performed for 1 case (0.9%) in the ISE group and in 3 cases (2.8%) in the CBC group.

Discussion: The results of this study demonstrated that intraarticular injection of epinephrine-added saline was more effective than postoperative blood collection and reinfusion in reducing blood loss after TKA.

INTRODUCTION Wear of polyethylene (PE) and the development of subsequent osteolysis remains a problem in total knee arthroplasty. The proximal femoral-PE insert articulation is known to be the primary producer of PE wear particles in conventional fixed bearing modular knee designs. Secondary production of PE wear occurs at the fixed insert-tibial interface due to relative micromotion between the components. Retrieval analyses of fixed bearing knees demonstrate a number of wear mechanisms that, in part, reflect the low conformity and high contact stress at the articulations and kinematics. Mobile bearing knees have been designed with increased conformity to decrease the contact stress and minimise the constraint to the PE insert with the hope of more natural kinematics. An increase in contact area has been hypothesized to produce lower wear rates. Experimental techniques have been reported to evaluate the contact stress and area footprints but are limited in that only the surface stresses can be examined. Subsurface stress distributions in PE insert may play an important role in the fatigue related wear mechanisms. This study explored subsurface stress distributions in PE using Finite element modeling (FEM) and an electronic pressure sensor or Fuji pressure sensitive film.

METHODS Two mobile bearing knees and their corresponding unigraphics parts files were supplied by the manufacture (MBK, Zimmer, BalanSys Mobile, Mathys) were studied. The contact surface areas and stresses of the proximal articulation between the femoral component and proximal PE insert versus flexion angle at 5x body weight (3600N), were examined using an electronic sensor (K-Scan, Tekscan, South Boston, USA) and an experimental jig (1). The distal articulation contact surface areas were measured using ultra super low (USL) Fuji Prescale pressure-sensitive film (0.27 0.6 MPa) (Fuji Photo Co.Inc., Tokyo, Japan) (2). Subsurface contact area and stress distributions were examined experimentally by placing the K-Scan sensor between two pieces of PE of varying thickness. Three dimensional finite element models were created in Patran (MSC, CA) and analysed using Abaqus (HKS, RI). Each component was meshed using modified 10 nodded tetrahedral elements. Contact conditions were defined as deform-deform between the femoral component and the PE. Boundary conditions were applied to the models as per the experimental testing. Subsurface stresses were investigated using Patran at various levels through the PE. Additional FE models were created using the femoral components articulating on a flat piece of PE to compare to the experimental data with different thickness PE. Data was analysed using a 2way analysis of variance following by a Tukey Honest Significant difference post-hoc test. The proximal and distal contact areas and stresses (proximal and subsurface) predicted from FEM were compared to the Tekscan data.

RESULTS Proximal articulation contact areas measured with TekScan were relatively constant up to 60° and decreased with higher degrees of flexion. Peak stresses for both designs were below the tensile yield stress of PE (21 MPa) throughout the range of flexion with the 3600 N load used in this study. Distal contact area patterns from USL Fuji film reflected the same general trend with flexion angle as the proximal surface data. The PE thickness study revealed subsurface contact areas to increase with increasing thickness of PE up to 8 mm. PE data agreed well with the experimental results in terms of contact stress distributions.
Paper #189
COMPARISON OF POSTERIOR CRUCIATE RETAINED AND POSTERIOR STABILIZED TOTAL KNEE ARTHROPLASTY
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Purpose: The objective of this study was to compare the clinical results between posterior cruciate retained prostheses (CR type) and posterior stabilized prosthesis (PS type) of total knee arthroplasty (TKA).

Materials and Methods: A prospective and randomized study was performed on 57 osteoarthritic knees who underwent primary TKA (Nex Gen). CR group consisted of 30 patients. PS group consisted of 27 patients. All TKA were performed by the same surgeon. All of the patients were evaluated for the postoperative range of motion (ROM), clinical results (Knee score of JOA), the time course changes of postoperative flexion, extensor mechanism function and anterior knee pain. The results suggested that in obtaining the adequate central stability and control of the flexion and extension gap stability, spherically congruent surfaces allows suitable laxity and maintenance of contact stability of the contact pressure, and which lead to achieving a successful TKA whether PCL retain or not.

Results: Clinical scores had a mean of 27 out of 30 points in CR group and 0/110.6 deg in CR group and 0/123.7 deg in PS group (P<0.003) at one year. The final ROM (extension/flexion) was 0/110.6 deg in CR group and 0/113.4 deg in PS group (P=0.7060). In the changes of laxity, PS group showed significantly different compared to CR group at 6 month and 12 month flexion of 90° (P=0.0011) and 6 month and 24 month adduction (P=0.0075) postoperatively.

Discussion and Conclusion: Considering that all patients in this study have good clinical results, approximately 10 mm in AP displacement and around 4° laxity in coronal directions were considered as favorable laxity in LCS mobile bearing prostheses both PCLR and PCLS designs. The results suggested that in obtaining the adequate central stability and control of the flexion and extension gap stability, spherically congruent surfaces allows suitable laxity and maintenance of contact stability of the contact pressure, and which lead to achieving a successful TKA whether PCL retain or not.

Paper #190
IN VIVO LAXITY OF LCS MOBILE BEARING PROSTHESES: A RANDOMISED, PROSPECTIVE STUDY OF POSTERIOR CRUCIATE LIGAMENT RETAINING VERSUS SACRIFICING TOTAL KNEE ARTHROPLASTY
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Purpose: We performed the stress arthrometric study with telos arthrometer on 60 knees with total knee arthroplasty, to determine the both anteroposterior and abduction/adduction (Abd/Add) laxity and the changes of laxity at 6 month and 12 month and 24 month after surgery prospectively in vivo and to identify any association between these laxity and whether PCL retain or not using the LCS prosthesis.

Materials and Methods: Thirty knees had PCL retaining (PCLR) and 30 had PCL sacrificing (PCLS) prostheses. The selected patients had successful arthroplasties at least 6 month. Both AP displacement and Abd/Add were measured using a Telos arthrometer (Fa Telos, Medizinisch-Technische GmbH, D-6103 Griesheim, Germany) applying 150 newtons.

Results: All values were not significantly statistical different between PCLR and PCLS (P=0.05). In comparison of 30° and 90° flexion, PCLR group showed significantly different (P=0.0011) but did not PCLS groups (P=0.7060). In the changes of laxity, PCLR group showed significantly statistical different only comparison of 6 month and 12 month flexion of 90° (P=0.0034) and 6 month and 24 month adduction (P=0.0075) postoperatively.

Paper #191
AUTOLOGOUS PATELLA RECONSTRUCTION DURING TKA IN PATELLECTOMIZED PATIENTS. ISOKINETIC STRENGTH AFTER 6 TO 12 YEARS
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Background: Patellectomized knees perform poorly with respect to extensor mechanism function and anterior knee pain. The clinical outcome after total knee arthroplasty (TKA) in this group of patients is inferior to patients with a patella independent of resurfacing.

Purpose: To evaluate clinical long-term outcome, isokinetic strength and radiographic appearance of a neo-patella in TKA, which was reconstructed using autologous bonegraft.

Materials and Methods: In the period of 1990 to 1995, nine previously patellectomized patients with a mean age of 55 years (range: 38 to 67) underwent cementless Low-Contact-Stress TKA for osteoarthrosis of the tibio-femoral joint. One patient deceased 5 years post surgery. Mean follow-up was 8.9 years (range: 6 to 12). The autograft was taken in five cases from the iliac crest, in two cases from the posterior femoral condyle and in another two cases from the opposite patella at time of simultaneous bilateral TKA surgery. Evaluation included clinical investigation, specific patella score, radiographic analysis and isokinetic strength measurement at 60 degrees per second (Biodex).

Results: Clinical scores had a mean of 27 out of 30 points (range: 19 to 30) and mean isokinetic strength of knee extension reached 71Nm (81%) compared with the opposite site. One patient with bilateral patellectomy and unilateral TKA showed...
an increase of 50% strength (51Nm versus 77Nm) in the knee with TKA and neo-patella. Radiographs in three planes showed minor signs of neo-patella bone resorption in three cases, but evidence of retubeculation and bone remodelling in all neo-patelae.

Conclusions: Reconstruction of a neo-patella in TKA using autograft provides near to normal isokinetic strength, no evidence of considerable autograft resorption, excellent or good clinical outcome and high patient satisfaction after a mean of 8 years. The study provides encouraging data for reconstructing a neo-patella in TKA with autograft.

Paper #192
THE TCP III PROSTHESIS IN REVISION TKR
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The purpose of this study is two-fold:
1. to evaluate the overall results of revision surgery in the treatment failed TKR with the TCP III like prosthesis;
2. to analyze the results in different modes of failure: mechanical, infection and painful or stiff knee.

Material & Methods: Between 1985 till May 2001, 116 failed knees were managed. 91 underwent complete revision, 18 were arthrodesed, 6 underwent patella revision only and 1 arthrolysis. Among the complete revisions: 45 were due to mechanical failure (loosening, wear or instability) 30 for infection and 16 for painful or stiff knee. In 80 of them, the implanted prosthesis was TCP III or CCK and were evaluated in this study. 33 were males and 57 females. The average age at revision was 72 years. Most of the cases were performed by the senior author. All cases were osteoarthritic except one which was rheumatoid. The distribution of TCP II like prosthesis was as follows: 45 were TCP III, 33 were CCK and 2 dual. Half of the infected cases were treated by one stage and half by two stage surgery. Patella was not resurfaced but reshaped if patella bone stock was not adequate. Evaluation was performed with HSS score.

Results: Sixteen patients died and 13 patients could not be traced in the last follow-up. Only 91 cases could be evaluated. The preop HSS score was poor for all the patients. The average follow-up was around 8.1 years (range of 1-16 years). As compared to preoperative situation almost all of the patients were on the overall subjectively satisfied. The average overall postop score on F-U was 80. The average postop score was 83.4 for mechanical failure, 78.2 for infection and 76.5 for painful knee. Two infected knees died after 3 years and one died perioperatively. Three cases had to be revised for the second time to a rotating hinge prosthesis: 2 due to instability and one due to loosening. The average flexion range was 97.7 deg for mechanical, 88 deg for infection and 85.3 deg for stiffness. On the overall there were 12.6% complications and 6.2% of cases underwent second complete revision.

Discussion:
The TCP II like prosthesis proved in our hands to be a successful and acceptable implant in revision knee surgery. The new modular CCK design, although considered an improvement over the TCP III design mainly due to modularity and versatility of sizing didn’t prove to be clinically better in this series. The best results and flexion range were observed in failed knee due to mechanical failure.

Paper #193
SALVAGE REVISION KNEE ARTHROPLASTY SURGERY
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Salvage revision knee arthroplasty surgery is becoming more common. We reviewed the results of 36 patients who had previously undergone a minimum of 2 revision surgeries (Range 2-6) before presentation. Previous surgery involved the use of autografts, modular systems and insertion of other condylar systems. All were treated with a SMILES prosthesis and results at 3 and 5 years are presented.

In all cases the alternative had been to perform an above knee amputation. All patients were aware of the risks involved in such complex surgery.

At 5 years 76% of the prostheses are still in situ and have a mean KSS Knee Score of 65 and Function Score of 60.

We believe the hinged prosthesis has an important part to play in salvage revision knee surgery, when modular systems are failing.

Paper #194
A PROSPECTIVE, RANDOMISED STUDY OF AUTOGRAgT VERSUS FREEZE DRIED ALLOGRAFT BONE-PATELLAR TENDON-BONE IN RECONSTRUCTION OF THE ANTERIOR CRUCIATE LIGAMENT.
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OLVG, Amsterdam, NETHERLANDS

Introduction
Although autografts (B-PT-B or hamstrings) are mostly sufficient in ACL surgery, there is an increasing need for alternatives in case of impending donor side morbidity or revision surgery. We started this prospective, randomised study using the autograft B-PT-B versus a freeze dried, irradiated B-PT-B allograft. We wanted to evaluate the efficay of a freeze dried allograft B-PT-B (Tutoplast, Tutugen Medical, Inc) and compare this graft with an autologous B-PT-B graft. Approval of the mediical ethics committee was achieved and all patients gave their informed consent to participate.

Patients and Methods
Between January 2000 and September 2001 we included 19 patients with unilateral instability of the anterior cruciate liga ment. They were prospectively randomised to undergo a reconstruction with either a B-PT-B autograft (10 patients) or a Tutoplast B-PT-B allograft (9 patients). All patients underwent the same surgical procedure and the same postoperative rehabilitation protocol. An arthroscopic assisted ACL replacement was performed. The graft was fixed with biodegradable screws in both tunnels. The follow-up was 7 to 22 months and carried out by an independent bservor.

Results
The mean age in the autograft group was 26.8 years (8 men, 2 women). The mean age in the Tutoplast group was 34.5 years (6 men, 3 women). In the autograft B-PT-B group were more, but less serious complications, especially donor side morbidity in 6 patients, without any donor side morbidity in the Tutoplast allograft group.

Two of the nine patients with a Tutoplast B-PT-B reconstruction had 6 and 10 months post-op a rerupture. There is a tendency
of increasing laxity in time in the Tutoplast B-PT-B allograft, measured by clinical examination and KT-1000 test. One patient in the autograft group had a positive clinical Lachman test, as three in the Tutoplast group had. The KT 100 Knee Arthrometer (30 lbs) showed less than 2 mm side-to-side difference in 8 patients in the autograft group and 2-5 mm side-to-side difference in 2 patients. The side-to-side difference in the Tutoplast group was in 3 patients less than 2 mm, in 2 patients 2-5 mm and in 2 patient more than 5 mm (the failures not included). MRI-investigation showed less signal intensity of the anterior cruciate ligament reconstruction in the Tutoplast group compared to the autograft group.

Conclusion
Because of the high rate of serious complications and the increasing laxity in time of the Tutoplast B-PT-B allograft group, the B-PT-B autograft reconstruction is superior to the Tutoplast B-PT-B Allograft. Therefore we do not support the use of Tutoplast B-PT-B allograft for anterior cruciate ligament reconstruction.

Patient assessments of function and symptoms (PSAB and ACL PSAFU) demonstrated that allograft patients reported significantly better function than autograft patients at 1-2 weeks (p=0.006); estimate difference = 0.5, 95%CI = [0.14, 1.86]; 3 months (p=0.03) [estimate difference = 0.34, 95% CI (0.03, 0.64)], and 1 year (p=0.001) [estimate difference = 0.49, 95% CI = (0.19, 0.78)]. Allograft patients consistently over time reported that their knee had less effect on their activity level than the autograft patients (p=0.03).

In the SF-36 there was a consistent and significant finding of patient assessments of pain (PSAB and ACL PSAFU) that allograft patients reported significantly less pain at the 1-2 week visit (p=0.006), in the autograft group than in the allograft group at 1 week (p=0.0001) and at 6 weeks (p=0.0385). The pain subscale of the SF-36 demonstrated that significantly more pain was reported in the autograft group than in the allograft group at 1 week (p=0.014) and at 6 weeks (p=0.003).

Conclusion: This analysis of outcomes of ACL repair indicates that when autograft and allograft reconstruction outcomes are compared objectively, allograft patients have:

1. slightly more lax knees that do not increase over time,
2. less pain at 1 week and 6 weeks,
3. better function at 1 week, 3 months and 1 year,
4. less effect on activity levels at all time frames.
5. Patients from both groups have similar long-term outcomes.

Paper #196
ARTHROSCOPIC ACL RECONSTRUCTION USING FRESH-FROZEN ALLOGENEIC TENDONS – MORE THAN 10 YEAR FOLLOW-UP STUDY
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PURPOSE: To clarify the long-term clinical results of arthroscopic ACL reconstruction using allogeneic tendons, we have evaluated the subjective and objective symptoms, knee stability, X-ray examination, and thigh muscle strength.

MATERIALS AND METHODS: From 1986 to 1990, 125 patients who had undergone arthroscopic ACL reconstructions for its insuffi-
ciency using fresh frozen allogeneic tendons. Forty-eight patients who returned to our clinic to consent the follow-up examination at 10 years or later postoperatively were included in this study. There were 22 male and 26 female patients with the mean age of 20.9 years at the time of surgery. Forty-three of the patients had sustained their knee injury during sport activity. Five had undergone the operation within one month after injury and the remaining 38 were operated on at 1 month or later after injury. The Allogeneic bone plug-free tendons such as Achilles, tibialis anterior or posterior tendons were prepared as a single graft of 8 – 10 mm, arthroscopically introduced into the knee joint through a tibial tunnel to a femoral drill hole in the center of the ACL footprint. The graft was fixed using screw posts or buttons via two-incision technique. ROM exercise was started at 2 weeks. Partial weight bearing was allowed at four weeks, followed by full weight bearing at six weeks. Jogging was recommended at 5 months, followed by sports activity at 10 months. At followup, the patients were evaluated subjectively and objectively according to the IKDC evaluation form. Knee stability was measured by KT2000™ knee arthrometer. Osteoarthritic changes were assessed by weight bearing knee flexion X-ray, and thigh muscle strength was analyzed by Cybex II™ or Biodex™.

RESULTS AND DISCUSSION: There was no deep infection nor graft rejection. The graft rupture was noted in 2 patients during sports activity prior to the followup. ACL tear in the contralateral knee was seen in 2 patients. IKDC activity level was graded as level I in 83% at preinjury, 76% at 2 years, and 41% at ten years, showing trend of reduction in activity level over years because of social reasons including graduation from school, employment and so on. In subjective evaluation, twelve patients (27%) were graded as normal, 73% as nearly normal, and 0% as abnormal. Eleven patients (25%) reported knee pain during strenuous activity, and 5 patients (11%) had pain on rainy or cold days. The average anterior laxity difference between the involved knees and the contralateral ones was 1.8 ± 1.7 mm (mean ± S.D.). Thirty six patients (82%) showed 3mm or less of anterior laxity difference. X-ray examination demonstrated that PF joint space narrowing in 5%, medial FT joint space narrowing in 14% and lateral FT joint space narrowing in 34%. Joint space narrowing, spur formation, or subchondral bone sclerosis was seen in 88% of patients who underwent meniscectomy, and 19% of patients who had normal or repaired menisci. Isokinetic peak torque was 88% and 95% of the contralateral limb at 60 deg/sec in extension and flexion, respectively.

CONCLUSION: This followup study of more than 10 years provides the evidence that arthroscopic ACL reconstruction using fresh-frozen allogeneic tendons has long-term effect to stabilize the knee and to maintain the knee function without morbidity of harvesting autogenous tissues.

Paper #197
IN VIVO ASSESSMENT OF GRAFT-TUNNEL MOTION AFTER ACL RECONSTRUCTION IN A SHEEP MODEL: A FEASIBILITY STUDY OF SOFT-TISSUE RADIO STEREOMETRIC ANALYSIS (RSA).
Dietrich Pape, Homburg/Saar, GERMANY, Presenter
Romain Sel, Homburg/Saar, GERMANY
Frank Adam, Homburg/Saar, GERMANY
Dieter M Kohn, Homburg-Saar, GERMANY
Department of Orthopaedic Surgery, University of S, Homburg/Saar, GERMANY

Objective
An in vivo sheep model was used to examine the feasibility of RSA to quantify micromotions between an ACL graft (soft tissue) and the surrounding bony tunnel in order to evaluate osseous graft incorporation.

Methods
Unilateral ACL reconstruction using an autologous Achilles tendon graft and rigid button fixation was performed in 10 Merino sheep. A double-stranded graft with a diameter of 5 mm was used. In all sheep the tunnel diameter was 5 mm. For RSA measurements three radio-opaque tantalum markers (0.8 mm) were inserted in the deep layers of the graft. Six tantalum markers (1 mm) were inserted both in theibia and the femur, three markers around each bony tunnel and three in the cortex of each bone using a standardized pattern of distribution. RSA measurements were performed at different time points (immediately after the procedure, after 3, 6, and 12 weeks and six months). Six months after the procedure, the animals were euthanized.

Results
Serial RSA evaluation showed micromotions between graft and bony tunnel early after surgery. The accuracy of the RSA setup was 0.3 mm. Conventional radiography and macroscopic evaluation after dissection of the specimens confirmed that no soft-tissue markers were lost in the joint.

Conclusion
The insertion of the tantalum beads for soft-tissue RSA did not result in any intraarticular loss or loosening of the markers. RSA evaluation allows for highly accurate 3-D measurement of motion between tendon grafts and surrounding bone tunnel. In the future RSA might be useful to evaluate tendon/ligament-to-bone fixations in orthopaedic sports medicine.

Paper #198
THE EFFECT OF ADJUSTED REHABILITATION ON OSSEOUS LESIONS ASSOCIATED WITH ANTERIOR CRUCIATE LIGAMENT RUPTURE
Annunziato Amendola, Iowa City, IA, USA
William C Vezina, London, CANADA
Alexandra Kirkley, London, CANADA
Lorie Forwell, London, CANADA
Peter J. Fowler, London, CANADA, Presenter
University of Western Ontario, London, CANADA

PURPOSE:
A controlled, prospective study of 23 patients with anterior cruciate ligament (ACL) reconstruction within one month of injury to determine the effect of restricting axial loading on osseous lesions.

METHOD:
Twelve patients were randomized to a standard postoperative ACL rehabilitation program and 11 to an adjusted “non-axial loading” regime where axial - loading activities were replaced with cycling and pool exercises. All patients underwent plain radiography and bone scintigraphy with SPECT images pre-operatively and one year postoperatively. Clinical outcome was assessed using the Lysholm knee scale, the Mohtadi ACL-Quality of Life outcome measure (ACL-QOL), and the IKDC including KT-1000 arthrometer. A classification system for the osseous lesions was developed to grade the bone scan appearances of the “bone bruises”. Diffuse articular tracer uptake (DATU) was seen in a number of the one year postoperative bone scans and a grading system was also established for this entity.

RESULTS:
At one year the adjusted rehabilitation group had significantly better scores on the Lysholm and the ACL-QOL No differences
were found between groups for the remainder of the clinical outcome measures or in the extent of residual persistent bone bruising on bone scintigraphy. There were more patients in the standard rehabilitation group with DATU at one year surgery, but this was not statistically significant.

CONCLUSION:
No significant benefit of a restricted axial loading rehabilitation program was demonstrated.

SIGNIFICANCE:
Seventeen of 23 patients (74%) had evidence of osteochondral sequelae related to the site of initial bone bruising, one year after ACL reconstruction.

Paper #199
POSTERIOR CRUCIATE LIGAMENT RECONSTRUCTION USING ARTHROSCOPIC INLAY METHOD
Sang-Jae Kim, Seoul, KOREA, Presenter
Hyeung-Cyu Kim, Seoul, KOREA
Su-chan Lee, Inchon City, SOUTH KOREA
Nam-Hong Choi, Seoul, KOREA
Yong-Su Lee, Seoul, KOREA
Jae-Hoon Jeong, Kayang-shi, KOREA
Yonsei University College of Medicine, Seoul, KOREA

This article describes an arthroscopic posterior cruciate ligament (PCL) tibial inlay reconstruction using a specially designed cylindrical bone plug. Using an achilles tendon allograft, we used a 10-mm diameter coring reamer to prepare the bone block by making the cancellous cylinder perpendicular to the tendon. The thin cortical base of 2mm thickness is preserved in a semicircular fashion 2mm larger in radius than the cancellous bone plug. So the cortical base is attached to the tibial tunnel is made through the proximal anterolateral tibial center of the cancellous portion along the axis of the plug. The tibial tunnel is made through the proximal anterolateral tibial cortex to the posterior flat spot of the tibia 1 cm below the articular margin and just lateral to the midline. Two femoral sockets (8 mm socket for anterior bundle and 6 mm socket for posterior bundle) are made through the low anterolateral portal with the knee in 100° flexion. A looped wire is passed through the tibial tunnel. The end of the looped wire is extracted through the low anterolateral portal. An arthrotomy was made through this portal about 2.5 cm in length for graft extraction. The end of each bundle using No. 2 Ethibond sutures. Leading suture is placed at each end of the tendon. A 0.02 inch diameter wire is looped around each base of the bundles and enters the bone plug from the center of cortex and pass through to the center of the cancellous portion along the axis of the plug. The depth of the looped wire is extracted through the low anterolateral portal. An arthrotomy was made through this portal about 2.5 cm in length for graft passage. Leading strand of wire of the bone plug is then pulled back through the tibial tunnel, thus the 10 mm long cylindrical bone plug is seated into the posterior aperture of tunnel. The bone plug is fixed to the tibial tunnel by tightening the leading wire to the endowasher on the anterolateral tibial cortex. Femoral fixation is obtained by the following manner. The anterior bundle of the graft is fixed first by an absorbable interference screw with the knee in 90° flexion. The posterior bundle of the graft is fixed in the same manner, the screw is first inserted a few thread in 90° knee flexion, then the knee is flexed to 30° while the screw is tightened with a flexible screw driver. Proximal migration of the tendon tip can be achieved by tensioning the posterior bundle for tightened the bundle.

Paper #200
CHRONIC MEDIAL COLLATERAL LIGAMENT INSUFFICIENT KNEE WITHOUT CRUCIATE LIGAMENT INJURY
Shuji Horibe, Sakai, JAPAN, Presenter
Akira Mase, Fukuoka, JAPAN
Norimasa Nakamura, Sakai, JAPAN
Yoshiki Shizuki, Sakai, JAPAN
Tomoki Mitsuoka, Kashihara, JAPAN
Konsi Shino, Hahako, Osaka, JAPAN
Osaka Rosai Hospital, Sakai, JAPAN

INTRODUCTION:
In spite of a high healing potential of a torn medial collateral ligament (MCL), some cases show valgus instability, which is commonly combined with posterolateral rotatory instability. However, rehabilitation programs of chronic medial instability without any cruciate ligament injuries have not been conducted. In this study, we described the clinical features of chronic MCL insufficiency without any other ligamentous pathology, and outcomes of MCL reconstruction.

MATERIALS AND METHODS:
Between 1993 and 2000, eight patients with chronic medial collateral ligament without any cruciate ligament injuries were treated in our department. All patients had been injured during contact sports activities and visited other hospitals after their initial injuries. There were six males and two females with a mean age of 24 years (range, 18 to 27). Either Lachman test or posterior drawer sign was negative, and MR findings demonstrated that both cruciates and posterolateral structure were intact in all cases. Stress roentgenograms demonstrated that the mean side-to-side difference in the medial joint opening was 3 mm with a range from 2 to 6 mm at 0 degrees and 5 mm with a range from 4 to 8 mm at 20 degrees. For these patients, MCL was reconstructed with autogenous or allogeneic fascia lata. The interval from the initial injury to MCL reconstruction ranged from 8 months to 10 years. For outcome analysis, clinical evaluation by standard physical examination as well as with IKDC form was performed in all cases at two years after operation.

RESULTS
Superficial MCL remnants were variable. In four cases, it was scarred tissue in whole length. MCL near the femoral insertion site was like scarred tissue and the ligament near the tibial insertion site looked normal in four cases. Deep MCL were thin and lax in all cases. At follow-up, range of knee motion was full, with valgus stress test was negative in all cases. IKDC activity level was I in five cases and III in two cases. According to the subjective evaluation, six were normal and two was nearly normal. There was no radiological abnormality in any of the cases. Thigh atrophy was not found in any of the cases. Stress roentgenograms demonstrated that mean side-to-side difference in the medial joint opening was 0.4 mm at 0 degrees with a range from 0 to 1 mm. At 20 degrees of knee flexion, mean side-to-side difference was 1 mm ranging from 0 to 2 mm.

DISCUSSION
In this series, all the patients were engaged in contact sports, during which they were susceptible to valgus force. Repetitive valgus stress to the scarred tissue, which could be assumed weaker than normal tissue, might have caused the residual medial instability. Considering good outcomes in this series, MCL replacement by an autogenous or allogeneic graft is a reasonable choice for its insufficiency.

**The FDA has not cleared the drug and/or medical device for the use described in this presentation (i.e., the drug or medical device is being discussed for an “off-label” use).**
Objective:
To determine the pattern of meniscal and articular cartilage damage in subjects who sustained an injury to more than one knee ligament. An analysis was performed on prospectively collected data using the Multi-center Orthopaedic Outcomes Network (MOON) and first author’s databases on subjects who underwent surgery due to multiligamentous injuries.

Methods:
Physicians affiliated with the MOON group evaluated and documented intra-articular findings at the time of surgery which were subsequently placed in the database. Subjects were placed in groups determined by their combination of ligamentous injuries (ex: ACL/PCL, ACL/PCL/MCL). Findings documented for each group included: partial or complete meniscal tear as well as presence and location of significant chondral injury. Criteria for significant chondral defect was; any grade 2 involving 50% or more of condylar width, all grade 3, or all grade 4 lesions. Chondral injury was graded in severity on a 1-4 scale with 1=softening, 2=lissures/superficial damage, 3=fragmentation/deep partial thickness damage, and 4=exposed bone. Occurrence and pattern of meniscal and chondral injury were identified for each group and compared to the isolated ACL injury group. Groups with more than 10 subjects were compared against the ACL only group. Groups with less than 10 subjects were considered rare and presented in table form only.

Results:
Data was collected on 2208 subjects. A total of 13 groups were identified. All groups were mutually exclusive. The groups were: ACL only (2028), ACL/MCL (73), ACL/LCL (46), ACL/PCL (19), ACL/MCL/LCL (12), PCL only (10), ACL/PCL/MCL (8), PCL/MCL (3), ACL/PCL/LCL (3), MCL only (2), PCL/LCL (2), LCL only (1), and ACL/PCL/MCL/LCL (1). A total of 40% of all multiligamentous injuries were in the ACL/MCL group. The ACL/LCL group accounted for another 25%. Together, these two groups represented 2/3 of all multiligament injuries. The ACL/MCL and ACL/LCL groups were significantly different from the ACL only group in their rates of medial meniscal damage (P< 0.001 and P< 0.05 respectively). The ACL/LCL group was also significantly different from the ACL only group in its rate of lateral meniscus damage (P< 0.05). The ACL/LCL group had significantly higher rates of lateral femoral condylar as well as patellar damage than the ACL only group (P< 0.05). The ACL/MCL group had significantly lower rates of femoral condylar damage than the ACL only group (P< 0.05).

Conclusions:
Patients who undergo knee surgery for a ligament injury are most likely to have injured only their ACL. ACL/MCL, ACL/LCL, ACL/PCL, and ACL/MCL/LCL are the most common multiligament injury combinations. All other groups are more rare multiligament injury combinations. Those patients who injure more than one knee ligament follow unique patterns of intra-articular damage. The meniscal and chondral injury patterns were different for different ligament injury combinations. Further study of these intra-articular injury patterns will assist surgeons in better understanding the prognosis and treatment implications of specific multiligament injury combinations.
Sport specialization: struggle, gymnastics, track and field athletics, hockey. A back-external dislocation of a forearm - at 43 patients, back - at 17, external - at 7, an isolated dislocation of a radial bone - at 9, fracture-dislocations Montedgia - at 11. At 40 patients a dislocation of a forearm in a combination with a separation and infringement internal epicondyle humerale. The rational choice of a method of treatment has allowed to lead the basic stage of rehabilitation successfully. At “pure” dislocations the closed reposition and back plaster bandage for 14-15 days. At fracture- dislocations at 1 stage also reposition of a dislocation, then for 3-rd day after a trauma operative intervention.

The purpose - to reach full congruence articulate surfaces. Open osteosynthesis internal epicondyly humerale by Kirshner wires - at 40 patients, open reposition of the head of a radial bone and transarticular fixing its by Kirshner wires - at 7, open reposition of the head radial and intramedular osteosynthesis cubital bone a pin - at 11. Complex rehabilitation was carried out in full. Loading on injured cubital joint was resolved in 3-6 months after a trauma. Results of treatment for 1 year till 5 years at all 87 patients are investigated. Anatomo-functional parameters excellent and good. The sport forecast favorable. Stricly individual approach at treatment has completely justified itself.

Results: 41 injuries and 39 overuse syndromes were observed. 78% of injuries happened in competition, 12% in cycling training and 10% in spare time. Localisation were 13,6% head, 42% upper limb/shoulder, 24,2% thorax, 20,2% lower limb. 65,2% of athletes who participated in Division I athletics from 1988-2000. Fracture subjects were identified through the Sports Injury Monitoring System (SIMS) and through physician documentation in the athletic medical records. For each subject, type (fracture vs. stress fracture) and location of fracture, sport, gender, age, year in school, position, height, weight, and success of season were recorded. Statistics for fracture subjects participating in soccer were then examined independently. These independent variables were examined by univariate analysis.

RESULTS: From 1988 to 2000, 445 fractures were identified among the 5900 athletes participating in 13 collegiate sports. Of these, 76% were fractures and 24% were stress fractures. Men sustained 310 total fractures (69%). Soccer players sustained 52 total fractures (11.7% of all fractures). 46 were fractures and 6 were stress fractures. Excluding stress fractures, only football had more fractures than soccer. Two-hundred and eighty seven males and 189 females participated in soccer. Male soccer players sustained 65% of all soccer fractures (30 fractures, 4 stress fractures); female soccer players sustained 18 fractures (16 fractures, 2 stress fractures). Overall, the foot contributed the most total fractures (n=20, 38%), followed by the hand and ankle (n=7 each, 13%). Men most commonly sustained foot fractures (44%), followed by face and ankle (15%) each fractures. As in the male soccer players, foot fractures were the most common fracture in females (n=5, 28%). Overall, tibia fractures only contributed 0.08% (n=4) of total fractures. By type of fracture, stress fractures occurred most commonly in the foot (n=4, 67%). Soccer players had the 9th highest risk of sustaining a fracture per number of players per team (risk=0.039/player/team).

DISCUSSION: Though the research on fractures is extensive, a comprehensive study of the incidence and effect of fractures on collegiate athletes is clearly absent from the current literature. Our study provides insight into the current types of fracture injuries that occur in college athletics including soccer. Previously, reported data on soccer and fractures has been limited to tibia and fibula fractures. Despite these reports, our data suggests that foot fractures are the most common type of fracture and that stress fractures are relatively uncommon in soccer.
for both male and female athletes. Further research on foot fractures in these athletes is warranted. With an updated record of fracture incidence, protective gear, rehabilitation programs, and training regimens might be altered to ensure more safety for all athletes as well as an improved rate of return to sport for those who have sustained fractures.

**Paper #206**  
**HYPERMOBILITY IS COMMON, BUT NOT A PROBLEM IN MALE SOCCER – A PROSPECTIVE STUDY**  
Per Hilmič, Copenhagen S, DENMARK, Presenter  
Marie Hansen, Copenhagen S, DENMARK  
Pernille Wiedemann, Copenhagen S, DENMARK  
Jas Parner, Copenhagen S, DENMARK  
Lars Øhle, MD, Solrød, DENMARK, Presenter  
Amager University Hospital, Copenhagen, DENMARK

It is a widespread theory that male soccer players are not hypermobile and if so they will have an increased risk of injuries especially to the joints. The purpose of this study was to find the prevalence of hypermobility in male soccer and to evaluate if hypermobility represents an injury risk factor.

Material and Methods: 998 male adult soccer players were followed during an 8 month soccer season, after informed consent. Pre-season demographic information were collected and all players were examined by physiotherapists using Beighton’s hypermobility score. All injuries, injury mechanisms, types of injury and time lost from soccer were registered during the 8 month period.

Results: Using 4 of 9 Beighton-criteria the prevalence of hypermobility was 10.7% compared to 5% in the background population. The hypermobile players did NOT have more injuries than normals. The injury mechanisms and the types of injuries did not differ significantly from normals. We found a trend that more traumatic/acute injuries could be found among the hypermobile group, and more overuse injuries among the normals. No significantly different results were found using 5 of 9 Beighton criteria. Looking at hyperextension of the knees alone no significant differences in the number of knee injuries could be found.

Conclusion: Hypermobility is common among male soccer players and it does not seem to be an injury risk factor.

**Paper #207**  
**COMPARATIVE STUDY OF BOVINE AND HUMAN ROTATOR CUFF ANTHROPOMETRICS**  
Vidyadhar V Upasani, San Diego, CA, USA  
André Malnair, San Diego, CA, USA  
Robert A Pelovitz, San Diego, CA, USA, Presenter  
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The supraspinatus tendon in the human rotator cuff is a common site of injury in athletes. Suture anchor techniques are currently being used to reattach the tendon to the head of the humerus. The purpose of this paper was to study anthropometric similarities between the human and bovine shoulder to establish it as an anatomically similar, consistent, and cost effective model to test current rotator cuff repair techniques and to develop further advancements in the future.

Anatomical measurements and comparative analysis on fourteen freshly frozen 12-16 week bovine shoulders showed no statistical differences (p<0.05) with several human anthropometrics. These data include the average tendon thickness across the first 30 mm of the tendon (2.99mm, 3.10mm), the average tendon width (36.08mm, 35.40mm), and the pennation angle of the inferior muscle insertion into the tendon (15.14 degrees, 14 degrees). The measurements shown in parenthesis are averages for bovine and human shoulders, respectively. The bovine data were also found to have smaller standard deviations showing the bovine shoulder to be a more consistent model for research.

This model has definitive implications as a biomechanical model for future mechanical testing. The similarity of anatomic dimensions between bovine and human anatomy indicates a likely correlation for strain based deformations in both longitudinal and radial orientations. While volumetric data could not be compared to human information, width and thickness data indicate that stress distribution and the stress-strain response of the tissue should also be similar.

**Paper #208**  
**THE SUPRASPINATUS FOOTPRINT: A RATIONALE GUIDE FOR THE MANAGEMENT OF ARTICULAR SIDED PARTIAL THICKNESS SUPRASPINATUS TEARS**  
Wesley M Nottage, Laguna Hills, CA, USA  
Charles James Ruotolo, Huntington Station, NY, USA  
Marc Raymond Safran, San Francisco, CA, USA, Presenter  
The Sports Clinic, Laguna Hills, CA, USA

Management of articular sided partial thickness supraspinatus tears is controversial. Most management decisions rest on determining the thickness of tendon loss and location, without any clear guidelines as to how to make this determination. This study confirms the normal cuff thickness at its humeral head attachment, and correlates the amount of exposed bone at the “footprint” attachment of the supraspinatus as an accurate measurement of the amount of tendon loss.

Forty-eight cadavers with an average age of 71.5 years were examined. Specimens with full or partial thickness cuff lesions were excluded, leaving 17 specimens average age 70 for evaluation. The anterior to posterior width of the supraspinatus was measured with a caliper as well as the medial to lateral width at the interval, mid-tendon, and posterior limit. The distance from the articular cartilage margin to the supraspinatus tendon insertion was measured.

The mean AP dimension of the supraspinatus attachment was 25mm, the mean superior to inferior tendon thickness at the rotator interval was 11.6mm, 12.1 mm at mid-tendon, and 12mm at the posterior edge. The distance from the articular cartilage margin to tendon insertion was 1.3mm to 1.9mm, with an average of 1.7mm.

Articular partial thickness supraspinatus tears with >7mm of exposed bone lateral to the articular margin should be considered significant tears involving at least 50% of the tendon thickness. Arthroscopic measurement of the exposed bone between the articular margin and the supraspinatus tendon insertion (footprint) is an accurate way to estimate supraspinatus tendon tear depth and provides a rational guideline for clinicians to use.
**Paper #209**  
**EXPERIMENTAL STUDY OF HUMERAL AVULSION OF THE GLENOHUMERAL LIGAMENTS. CONSEQUENCES FOR SHOULDER INSTABILITY.**  
Nicole Pouliaert, Antwerp, BELGIUM, Presenter  
Olivier Gagey, le Kremlin-Bicêtre, FRANCE  
Institut d’Anatome, Paris, FRANCE

**Background:** Humeral avulsion of the glenohumeral ligaments (HAGL) is an infrequent cause of shoulder instability. Experimental studies on this lesion are rare.

**Material and methods:** In fourteen fresh cadaver shoulders a selective cutting sequence was performed. After each section an abduction-external rotation manoeuvre with axial compression and translation was carried out to provoke dislocation. The resulting instability was graded on a scale of five, ranging from no translation to a locked dislocation.

**Results:** Cutting of only the inferior glenohumeral ligament complex resulted at the most in increased translation, but not in subluxation. For subluxation to occur, at least the middle glenohumeral ligament needed to be cut. The entire humeral capsuloligamentous complex, from the inferior up to and including the superior glenohumeral ligament needed to be sectioned before subluxation or dislocation occurred. In half of the cases an additional lesion of the subscapularis or the latissimus dorsi is necessary to allow a locked antero-inferior dislocation.

**Discussion:** Extensive damage to the humeral side of the capsuloligamentous complex and, frequently, associated lesions of the subscapularis or latissimus dorsi muscles are necessary to allow dislocation. This might be the primary reason for the low incidence of HAGL observed in clinical series of shoulder instability.

**Results:** Cutting of only the inferior glenohumeral ligament complex resulted at the most in increased translation, but not in subluxation. For subluxation to occur, at least the middle glenohumeral ligament needed to be cut. The entire humeral capsuloligamentous complex, from the inferior up to and including the superior glenohumeral ligament needed to be sectioned before subluxation or dislocation occurred. In half of the cases an additional lesion of the subscapularis or the latissimus dorsi is necessary to allow a locked antero-inferior dislocation.

**Introduction:** Several studies have compared mini-open (MORCR) to open rotator cuff repair (ORCR). Arthroscopic RCR (ARCR) has encouraging short-term results. We sought to objectively compare early results between techniques in a prospective double-blind fashion.

**Methods:** 50 pts undergoing RCR were enrolled; 28 MORCR, 14 ORCR, 8 ARCR. 20 shoulders served as controls. Avg. pre-op RCT size was 12x20 mm; age of the RCT was consistent for groups.

**Outcomes:** Patients underwent physical examination and completed UCLA, L’Insalata, and ASES Shoulder questionnaires.

**Results:** Anatomic: Gray scale features documented well-marginated post-op. Results were blinded.

**Vascular:** Pts underwent Power Doppler sonography (PDS) of achieved UCLA, L’Insalata, and ASES Shoulder questionnaires. Outcomes: Patients underwent physical examination and complete UCLA, L’Insalata, and ASES Shoulder questionnaires. Vascular: Pts underwent Power Doppler sonography (PDS) of affected shoulders at 6mos (T#1), 3mos (T#2), and 6mos (T#3) post-op. Results were blinded.

**Anatomic:** Gray scale features documented well-marginated intrasubstance, partial or full-thickness defects, thinning of repair, location of anchors. Defects categorized according to Harrisman classification.

**Results:**

**Outcomes:** Ultrasound findings of a defect didn’t correlate with functional assessment and outcome at 1 year when compared to those without defect. UCLA, L’Insalata, and ASES score was 28.8, 80.6, and 81. ARCR did significantly worse at 6mos than ORCR or MORCR, according to questionnaire (p<0.05). Average of 2.2 anchors used in the ARCR group, 3.2 for MORCR, 5 for ORCR.

**Vascular:** There is a significant and predictable decrease in RC vascularity over time regardless of surgical technique. Average vascular score was 11.6/T#1, 8.3/T#2, 3/T#3, and 2.4 for controls. The most robust flow was at peritendinous region at each time; lowest vascular flow was at anchor site/cancellous trough. There was no significant difference in vascular score between RCR with a documented defect and those without.

**Anatomic:** 48% of pts were found to have a defect in the RCR at some point post-op. Defects were seen in 50% pts at T#1, 45% at T#2, and 43% at T#3. Majority of RC defects were classified as Type 1 B. Average defect size at each time point was 1 x 1 cm². 33% of asymptomatic controls were found to have a defect consistent with RCT, 7.6 x 7.1 mm.

**Discussion/Conclusion:**

Outcomes tools demonstrate consistently worse short-term result with ARCR compared to MORCR and ORCR. Whether or not poor short-term results are a function of surgical learning curve or whether result is dependent on number of suture anchors and subsequent suture strands crossing the repair is unclear.

**Paper #211**  
**ROTATOR CUFF REPAIR IN SPINAL CORD INJURY PATIENTS**

John E Zvijac, Coral Gables, FL, USA, Presenter  
Kathleen Beckett, Coral Gables, FL, USA  
John William Uribe, Coral Gables, FL, USA  
Matthias Rolf Schurhoff, Coral Gables, FL, USA  
Jeremy Blair Green, Coral Gables, FL, USA  
UHZ Sports Medicine Institute, Coral Gables, FL, USA

**Previous studies on the effect of rotator cuff tears on wheelchair bound patients concentrated on non-surgical treatment. We conducted a retrospective review to determine the effectiveness of surgical intervention of rotator cuff tears in spinal cord injured patients. Five male patients with rotator cuff tears confirmed by physical examination and magnetic resonance imaging, underwent rotator cuff repair. Two of eight shoulders were revisions. The patients were evaluated postoperatively using the American Shoulder and Elbow Surgeons’ Scoring System. These results were compared to preoperative functional assessment. Patients were given a subjective questionnaire to assess their overall experience. Postoperative range of motion improved in six of eight shoulders. Strength was increased in six of eight shoulders. Patients reported satisfaction with the results in seven of eight shoulders, and all five patients would recommend the procedure to other spinal cord injury patients. At recent follow-up seven out of eight shoulders returned to their pre-injury level of function. Surgery for spinal cord injury patients with rotator cuff tears can improve their functional capability and autonomy while reducing their pain. Compliance with the demanding postoperative rehabilitation is essential, therefore proper patient selection is crucial for optimal results.
EFFECTS OF INTRA-CLINICIAN REPEATABILITY

Volker Musahl, Pittsburgh, PA, USA, Presenter
Susan Moore, Pittsburgh, PA, USA
Patrick McMahon, Pittsburgh, PA, USA
Richard Debski, Pittsburgh, PA, USA
Musculoskeletal Research Center, Department of Orth, Pittsburgh, PA, USA

Objectives: Clinical exams translate the humerus with respect to the scapula and are utilized to diagnose glenohumeral joint instability. The objective of this study was to assess the repeatability of simulated anterior and posterior (a-p) drawer tests, and to determine intra-clinician repeatability in cadaveric shoulders with simulated rotator cuff (RC) forces. Therefore, a clinical exam was performed with and without orientation feedback.

Methods: Eight fresh-frozen human cadaveric shoulder specimens (50±6 yrs) were dissected free of all soft tissue except the RC tendons and the glenohumeral joint capsule. The scapula was mounted to a Plexiglas fixture and 13.3 N was applied to the RC tendons to simulate passive muscle tension. Translation of the humerus with respect to the scapula was recorded using a 6-degree of freedom (DOF) magnetic tracking device (The Bird, Ascension Technologies, Inc.). Sensors were rigidly fixed to the scapula and humerus and anatomical landmarks were digitized for description of joint motion. The starting position, which was determined using feedback from the magnetic tracking device, was defined with the humeral head centered in the glenoid cavity at 0° of external rotation with the humerus 60° abducted and aligned in the coronal plane of the scapula. The clinician performed an a-p drawer test at 0°, 30°, and 60° of external rotation by applying a manual maximum anterior/posterior load. For each specimen, the a-p drawer test was subsequently performed five times. Once in the starting position, the a-p drawer test was performed first without feedback from the technician and then with feedback. Feedback was defined as orienting the clinician for all rotational positions of the shoulder during the entire test. Statistical comparisons were made using a repeated measures ANOVA to compare the feedback exam to the non-feedback exam.

Results: The repeatability for the recorded kinematics of the a-p drawer test in the anterior direction was 1.7 mm for the feedback test and 3.3 mm for the non-feedback test. There was a significant difference (p<0.05) between the feedback and non-feedback tests for 30° and 60° of external rotation. For the posterior drawer test, the repeatability was 1.9 mm and 6.0 mm for the feedback and non-feedback tests, respectively. There were no significant differences (p>0.05) between the feedback and non-feedback tests for all tested external rotations. The repeatability for the abduction angle was 4.4° and for external rotations 4.1°, as compared to 3.7° and 10.2°, respectively for the non-feedback stage. These findings were significant (p<0.05) for the abduction angle and for all tested external rotations.

Conclusion: In this study, the repeatability of the a-p drawer test and the intra-clinician repeatability were determined. Significant differences were found for the repeatability of the clinical exam with and without feedback. However, the resultant translations showed significant differences only for two of three tested external rotational angles in the anterior direction and no significant differences in the posterior direction. The data obtained in this study suggest that the magnitude of anterior translation significantly changes with small changes in external rotation during the clinical exam. In the future, the kinematics recorded with this model will be replayed on a 6 DOF robotic manipulator in order to assess in situ forces in different capsular components.

ANTERIOR INSTABILITY FOLLOWING SHOULDER REPLACEMENT: CAUSES AND TREATMENT.

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Aim: We report the cause and results of treatment of anterior instability following shoulder replacement.

Material and Methods: Retrospective multicentre study of 51 patients presenting with anterior prosthetic instability. 42 cases were following primary replacement and 9 cases were following revision surgery. 29 (57%) patients had received a total shoulder replacement and 22 (43%) a hemiarthroplasty. 38 patients (75%) presented with a dislocation and 13 (25%) presented with painful subluxations. The initial indication for replacement was osteoarthritis in 29 cases, rheumatoid arthritis in 7 cases and a fracture in 15 cases. The instability occurred early (within 6 weeks) in 23 cases and late in 28, of which 7 were traumatic and 21 were atraumatic. Conservative treatment by reduction and immobilisation was performed in 16 cases and prosthetic revision in 35 cases. Clinical and radiographic follow-up averaged 41 months.

Results: Subscapularis rupture or incompetence was found to be the principal cause of anterior instability, occurring in 87% of cases. Technical errors in prosthetic placement were also found, such as prosthetic malrotation or an oversized head. Associated complications were common: glenoid loosening (24%), dissociation of the polyethylene from a metal-backed glenoid component (10%), infection (10%), humeral fracture (4%). The final Constant score averaged 54 points and 55% of patients were disappointed or dissatisfied. No shoulder was stable following conservative treatment. Prosthetic revision also gave disappointing results with a 51% recurrence of instability.

Conclusion: Anterior instability of a shoulder prosthesis is a serious complication due to the poor results following treatment. Failure of the subscapularis repair appears to be the principal cause.

PROSPECTIVE OUTCOME STUDY OF ISOLATED ARTHROSCOPIC DEBRIDEMENT FOR GRADE IV GLENOHUMERAL ARTHRITIS.

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INTRODUCTION: Management of glenohumeral arthritis has traditionally relied upon arthroplasty as the first surgical intervention. Recently investigators have attempted arthroscopy with capsular or bony procedures in the management of shoulder arthritis. The purpose of this study is to define the ability and time course of isolated arthroscopic debridement to provide improvements in pain and function among unselected patients with grade IV glenohumeral arthritis (DJD).

METHODS: Eighteen patients with shoulder DJD who failed conservative treatment and being considered for shoulder
arthroplasty (TSA) were prospectively studied. These patients underwent arthroscopic debridement and subacromial bursectomy of the shoulder. No patient underwent a capsulotomy/release, glenoidplasty, acromioplasty or osteophyte excision. Standardized data collection was performed pre-operatively and at regular post-operative intervals (including UCLA Shoulder Arthritis and ASES Standardized Shoulder Assessment Form, and full examination) at 2 weeks, 6 weeks, 3 months, 6 months, 1 year and annually thereafter. Post-operative data also included a self-assessment of subject satisfaction with the procedure and with change in pain level, change in pain medication usage and change in function as compared with pre-operative measures.

RESULTS: Twelve men and 6 women (average age = 64 years; range = 42 - 85) with severe pain and night pain comprised the study population. All were right hand dominant and 11 of the surgeries involved the dominant shoulder. These patients had shoulder pain for an average of 63 months (9 - 240), with the pain being described as severe for 20 months (6 - 60). There were no cases of post capsulorrhaphy or inflammatory arthritis. Pre-operative UCLA pain rating averaged 2.7, function 4.1, and total of 14, while ASES Standardized Shoulder Assessment function averaged 27. Radiographically, 15 patients had severe DJD as classified by Samilson, 2 moderate and 1 minimal. The one with minimal DJD had severe cuff arthropathy with penciling of the distal clavicle. Ten subjects had flattening of the humeral head by an average of 3.8mm. All patients had grade 4 chondral change of the glenoid, and 16 had grade 4 change of the humeral head. The rotator cuff was intact in 12, torn in 4 and partially torn in 2. The labrum was intact in 9, while 5 had unstable articular cartilage flaps and 6 had loose bodies. Assessment of synovitis was mild in 2, mild-moderate in 5, moderate in 9, and marked in 6. The biceps was normal in 6, torn in 3, partially torn in 7, inflamed in 1 and 1 had a type I SLAP lesion. There were no post-operative complications. Fourteen of 18 subjects (78%) were classified as good to excellent at an average of 24 months (12 - 50 months). Three patients were classified as poor at final follow up (1 underwent a TSA at 9 months). One patient underwent a repeat arthroscopic debridement at 37 months. Pain and function scores improved from the first visit as compared with pre-op, with maximal pain benefit (2.7 to 6.3) and overall UCLA rating (14 to 24) at 3 months, and maximal function improvement at 6 months. Pain improvement was noted in 60% of subjects at 2 weeks, and greater than 80% of patients thereafter, while patient satisfaction was over 80% at all visits except the 6 week visit. Satisfaction scale improved steadily and reached at plateau at 6 months. Functional improvement was small (UCLA from 4.1 pre-op to 6.7; ASES from 27 pre-op to 36).

DISCUSSION: Isolated arthroscopic debridement relieves pain in nearly 80% of patients with severe glenohumeral arthritis by 3 months and may provide relief for more than 4 years. Some improvement in function may be seen. Isolated arthroscopic debridement can be considered as a temporizing procedure that may be included in the algorithm of management of severe shoulder arthritis. This includes patients with large osteophytes, obliteration of joint space and flattening of the humeral head.

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**Paper #215**

**THE “HOURGLASS BICEPS”: ANOTHER CAUSE OF SHOULDER PAIN.**

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**Aim:**
We present a mechanical condition affecting the long head of the biceps tendon in which incarceration within the joint is an unrecognized cause of pain. This is caused by a hypertrophic intra-articular portion of the tendon that is unable to slide into the bicipital groove during elevation of the arm.

**Results:**
All patients presented with anterior shoulder pain and a loss of passive elevation of 10-200. A dynamic test at operation, involving elevation of the arm with the elbow extended, demonstrated incarceration of the tendon within the joint. This causes a characteristic buckling of the tendon and squeezing of the tendon between the humeral head and the glenoid. Constant score increased from 37 points pre-operatively to 77 points post-operatively.

**Discussion:**
1) The clinical sign of a loss of 10-200 of passive elevation, bicipital groove tenderness as well as the MRI/arthrographic finding of a hypertrophied tendon can alert the clinician to the possibility of an “hourglass biceps.”
2) Definitive diagnosis is made at surgery, either open or arthroscopic, demonstrating the incarceration and squeezing of the tendon within the joint when elevating the arm with the elbow extended (the “hourglass test”).
3) Simple tenotomy cannot resolve this mechanical block, and tenotomy with excision of the intra-articular portion of the tendon or tenodesis must be performed.
AIM OF THE STUDY:
To evaluate the results of arthroscopic resection of the superomedial corner of the scapular, using a new superior portal, in patients with a painful snapping scapular.

MATERIALS & METHODS:
An analysis was made of 10 patients who had arthroscopic resection of the superomedial corner of the scapula. There were 4 women and 6 men with a mean age 26.9 years (range 16 to 40). The average duration of symptoms was 53.2 months (range 12 to 154). X-ray and CT scans were normal. The patients were evaluated by questionnaire and clinical examination, and the results assessed by the UCLA rating score.

RESULTS:
Average follow-up period was 11.3 months (range 3 to 23). There were no post operative complications. The scapulothoracic crepitus disappeared in 2 patients, decreased in 7 patients and remained the same in 1 patient. The mean postoperative visual analog pain scale was 2.7. All felt the procedure to be worthwhile. On the UCLA score there were 4 excellent, 4 good and 2 fair results.

CONCLUSION:
Scapulothoracic arthroscopy using medial and superior portals is a safe procedure. Resection of the superomedial corner of the scapula reliably improves symptoms from the painful snapping scapula.