

# FINAL PROGRAM



**Combined Congress  
of the International  
Arthroscopy Association  
and the International  
Society of the Knee**



**27-31 MAY 1995**

**Hong Kong Convention  
and Exhibition**

**Hong Kong**



## WELCOME MESSAGE



On behalf of the International Arthroscopy Association and the International Society of the Knee, we extend a very warm welcome to everyone attending this Combined Congress meeting being held in the vibrant and bustling city of Hong Kong.

The Program Committee under the guidance of Chairman Dr. Roland Jakob, has put together an outstanding program that should prove to be interesting and informative to all program participants. We are very excited about the scientific sessions that span the interest of all orthopaedic surgeons. Equally exciting are the Key Note Lectures that feature the hottest topics in orthopaedic surgery, Pro-Con Seminars that allow discussion concerning various orthopaedic opinions, and Concurrent Instructional Courses that highlight the newest orthopaedic procedures. We have invited orthopaedic surgeons from around the world to complement the wonderful program. Please check the final program for topics, presenters and times of all presentations.

We would also like to thank Dr. K. M. Chan, our Local Host, for his efforts in co-ordinating the meeting and fabulous social events.

It is our sincere hope that all who attend the Combined Congress meeting will enjoy their stay in Hong Kong. We like to think of this meeting as the perfect time to renew old friendships, make new acquaintances and take home knowledge that will benefit not only you, but also your colleagues.

Welcome to Hong Kong.

Harold R. Eikelaar, MD  
1993–1995 President, IAA

Rene Marti, MD  
1993–1995 President, ISK

# 1993-1995 EXECUTIVE COMMITTEE



## IAA

- Harold Eikelaar, MD - President
- Gary G. Poehling, MD - First Vice President
- Craig D. Morgan, MD - Secretary
- Richard B. Caspari, MD - Treasurer
- David J. Marshall, MD - Immediate Past President

### At-Large Members

- Bertram Zarins, MD
- Gregory Keene, MD
- Giuliano Cerulli, MD
- Wilhelm Klein, MD
- Dieter Kohn, MD
- Kyosuke Fujikawa, MD
- Jung-Man Kim, MD, PhD
- Konsei Shino, MD
- G. P. Hermans, MD
- Barry Tietjens, MD
- Alfredo S. Panni, MD
- John Bergfeld, MD

Handwritten marks: 'y', 'x', and a bracket grouping G. P. Hermans, MD, Barry Tietjens, MD, Alfredo S. Panni, MD, and John Bergfeld, MD.



## ISK

- Rene Marti, MD - President
- Peter Fowler, MD - Vice President
- Richard Caspari, MD - Secretary/Treasurer
- Jan Gilquist, MD - Immediate Past President

### At-Large Members

- Giancarlo Puddu, MD
- Carl Wirth, MD
- Ponky Firer, MD
- John B. King, MD
- John Bergfeld, MD
- G. P. Hermans, MD
- Craig D. Morgan, MD
- Konsei Shino, MD

## 1995 IAA/ISK COMBINED CONGRESS PROGRAM COMMITTEE

- |                             |                                  |
|-----------------------------|----------------------------------|
| Roland Jakob, MD - Chairman | Ponky Firer, MD                  |
| K. M. Chan, MD - Local Host | Freddie Fu, MD                   |
| Paolo Aglietti, MD          | Greg Keene, MD                   |
| Paul Aichroth, MD           | Dieter Kohn, MD                  |
| John Bartlett, MD           | Gideon Mann, MD                  |
| Philippe Beaufils, MD       | Konsei Shino, MD                 |
| Rodolfo Carpignano, MD      | Rene Marti, MD (Ex-Officio)      |
| Ramon Cugat, MD             | Harold Eikelaar, MD (Ex-Officio) |
| Lars Engebretsen, MD        |                                  |

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## PRESIDENTS

International Arthroscopy Association  
1993–1995 — Harold R. Eikelaar, MD — The Netherlands

International Society of the Knee  
1993–1995 — Rene Marti, MD — The Netherlands

## PAST PRESIDENTS



### International Arthroscopy Association

1991–1993	David J. Marshall, FRACS	Australia
1989–1991	David J. Dandy, FRCS	England
1987–1989	Jan Gillquist, MD	Sweden
1984–1987	John B. McGinty, MD	United States of America
1982–1984	Isao Abe, MD	Japan
1978–1981	Robert W. Jackson, MD	Canada
1976–1978	Masaki Watanabe, MD (Deceased)	Japan



### International Society of the Knee

1991–1993	Jan Gillquist, MD	Sweden
1989–1991	Kenneth E. DeHaven, MD	United States of America
1987–1989	Professor Lamberto Perugia	Italy
1985–1987	Richard M. Tooth, MD	Australia
1983–1985	Jack C. Hughston, MD	United States of America
1981–1993	Professor Ian S. Smillie (Deceased)	Scotland
1979–1981	Professor Albert Trillat (Deceased)	France
1977–1979	Don H. O'Donoghue, MD (Deceased)	United States of America

## Continuing Medical Education Credit:

The Combined Congress of the International Arthroscopy Association, the International Society of the Knee and the American Academy of Orthopaedic Surgeons, sponsor the scientific presentations at the Combined Meeting.

The American Academy of Orthopaedic Surgeons is accredited by the Accreditation Council for Continuing Medical Education to sponsor continuing medical education for physicians.

The American Academy of Orthopaedic Surgeons designated this continuing medical education activity for 30 hours in Category 1 of the Physician's Recognition Award of the American Medical Association.

## Disclaimer:

The material presented at the Combined Congress of the International Arthroscopy Association and the International Society of the Knee meeting is for educational purposes only. The material is not intended to represent the only, nor necessarily best, method or procedure appropriate for the medical situations discussed, but rather is intended to present an approach, view, statement or opinion of the faculty that may be helpful to others who face similar situations.

The Combined Congress of the International Arthroscopy Association and the International Society of the Knee disclaims any and all liability for injury or other damages resulting to any individual attending this meeting and for all claims that may arise out

of the use of the techniques demonstrated therein by such individuals, whether these claims shall be asserted by physicians or any other person.

## FDA:

The Combined Congress of the International Arthroscopy Association and the International Society of the Knee further notes that the approval of the Food and Drug Administration (FDA), or national equivalent of its members from other countries, is required for procedures and drugs that may be considered experimental. Instrumentation and procedures presented at this meeting may not have received the approval of the appropriate Federal authority. The Combined Congress of the International Arthroscopy Association and the International Society of the Knee supports the use of techniques with the requisite government approval only.

## Disclosure:

Faculty is required to disclose whether or not they, or their department, received something of value from a commercial or other party that directly or indirectly relates to the subject of their presentation. This disclosure is indicated in the scientific program.

# IAA/ISK COMBINED CONGRESS

MAY 26-31, 1995

## MEETING AT A GLANCE

### Friday, May 26

Committee Meetings .....	8 AM-3 PM
Registration .....	1-5 PM
Board of Directors Meeting .....	3-6 PM
Poster Exhibit Set-Up .....	4-8 PM
Commercial Exhibit Set-Up .....	4 PM

### Saturday, May 27

Continental Breakfast .....	7 AM
Registration .....	7 AM-6 PM
Poster Exhibits .....	7 AM-6 PM
Commercial Exhibits .....	7 AM-6 PM
Video Theater .....	9 AM-1 PM
Opening Welcome .....	7:30 AM
Scientific Sessions .....	8 AM
Concurrent Instructional Courses .....	5 PM
Pro-Con Seminar .....	5:45 PM
Welcome Reception .....	7 PM

### Sunday, May 28

Continental Breakfast .....	7 AM
Registration .....	7 AM-5 PM
Poster Exhibits .....	7 AM-5 PM
Commercial Exhibits .....	7 AM-5 PM
Video Theater .....	9 AM-1 PM
Key Note Lecture .....	7:30 AM
Scientific Sessions .....	8:20 AM
Instructional Course .....	1:30 PM
Pro-Con Seminar .....	2:15 PM
First Business Meeting .....	3:15 PM

### Monday, May 29

Continental Breakfast .....	7 AM
Registration .....	7 AM-2 PM
Poster Exhibits .....	7 AM-2 PM
Commercial Exhibits .....	7 AM-2 PM
Video Theater .....	9 AM-1:00 PM
Key Note Lecture .....	7:30 PM
Scientific Sessions .....	8:20 AM
Concurrent Instructional Courses .....	11:10 AM
Pro-Con Seminar .....	11:55 AM

### Tuesday, May 30

Continental Breakfast .....	7 AM
Registration .....	7 AM-5 PM
Poster Exhibits .....	7 AM-6 PM
Commercial Exhibits .....	7 AM-6 PM
Video Theater .....	9 AM-1 PM
Key Note Lecture .....	7:30 AM
Second Business Meeting .....	8:20 AM
Scientific Sessions .....	9:50 AM
Instructional Course .....	11:30 AM
Pro-Con Seminar .....	12:15 PM
Scientific Sessions .....	1:50 PM
Instructional Course .....	4:40 PM
Pro-Con Seminar .....	5:25 PM
Evening Gala Farewell Banquet .....	7 PM
Dismantel Commercial Exhibits .....	6:30 PM

### Wednesday, May 31

Continental Breakfast .....	7 AM
Registration .....	7 AM-12 NOON
Poster Exhibits .....	7 AM-4:30 PM
Key Note Lecture .....	7:30 AM
Third Business Meeting .....	8:15 AM
Scientific Sessions .....	9:10 AM
Pro-Con Seminar .....	1:10 PM
Scientific Sessions .....	1:40 PM
Instructional Course .....	3:20 PM
Awards Presentation .....	3:50 PM
Program Closes .....	5 PM
Dismantel Poster Exhibits .....	5 PM

• Please note program participants and scheduled times are subject to change.

## SOCIAL EVENTS

### Saturday, May 27

Join us for the Combined Congress Presidents' Reception in the Hong Kong Convention and Exhibition Centre and admire the breath taking view of Victoria Harbour, Kowloon Peninsula, Kai Tak Airport and the mountains beyond. Take this opportunity to visit with your colleagues from around the world while enjoying Hong Kong's finest specialties and cocktails. Admission to this reception is included in the Congress registration fee.

### Tuesday, May 30

Be our honored guest at the Farewell Banquet to be held at the elegant and graceful Grand Hyatt. Tonight you will enjoy some of the great spectacles of Hong Kong's rich history. Your entrance fee to the Farewell Banquet is included in the separate banquet fee. Please make your reservations for this special banquet on the Congress Registration form located in the Preliminary Program.

# INTERNATIONAL ARTHROSCOPY ASSOCIATION

## John J. Joyce Award

In 1981, Dr. John J. Joyce, III, offered a prize for the best arthroscopy paper read during the Scientific Program of the 4th Congress of the International Arthroscopy Association in Rio de Janeiro and the 5th Congress held in London. With characteristic generosity, Dr. Joyce offered to endow a prize to be awarded at every IAA Congress. The IAA Directors accepted this offer, and named the prize the John J. Joyce Award. In 1974, Dr. Joyce was one of the founders of the IAA, and the author of numerous orthopaedic papers and chapters of books. Until the time of his death in 1991, Dr. Joyce continued to edit articles for the Journal Of Arthroscopic and Related Surgery.

A Committee will select the first, second, and third-place prize-winning papers from manuscripts presented at the 1995 Congress.

### *1993 Recipients*

Freddie Fu - USA  
M. M. Malek - USA  
Mitsuo Ochi - Japan

### *1991 Recipients*

Dieter Kohn - Germany  
Paul Marks - Canada  
Mark Rodosky - USA

### *1989 Recipients*

PH Neyret - France  
Craig D. Morgan - USA  
Konsei Shino - Japan

### *1987 Recipients*

Kevin Angle - Australia  
Dieter Kohn - Germany  
Konsei Shino - Japan

### *1984 Recipients*

Gregory Keene - Australia  
J. Y. DuPont - France  
D. J. Olgilvie Harris - Canada

### *1981 Recipients*

James Glick - USA  
Darrel Olgilvie Harris - Canada  
Terry Whipple - USA

## INTERNATIONAL SOCIETY OF THE KNEE

### Albert Trillat Young Investigator's Award

The International Society of the Knee (ISK) has established a young investigator's research award in memory of Professor Albert Trillat, past president and founder of the Society. Professor Trillat died April 1, 1988. The purpose of this award is to provide recognition for a young researcher who has done outstanding clinical laboratory research contributing to the understanding, care or prevention of injuries to the knee. The award consists of: \$3,000.00(US) honorarium, award certificate, presentation of the paper at the Congress, and possible publication in the American Journal of Sports Medicine. To be eligible, the young researcher must be under 40 years of age, and be the principal investigator of the research submitted. Manuscripts are reviewed by the ISK Executive Committee, which selects the winning paper. The award is formally presented during the Congress.

*1995 Recipient:* Robert La Prade, MD - USA

*1993 Recipient:* Bruce D. Beynnon - USA

*1991 Recipients:* Ulrich Bosh - Germany  
Werner Kasperczyk - Germany

*1989 Recipient:* Kevin Robert Stone - USA

# INTERNATIONAL ARTHROSCOPY ASSOCIATION

## Scholarship and Traveling Fellowship Awards

### LINVATEC SCHOLARSHIP AWARD:

1. Reimbursement of travel, hotel and miscellaneous expenses to attend the 1995 Combined Congress in Hong Kong.
2. A credit of up to \$7,500.00 (US) to purchase, on a one-time basis, any product contained in the current Concept Arthroscopy catalog, for use in hospital of choice.
3. The successful applicant will receive a one-year Associate Membership in the IAA, which included a one-year subscription to the Journal of Arthroscopic and Related Surgery.

### *1995 Winner*

Reha Nevzat Tandogan, MD - Turkey

### *1993 Winner*

Valdis Zatlars, MD - Latvia

### ACUFEX TRAVELING FELLOWSHIP AWARD:

1. Reimbursement of travel costs. Three week study to included an intensive didactic and cadaver study at the AAOS/AANA Orthopaedic Learning Center in Rosemont, IL and study at two other locations for one week each, to participate in hands-on clinical experiences with designated orthopaedic surgery instructors.
2. Per diem allowance and accommodations for three weeks' duration of Fellowship.
3. Waiver of registration fee to attend the 1995 Combined Congress meeting in Hong Kong.
4. One-year Associate Membership in the IAA, including a one-year subscription to the Journal of Arthroscopy and Related Surgery.

### *1995 Recipient*

Radovan Kubes - Czech Republic

## OPTIONAL TOURS & EXCURSIONS

Please note: times are subject to change.

### HALF DAY CITY SIGHTSEEING

**Depart 8:30 AM—Return 1:00 PM**

An excellent orientation tour—the City changes so rapidly that it will refresh “old memories” and delight “first timers.” Start with a Peak Tram ride up to Victoria Peak for a panoramic view of Hong Kong Island, Kowloon and the surrounding islands. Then visit picturesque Repulse Bay. Proceed next to the well known fishing village of Aberdeen to see the “floating community”—still very much a part of Hong Kong’s society. Here an opportunity to join a “Sampan” is available, allowing a “close up” view of waterborne life. Afterwards, take a short visit to a prestigious jewellery factory, where meticulous craftsmen fashion works of art from gold and gems.

### HALF DAY KOWLOON TOUR

**Depart 8:30 AM—Return 1:00 PM**

Enjoy a unique visit to “bird street” where Chinese gather to exhibit their pets. Next, visit the open-air jade market—possibly the most important jewel market in the eyes of the Chinese. Jade is held as more than a jewel. Traditionally, this stone is believed to possess special medicinal qualities and some say that astrological “lucky” signs are found in the jewel. At the jade market, special buying-and-bargaining codes have been created—these are kept secret from most outsiders. Watch the hands under the towels; each movement signifies a special price for the stone. While “real” jade is very expensive, other “real” jade is actually quite cheap and makes a perfect souvenir of Hong Kong. Along Reclamation Street are dozens of traditional shops, as well as a local food market. Stop at the amazing Wongtaisin Temple and have your fortune told, then enjoy a stop at one of Hong Kong’s largest Chinese Emporiums.

### HALF DAY SHOPPING TOUR

**Depart 9:00 AM—Return 1:00 PM**

Hong Kong is a shopper’s paradise and now with our exclusive SHOPPING SHUTTLES, those not as accessible places are but an air-conditioned coach ride away. Our shuttles first visit Kaisers Estates—home of Asia’s largest jewelry factory together with various other fine factory outlet stores including ladies’ designers clothing. Additional stops include a massive emporium for Chinese arts and crafts or the Duty Free shop.

### HARBOUR CRUISE

**Depart 9:00 AM—Return 11:00 AM**

Hong Kong’s lifeblood is its unique harbour and not to be missed is a cruise through the bustling main anchorage. See the unceasing marine activity and enjoy spectacular view of the sky-scrapers and mountains. The cruise is on an authentic style Chinese junk passing through a fascinating typhoon shelter with an amazing congregation of small crafts. Watch lighters and cargo being handled alongside oceangoing freighters and wharves at the Wanchai waterfront. Cross the highway to busy Hong Kong International Airport before returning by the new Tsim Sha Tsui seawall. Drinks will be served on board and bar facilities are available.

### LANTAU ISLAND MONASTERY TOUR WITH LUNCH

**Depart 9:00 AM—Return 4:00 PM**

A cruise by an authentic Chinese Junk through the Sulphur Channel, Green Island and Peng Chau Island before arriving at Silvermine Bay, Lantau. Two soft drinks will be served on board. On the island, transfer by coach to the Po Lin Monastery situated high in the mountains where a vegetarian lunch will be served by the monks. View Asia’s tallest and newest outdoor giant bronze Buddha situated high in the mountain. En route, stops are made at the Cheung Sha Beach, Shek Pik Reservoir and, Tai-O Fishing Village.

### FULL DAY MIDDLE KINGDOM AND OCEAN PARK TOUR

**Depart 10:00 AM—Return 4:00 PM**

A combination of 2 of Hong Kong’s most popular attractions:

**Middle Kingdom**—Walk through the history of China where a series of full size temples, shrines, street scenes, pavillions, pagodas, and palaces are re-created to show visitors what life was like in the thirteen dynasties. Enjoy Chinese cultural displays—opera, folk dancing, acrobatics and take a peep into Hong Kong’s early years.

**Ocean Park**—opened in 1972, the park is the largest Oceanarium in Asia. A fast 8-minute ride by cable car to the Headland gives you a glorious view of Repulse Bay, Deep Water Bay, Aberdeen and the South China Sea. Sealions, dolphins, sharks, penguins and killer whales are housed in simulated environments similar to their natural habitat and, at showtime, the world’s largest marina mammal theater provides exciting entertainment. Enjoy thrill rides—the exhilarating Rollercoaster, Spider, Space Wheel and Raging River are all here.

### FULL DAY MACAU EXCURSION

**Depart 8:00 AM—Return 5:00 PM**

A full day excursion to Portuguese Macau—the oldest European settlement in the Orient. A swift 60-minute jetfoil ride brings you to the Monte Carlo of the Far East. Visit the Old Fort, Penha Hill, the Bishop’s home along the Praia Grande, the ruins of the historic Church of St. Paul and the Macau Grand Prix race course. Stop at the Chinese Border gate for a glimpse of the Chinese border guards before proceeding to the casino. Leave Macau in the mid-afternoon and arrive back in Hong Kong and your hotel at approximately 5:00 PM. Passport is required. Transfers, jetfoil tickets, lunch and port tax are included. Macau visa—if required—is excluded. (Visitors wearing short pants/trousers are NOT allowed to enter casino)

### FULL DAY ZHONGSHAN EXCURSION

**Depart 7:00 AM—Return 7:00 PM**

Tour commences with an early transfer to the pier. Board a jetfoil/super shuttle ferry for a 60-minute journey. Arrive at Macau and a transfer-cum-sightseeing tour will be conducted before reaching the border gate of China. After brief immigration and customs formalities, proceed to the provincial town of Shiqi. En route, highlights include a visit to the former residence of Dr. Sun Yat-Sen, the founder of modern Chinese Republic, the Dr. Sun Memorial Secondary School and Shiqi People’s Commune. A Chinese lunch will be served at the Guest House Restaurant in Shiqi. Return in the late afternoon from Macau. Tour package includes transfers, lunch, China visa and jetfoil tickets. (Passport and health documents required. Passport details required 48 hours prior to departure for visa application.)

## GUANGZHOU (CANTON) DAY EXCURSION

(Daily) Depart 7:00 AM—Return 10:00 PM

Start with a 45 minute hovercraft ride to Shekou to visit a kindergarten (except Sundays and holidays) and a commune to see and experience the local life. After lunch at a local Chinese restaurant, a city tour of Guangzhou (Canton) is arranged. Visits include copies of terra cotta warriors from Xian, Yuexiu Park, Memorial Hall of Dr. Sun Yat Sen, National Peasant Movement Institute (run by Chairman Mao) and if time permits, visit Guangzhou Zoo to see the pandas—an endangered species—before taking the “through” train back to Hong Kong in the evening.

## 4 DAY BEIJING

Departure June 2

Visit Tiananmen Square and the Imperial Palace, the Temple of Heaven where the emperors of the Ming and Qing dynasties prayed to heaven for good harvest. After dinner, enjoy cultural shows (subject availability). Next day, visit to the Great Wall and the Ming Tombs, housing the tombs of 13 emperors of the Ming Dynasty. Dinner is the famous Peking Duck at a local restaurant. Tour Cost includes China visa fee, sharing twin accommodation at Swissotel or similar in Beijing, meals as specified in itinerary, sightseeing with English speaking guide, transfer airport/hotel/airport in Beijing and Hong Kong, and economy class air tickets HKG/PEK/HKG.

## 6 DAY BEIJING/XIAN

Departure June 2

(Please see description of 4 DAY BEIJING for sightseeing in Beijing). Xian city tour begins with the Great Mosque, Xian’s principal mosque and one of the largest and best preserved Muslim sanctuaries in China. A stop will be made at the Bell Tower which was built in 1384. Dinner at a local restaurant. Next day, view the astonishing army of life-sized terracotta warriors that have been standing guard by the tomb of the Emperor Qin Shi Huang Di for over 2,000 years. Travel to the Hua Qing Hot Springs, a former winter resort for emperors and an oasis of greenery and red-roofed pavilions set amidst the stark scenery of Xian. Proceed to the 6,000-years-old Banpo Village, the site of a neolithic community which practiced the Yangshao Culture. Dinner at a local restaurant. Tour Cost includes China visa fee, sharing twin accommodation at Swissotel or similar in Beijing, at Sheraton Hotel or similar in Xian, meals specified in itinerary, sightseeing with English speaking guide, economy class air tickets HKG/PEK/SIA/HKG and transfer hotel/airport/hotel in Beijing, Xian and Hong Kong.

## 6 DAY BEIJING/GUILIN

Departure June 2

(Please see description of 4 DAY BEIJING for sightseeing in Beijing). After arrival in Guilin, visit the spectacular Reed Flute Cave which can hold up to 1,000 people in its enormous chamber. Next day, have a scenic boat cruise down the Li-Jiang River to the small town of Yang Shuo. Along the route there is an endless change of spectacular scenery and colourful river traffic which ranges from one-man bamboo rafts to large junks plus an occasional wading water buffalo. In the afternoon, arrive Yang Shuo where you can have a stroll in the “Free Markets”. Then transfer back to Guilin by coach. Dinner included. Tour Cost includes China visa fee, sharing twin accommodation at Swissotel or similar in Beijing, Holiday Inn or similar in Guilin, meals specified in itinerary, sightseeing with English speaking guide, transfers hotel/airport/hotel in Beijing, Guilin and Hong Kong, and economy class air tickets HKG/PEK/KWL/HKG.

## SCIENTIFIC PROGRAM

All Scientific Sessions, Instructional Courses, Pro-Con Seminars, and Key Note Lectures will be held in Convention Hall I, II, and III of the Hong Kong Convention and Exhibition Centre.

Please note that the Program Schedule is subject to change.

Note: Names in **Bold Face** indicate Presenter.

### SATURDAY, May 27, 1995

7:00 AM	Registration Opens
7:00 AM	Continental Breakfast
7:00 AM	Poster Exhibits Open
7:00 AM	Commercial Exhibits Open
9:00 AM	Video Theater Open
7:30 AM	Opening Welcome

### SCIENTIFIC SESSIONS: IAA/ISK Research Seminar

Moderators: **Gary Poehling**  
**Per Renstrom**

8:00 AM **Paper #1**  
**Evan F. Ekman, Gary G. Poehling**  
“Compartment Pressures During Arthroscopy: An Investigation Using A Swine Model”

8:10 AM **Paper #2**  
**Kumta Shekhar, Kevin Yip, K. S. Leung, P. C. Leung, K. M. Chan**  
“Osteochondral Fracture Fixation: An Experimental Study With PGA Implants”

8:20 AM **Paper #3**  
**Antonio Delcogliano, Carlo Fabbriani, Salvatore Franzese, Antonio Caporaso, Camilla Sagarriga Visconti, Giulio Maccauro, Giovanni Lorini, Claudio Cappabianca**  
“X-Ray Microfocus, Sem, Fluorescent And Light Microscopy To Evaluate The Bone-Biomaterial Interactions”

8:30 AM **Paper #4**  
**Fergal P. Monsell, A. J. Long, D. W. Hukins, M. L. Porter, A. Redhead**  
“Evaluation Of Rotation And Translation As Components Of Knee Flexion”

8:40 AM **Paper #5**  
**Norinao Matsumoto, Shuji Horibe, Konsei Shino, Norimasa Nakamura, Akira Maeda, Yoshiki Shiozaki, Takao Senda**  
“The Effect Of Initial Tension On Remodeling Process Of A Transplanted Tendon Graft”

8:50 AM **Discussion**  
Moderators: **Hans-Ulrich Staubli**  
**Toru Fukubayashi**



9:00 AM Paper #6

A. Zschaebitz, H. Koepf, H. J. Gabius, E. Stofft

"Exploring The Biological Role Of Lectin Oligosaccharid Interactions In The Matrix Of The Anterior Cruciate Ligament"

9:10 AM Paper #7

Takashi Toyoda, Hideo Matsumoto, Kyosuke Fujikawa, Seiji Saito, Kazuhiko Inoue  
"Effect Of Tensile Load On Cultured Cells From The Anterior Cruciate Ligament Of Rabbits"

9:20 AM Paper #8

Karl Golser, G. Sperner, P. Seykora, C. Hauser

"Sensory Innervation Of The ACL And The Patellar Tendon"

9:30 AM Paper #9

Yukiyoshi Toritsuka, Konsei Shino, Shuji Horibe, Akira Maeda, Juro Nagano, Norimasa Nakamura, Norinao Matsumoto

"Effect Of Freezing Or Freeze-Drying With  $\gamma$ -Irradiation On Remodeling Process Of Tendon Allografts In A Rat Model"

9:40 AM Paper #10

Stephen H. Liu, J. M. Kabo, Gerald A. M. Finerman, Joseph Lane

"Mechanical Performance Of Endoscopic Anterior Cruciate Ligament Fixation Techniques: Comparison Of An *In Situ*-Setting, Injectable Bone Mineral Substitute and Metallic Devices"

9:50 AM Discussion

Moderators: Masahiro Kurosaka  
Harold Eikelaar

10:00 AM Paper #11

K. M. Chan, C. K. Li

"Healing Of The Patellar Tendon Donor Site After The Removal Of The Central One-Third—A Biomechanical And Biochemical Comparison Between "Close" And "Open" Procedure"

10:10 AM Paper #12

Moises Cohen, Rene Jorge Abdalla, Beno Ejnisman, Eduardo Abdalla Saad

"Experimental Radiographic, Histologic And Histochemic Study Of Human Menisci Cellularity And Vascularity"

10:20 AM Paper #13

Herman H. De Boer, Ewoud van Arkel

"Twenty Five Human Meniscus Transplantations—A Two To Five Years Follow-Up"

10:30 AM Paper #14

Alfredo Schiavone Panni, Carlo Fabbriani, Luciano Lucania, Guisepe Milano, Camilla Sagarriga Visconti

"Cryopreserved And Deep-Frozen Meniscal Allografts: An Experimental Study"

10:40 AM Paper #15

Yuji Tokunaga, Kyosuke Fujikawa, Hideo Matsumoto

"An Experimental Study On Partial And Total Meniscal Allografts"

10:50 AM Discussion

11:00 AM COFFEE BREAK

Moderators: TBA

11:30 AM Paper #16

Zhongnan Zhang, James A. Arnold, Tom Williams, Biff McCann

"Trephination And Suturing To Avascular Meniscal Tears—Animal And Clinical Studies"

11:40 AM Paper #17

Matthias Grothues-Spork, Wolfgang Noack, Manfred Bernard, Peter Hertel

"Laser Chondroplasty: Effects And Side Effects"

11:50 AM Paper #18

Christian Hendrich, Werner Siebert

"Mutagenic Risk Of Laser Application In Arthroscopic Surgery"

12:00 Noon Paper #19

Manfred Bernard, Matthias Grothues-Spork, Peter Hertel

"Reactions Of Meniscal Tissue After Laser Application—An In Vivo Study"

12:10 PM Paper #20

Gregory Keene, Dennis J. Edwards

"Osteo-Arthritic Changes Following Meniscectomy, Allograft Meniscal Transplantation And Autograft Transplantation"

12:20 PM Discussion

12:30 PM LUNCH BREAK

SCIENTIFIC SESSIONS: Shoulders

1:30 PM Albert Trillat Award Presentation

Robert La Prade

Moderators: Jium-Jer Wu

P. Timothy Keenan

1:40 PM Paper #21

Alfredo Schiavone Panni, Antonio Gigante, Giuseppe Milano, Luciano Lucania, Carlo Fabbriani

"Histological Analysis Of The Coraco-Acromial Ligament, Correlation Between Age-Related Changes And Cuff Tears"

1:50 PM Paper #22

Kenji Hayashida, Minoru Yoneda, Tomio Yamamoto

"Useful Physical Signs For Diagnosis Of The Painful Throwing Shoulder"

2:00 PM Paper #23

Hirota Sano, Yoshihiro Kato, Eiji Itoi, Shiro Tabata, Kenichi Haga

"MR Arthrography In The Assessment Of Anterior Soft Tissue Damage Of The Shoulder With Traumatic Anterior Instability—Comparison With Double-Contrast CT Arthrography"

2:10 PM Paper #24

Minoru Yoneda, Kenji Hayashida, Yasuo Shikinami, Konsei Shino  
"A Simple And Secure Anchoring System For Caspari's Transglenoid Multiple Suture Technique: The Use Of A Biodegradable Poly-L-Lactic Acid Button"

2:20 PM Discussion

Moderators: Robert Leach  
Eiji Itoi

2:30 PM Paper #25

Andreas B. Imhoff, Thomas Ledermann, Hansjorg Leu  
"The Use Of Holmium: Yag-Laser In Arthroscopic Subacromial Decompression—A Prospective Study"

2:40 PM Paper #26

Oliver Ruhmann, Dieter M. Kohn, G. Peters  
"Revision Surgery After Unsuccessful Arthroscopic Subacromial Decompression (ASD)"

2:50 PM Paper #27

Stephen C. Weber  
"Arthroscopic Debridement And Acromioplasty Versus Mini Open Repair In The Management Of Significant Partial Thickness Rotator Cuff Tears"

3:00 PM Paper #28

Michael Lehmann, Peter Habermeyer  
"The Rotator Interval Lesion—An Arthroscopic Approach"

3:10 PM Paper #29

Answorth A. Allen, Patrick Wong  
"Arthroscopic Release Of Refractory Capsular Contracture Of The Shoulder"

3:20 PM Discussion

3:30 PM COFFEE BREAK

**SCIENTIFIC SESSIONS: Shoulder, Elbow, Ankle**

Moderators: TBA CAS PARI  
WILLEMMS

4:00 PM Paper #30

J. F. Kempf, Philippe Beaufils, F. Bonnet, P. Gleyze, D. Mole, G. Walch, A. Frank  
"Arthroscopic Acromioplasty For Rotator Cuff Tears: A French Multicentric Study Of Two Hundred Ten Cases"

4:10 PM Paper #31

Brian Day, W. Regan, K. Stothers  
"Proximal Lateral Approach To Arthroscopy Of The Elbow Joint: Clinical Assessment Of A Safer Approach"

WITHDRAWN

4:20 PM Paper #32

Gideon Mann, Y. Matan, A. Finsterbush, U. Frankl, S. Ben-Gal, J. Lowe, M. Nyska, O. Eligshuv, M. Yahalom, A. Borowski, A. Soran, H. Yaakobi, N. Sharvit, S. Shimla, S. Suderer  
"Shoe And Insole Effect On Medical Complaints, Overuse Injuries And Stress Fractures In Infantry Recruits—A Prospective, Randomized Study—Preliminary Results"

4:30 PM Paper #33

Paul A. Dowdy, A. Amendola, B. V. Watson, J. D. Brown  
"Non-Invasive Ankle Distraction: Relationship Between Force, Magnitude Of Distraction, And Nerve Conduction Abnormalities"

4:40 PM Paper #34

Andre Frank, P. Cohen (Sore Band and Hartz (1980 IJJS))  
"Arthroscopic Treatment Of Osteochondral Lesions Of The Talar Dome"

4:50 PM Discussion

5:00 PM Concurrent Instructional Courses

J. Andrews, L. Pederzini and Niel van Dijk  
"Value Of Arthroscopy In Other Joints: Elbow, Wrist, Ankle"

Rene Marti and Philipp Lobenhoffer 501  
"Fractures Of The Knee"

5:45 PM Pro-Con Seminar

Paul Aichroth and Angela Smith  
"The Pediatric ACL—To Fix Or Not To Fix"

7:00 PM Welcome Reception

Hong Kong Convention and Exhibition Centre-Grand Foyer

**SUNDAY, May 28, 1995**

7:00 AM Registration Opens  
7:00 AM Continental Breakfast  
7:00 AM Poster Exhibits Open  
7:00 AM Commercial Exhibits Open  
9:00 AM Video Theater Open  
7:30 AM Key Note Lecture  
Carl Joachim Wirth  
"Cartilage Enhancement Methods"

*scapula, collar, clavicle, Coracoclavicular*  
*Fibula, Hydroxyapatite*  
*Bridgipadelli polymer*  
*(N. Eynon, J. Mea 331, 893, 895, et al)*  
*Mats Brittberg, 1994*

**SCIENTIFIC SESSIONS: Femoropatellar Joint**

Moderators: Jean Yves DuPont  
David J. Marshall

8:20 AM Paper #35

Scott Forsyth Dye, Steven Shifflett, Geoffrey Vaupel, Dante Pinto  
"An Unrecognized Aponeurotic Layer Anterior To The Patella"

8:30 AM Paper #36

Ilkka K. Kiviranta, Tiina Lyyra, Urho Vaatainen, Raija Seuri, Heikki Jaroma, Jukka Jurvelin

"General Softening Of The Knee Joint Articular Cartilage In Patients With Chondromalacia Of The Patella"

8:40 AM Paper #37

Joseph Lowe, Gideon Mann, S. Ben-Gal, A. Finsterbush, U. Frankl, Y. Matan  
"Anterior Knee Pain Syndrome: Prevention By Using A Knee Support With A Patellar Guiding Ring—A Prospective And Randomized Study"

8:50 AM Discussion

Moderators: Darn DuPlessis  
TBA *Philippe Beau filly*

9:00 AM Paper #38

Maurilio Marcacci, S. Zaffagnini, F. Iacono, A. Visani, M. P. Neri, A. Petitto  
"The Treatment Of Patella Recurrent Dislocation: Results After Thirty Years Follow Up"

9:10 AM Paper #39

Daniel Julio De Antoni, Maria Laura Claro, Ricardo Raul Janez  
"Lumbar Arthroscopic Discectomy"

9:20 AM Paper #40

Vladimir R. Bobic  
"Arthroscopic Osteochondral Autograft Transplantation In Anterior Cruciate Ligament Reconstruction: A Preliminary Clinical Study"

9:30 AM Paper #41

Diederick B. Wouters, Rudolf R. M. Bos, Eduard L. Mooyaart, James R. van Horn  
"Treatment Of Osteochondritis Dissecans, Using Biodegradable Pins And Screws—A Comparative Study In Goat Knees"

9:40 AM Paper #42 *no presented*

Holger E. Koepf, Albrecht Zschaebitz, Hans Gabius, Eckart Stofft  
"Correlative Arthroscopic And Histologic Evaluation Of Synovitis In Knee Joints"

9:50 AM Paper #43

Jon Minter, Peter J. Holzach, Peter Matter *food - vision - reduce - price*  
"Arthroscopic Assisted Treatment Of Lateral Tibial Plateau Fractures In Skiers"

10:00 AM Discussion

10:10 AM COFFEE BREAK

**SCIENTIFIC SESSIONS: Meniscus, ACL**

Moderators: Kenneth DeHaven  
Alex Finsterbush

10:40 AM Paper #44

Roland P. Jakob, M. Rueggsegger, R. Buhmann, M. Kowalski, D. Shelbourne  
"The Posterior Horn Of Lateral Meniscus Attachment To The ACL—A Proper Ligament With Clinical Relevance"

10:50 AM Paper #45

Peter J. Fowler, Paul A. Dowdy, A. Miniaci, Steven P. Arnoczky, D. R. Boughner  
"The Effect Of Immobilization On Meniscal Healing: An Experimental Study In The Dog"

11:00 AM Paper #46

Montserrat Garcia, Juan Jose Vazquez, Ramon Cugat  
"ACL And Compression Force On The Meniscal Posterior Horns"

11:10 AM Paper #47

Michel Bercovy, Eric Weber  
"Consequences Of Meniscal Tears On ACL Reconstructions"

11:20 AM Discussion

Moderators: Yoshi Koga  
Hans Paessler *R. CUGAT*

11:30 AM Paper #48

Akira Maeda, Shuji Horibe, Konsei Shino, Yoshiki Shiozaki *Japan*  
"Inherent 'Knee Laxity' Influences The Incidence Of The Meniscal Tear In Acute Anterior Cruciate Ligament Injury"

11:40 AM Paper #49

Shintaro Asahina, Takeshi Muneta, Haruyasu Yamamoto, Kohtaro Furuya *Japan*  
"Factors Affecting Healing Rate Of Arthroscopic Meniscal Repair"

11:50 AM Paper #50

Bengt Balkfors, Peter Thureson, Nils Westlin *Sweden*  
"Isolated Ruptures Of The MCL—Three Weeks In Plaster Versus Early Mobilization"

12:00 Noon Paper #51

Ramon Barredo, Ernesto Guerra *Sweden*  
"Anterior Knee Instability In Professional Soccer Players"

12:10 PM Discussion

12:30 PM LUNCH BREAK

1:30 PM Instructional Course

Gregory Keene and David Dejour  
"Patellar Pain And Instability"

2:15 PM Pro-Con Seminar

Peter Fowler, Roland P. Jakob, and B. Moyen  
"Synthetic Augmentation Of ACL/PCL"

2:45 PM COFFEE BREAK

3:15 PM First Business Meeting

## MONDAY, May 29, 1995

- 7:00 AM Registration Opens  
7:00 AM Continental Breakfast  
7:00 AM Poster Exhibits Open  
7:00 AM Commercial Exhibits Open  
9:00 AM Video Theater Open  
7:30 AM **Key Note Lecture**  
**Freddie Fu**  
"Meniscus: Meniscectomy, Repair, Transplant, None"

### SCIENTIFIC SESSIONS: ACL

- Moderators: **Rene Verdonk**  
**David Dandy**
- 8:20 AM **Paper #52**  
**Rene Jorge Abdalla**, Moises Cohen, Carlos Gorios, Luis R. Nakashima  
"Partial ACL Lesions: Clinical And Vascular Anatomic Correlation"
- 8:30 AM **Paper #53**  
**Robert L. Hole**, Emire Kamaric, David Lintner, J. Bruce Moseley  
"Increased Tibial Translation Following Partial Sectioning Of The ACL"
- 8:40 AM **Paper #54**  
**Ken-ichi Murase**, K. Ohtuka, H. Kakihana, M. Itou  
"Analysis Of The So-Called End Point Of Lachman Test"
- 8:50 AM **Paper #55**  
**Fredrik Nyquist**, Ingemar Onsten, Peter Thuresson  
"Anterior Cruciate Ligament Reconstruction, A Roentgen Stereophotogrammetric Analysis Of The Effectiveness Of Graft Fixation With Interference Screws"
- 9:00 AM **Discussion**  
Moderators: **Konsei Shino**  
**John Bartlett**
- 9:10 AM **Paper #56**  
**David A. McGuire**, F. Alan Barber, Burton F. Elrod, Lonnie Paulos  
"Use Of Bioabsorbable Interference Screws In Anterior Cruciate Ligament Reconstruction: Mid-Term Results"
- 9:20 AM **Paper #57**  
**Walter R. O'Brien**, Niklaus F. Friederich, Werner Muller, Charles E. Henning  
"Two-Dimensional Knee Kinematics After Anterior Cruciate Ligament Reconstruction: The Role Of Isometric Graft Placement"
- 9:30 AM **Paper #58**  
**Dieter M. Kohn**, T. Busche, J. Carls  
"Drill Hole Position In Endoscopic Anterior Cruciate Ligament Reconstruction—Results Of An Advanced Arthroscopy Course"

- 9:40 AM **Paper #59**  
**Manfred Bernard**, Peter Hertel, Heinrich Hornung  
"A Fluoroscopic Method For Intraoperative And Postoperative Control Of ACL-Positioning—Proximal Insertion"
- 9:50 AM **Discussion**  
Moderators: **P. J. Erasmus**  
**Rodolfo Carpignano**
- 10:00 AM **Paper #60**  
**Torbjorn Grontvedt**, L. Engebretson, O. Fasting, A. Molster, P. Benum, T. Strand  
"A Prospective, Randomized Study Comparing Three Surgical Procedures For Treatment Of Acute Anterior Cruciate Ligament Tears: Five Year Results"
- 10:10 AM **Paper #61**  
**Nicola Santori**, Lamberto Perugia, Pier Paolo Mariani, Ezio Adriani  
"Clinical And Radiological Comparison Of One And Two Incision Technique For Arthroscopic ACL Reconstruction With Patellar Tendon"
- 10:20 AM **Paper #62**  
**Christian Fink**, C. Hoser, K. P. Benedetto, P. Burkart  
"Long Term Results of ACL-Reconstruction—A Two Stage Follow-Up Study"
- 10:30 AM **Discussion**
- 10:40 PM **COFFEE BREAK**
- 11:10 AM **Concurrent Instructional Courses**  
**Giancarlo Puddu**, Philippe Beaufiles, and Francois Kelberine  
"Arthroscopic Treatment Of Joint Contractures—Knee, Shoulder, Elbow"
- Kazunori Yasuda and Savio Woo**  
"Biological/Biomechanical Aspects Of Ligament Healing"
- 11:55 AM **Pro-Con Seminar**  
**Peter Habermeyer and H. Resch**  
"Open Versus Arthroscopic Stabilization Of The Shoulder"

### FREE AFTERNOON

## TUESDAY, May 30, 1995

- 7:00 AM Registration Opens  
7:00 AM Continental Breakfast  
7:00 AM Poster Exhibits Open  
7:00 AM Commercial Exhibits Open  
9:00 AM Video Theater Open  
7:30 AM **Key Note Lecture**  
**Lars Engbretsen**  
"PCL And Posterolateral Reconstruction" *LCP. orthop. Trans 1987 34 PCL F/U 15 ans*
- 8:20 AM **Second Business Meeting**
- 9:15 AM **COFFEE BREAK**

## SCIENTIFIC SESSIONS: ACL

Moderators: **K. Fujikawa**  
**W. Wilhelms**

**9:50 AM Paper #63**

**Lamberto Perugia**, Pier Paolo Mariani, Ezio Adriani, Gaetano Maresca  
"Donor Site Problems After Patellar Tendon Harvesting For ACL Reconstruction:  
Tendon Defect Closure Or Not?"

**10:00 AM Paper #64**

**Peter Thuresson**, B. Balkfors, O. Johansson, R. Sandberg  
"ACL Reconstruction With The Patellar Tendon—Augmentation Or Not?"

**10:10 AM Paper #65**

**Dennis J. Edwards**, Gregory Keene  
"The Value Of Cold Compression After ACL Reconstruction" → *Placebo*

**10:20 AM Paper #66**

**Masayuki Hamada**, Konsei Shino, Tomoki Mitsuoka, Hiroaki Kinoshita  
"Cross-Sectional Area Measurement Of The Semitendinosus And Patellar Tendon  
Using MRI—As An Aid For Selecting Autogenous Graft For ACL Reconstruction"

**10:30 AM Discussion**

Moderators: **Glen Terry**  
**Wilhelm Klein**

**10:40 AM Paper #67**

**Kotaro Ikeda**, Toru Fukubayashi, Shigeru Hioki, Koichiro Hayashi, Mamoru Niitsu  
"Morphological Change Of Thigh Muscles After ACL Reconstruction Using The  
Semitendinosus And Gracilis Tendons"

**10:50 AM Paper #68**

**Stephen H. Liu**, J. Mike Kabo, B. Ferrel, Bryant Wiley  
"Limits Of Initial Mechanical Fixation For Two Types Of Bone-Tendon-Bone Grafts  
For ACL Reconstruction"

**11:00 AM Paper #69**

**Riko Nakajima**, Yuichiro Maruyama, Hiroyuki Nakajima, Katsuo Shitoto, Yasuo  
Yamauchi  
"Hamstring Muscle Strength After Arthroscopic-Assisted ACL Reconstruction With  
The Semitendinosus And Gracilis Muscles (STG)"

**11:10 AM Paper #70**

**Ponky Firer**  
"A Better Technique Of Reconstructing The ACL Using Hamstrings"

**11:20 AM Discussion**

**11:30 AM Instructional Course**

**Barry Tietjens**, **Thomas Rosenberg** and **Paolo Aglietti**  
"Patellar Ligament Versus Hamstring Grafts For ACL"

*Meeting Posters*

**12:15 AM Pro-Con Seminar**  
**Donald Shelbourne and Robert Johnson**

"Rehabilitation: Rapid Versus Regular/Scientific Versus Clinical"

**12:45 PM LUNCH BREAK**

## SCIENTIFIC SESSIONS: ACL, Hamstring, Rehabilitation, Complications, Posterolateral

Moderators: **Russell Tregonning**  
**TBA**

**1:50 PM Paper #71**

**M. A. Scherer**, G. Metak, K. Herfeldt, G. Blumel  
"Nervous Structures In The Anterior Cruciate Ligament"

**2:00 PM Paper #72**

**B. Fromm**, J. Graf, W. Kummer  
"Nerve Supply Of Anterior Cruciate Ligaments And ACL-Allografts"

**2:10 PM Paper #73**

**Konsei Shino**, Masayuki Hamada, Masao Tanaka, Yukiyoishi Toritsuka, Yoshito Matsui  
"In Vivo Direct Measurement Of Load Applied To ACL Grafts"

**2:20 PM Paper #74**

**Masahiko Imamoto**, Hideo Matsumoto, Kyosuke Fujikawa, Tsuyoshi Takeda,  
Nobuyuki Rokuuma  
"Motion Analysis Of ACL Deficient Knees In Walking, Jumping And Hopping"

**2:30 PM Paper #75**

**Werner E. Siebert**, F. Sommerfeld  
"Evaluation Of Functional Knee Braces By Dynamic Motion Analysis"

**2:40 PM Discussion**

Moderators: **Arthur Boland**  
**TBA**

**2:50 PM Paper #76**

**Paolo Aglietti**, R. Buzzi, R. De Felice, G. Zaccherotti  
"Results Of Surgical Treatment For Arthrofibrosis Of The Knee After ACL  
Reconstruction"

**3:00 PM Paper #77**

**Kurt-Alexander Riel**, Jakob Primbs, Erwin Hipp  
"Septic Knee Joint—Arthroscopic Irrigation And Long-Term Results"

**3:10 PM Paper #78**

**Robert F. LaPrade**, Glenn C. Terry  
"The Biceps Femoris Complex At The Knee: Its Anatomy And Injury Patterns  
Associated With Acute Anterolateral-Anteromedial Rotatory Instability"

**3:20 PM Discussion**

Moderators: **Brian Casey**  
**Craig Morgan**

**3:30 PM Paper #79**

**Jean-Luc Meystre, P. Trouilloud**

"Postero-Posterolateral Instabilities Of The Knee: Experimental Study Of An Extra-Articular System To Protect The Grafts"

**3:40 PM Paper #80**

**G. Metak, M. A. Scherer, C. Kaddick, G. Blumel**

"On The Significance Of The Popliteal System For The Knee Joint"

**3:50 PM Paper #81**

**Mitsuo Ochi, Kenji Kobayashi, Yoshio Sumen, Yoshikazu Ikuta**

"Does PCL Insufficiency Induce The Structural Change Of ACL Collagen Fibers?"

**4:00 PM Discussion**

**4:10 PM COFFEE BREAK**

**4:40 PM Instructional Course**

**J. Richard Steadman and Christopher Harner**

"Revision In ACL Surgery"

**5:25 PM Pro-Con Seminar**

**Gilles Walch and Ralph Hertel**

"Arthroscopic Or Open Subacromial Decompression"

**7:00 PM Evening Gala Farewell Banquet**

Grand Hyatt Hotel

## WEDNESDAY, May 31, 1995

**7:00 AM Registration Opens**

**7:00 AM Continental Breakfast**

**7:30 AM Key Note Lecture**

**Henri Dejour**

"Osteoarthritic Knee In The Middle Age: Osteotomies With/After Ligament Surgery"

**8:15 AM Third Business Meeting**

## SCIENTIFIC SESSIONS: PCL, Anesthesia

Moderators: **Iain McLean**  
**Peter Dobson**

**9:10 AM Paper #82**

**Melbourne D. Boynton, Barry R. Tietjens, William G. Raasch**

"Meniscal Injuries In The Isolated PCL Deficient Knee"

**9:20 AM Paper #83**

**John A. Bergfeld, Richard Edelson**

"Biomechanical Effects Of An Alternative Tibial Attachment Site In Bone-Patellar Tendon-Bone Graft Reconstruction Of The PCL"

Final Program

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Hong Kong

**9:30 AM Discussion**

**9:45 AM COFFEE BREAK**

## SCIENTIFIC SESSIONS: Anesthesia, Osteotomy

**10:20 AM Paper #84**

**Karl Peter Benedetto, W. Hackl, C. Hoser, C. Fink**

"Complications Of PCL Reconstruction By Using Anterior And Posterior Inter Muscular Approach"

**10:30 AM Paper #85**

**Inger Kjeldal, Birgitte S. Nielsen, Stig Lau Hansen**

"Postarthroplastica Analgesia With Intraarticular Morphine"

**10:40 AM Paper #86**

**M. D. Richardson, John Hart, A. Bjorksten, K. McCullough**

"Postoperative Knee Arthroscopy Analgesia: Two Prospective, Randomized, Double Blind Clinical Trials Designed To Evaluate The Efficacy Of Intra-Articular Morphine"

**10:50 AM Paper #87**

**Clarence L. Shields Jr., Patrick A. Ruwe, Irv Klein**

"The Effect Of Intra-Articular Injection Of MSO4 And Bupivacaine On Post-Arthroscopic Pain Control"

**11:00 AM Discussion**

Moderators: **Tomi Koshino**  
**TBA**

**11:10 AM Paper #88**

**Hiroyuki Shiozaki, Yoshio Koga, Go Ohmori, Hieaki E. Takahashi**

"The Epidemiology Of Osteoarthritis Of The Knee: A Fourteen Year Longitudinal Study"

**11:20 AM Paper #89**

**Shaw Akizuki, Yukihiro Yasukawa, Tsutomu Takizawa**

"Does Abrasion Arthroplasty Accelerate A Regeneration Process Of Eburnated Articular Surface?"

**11:30 AM Paper #90**

**Dae Kyung Bae, Bo Yeon Park, Moo S. Moon, Oh S. Kwon**

"A New Design Of Miniplate Staple For High Tibial Osteotomy"

**11:40 AM Paper #91**

**Philippe Hardy, Jerome Lemoine, Alain Lortat-Jacob, Jerome Benoit**

"Paralysis Of The Foot And Toe Extensors After Valgus Tibial Osteotomy"

**11:50 AM Paper #92**

**Carl Joachim Wirth, Djordje Lazovic, Thilo Busche**

"High Tibial Osteotomy Versus Unicompartmental Joint Replacement In Degenerative Knee Joint Disease"

**12:00 Noon Discussion**

Hong Kong

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Final Program

12:10 PM LUNCH BREAK

1:10 PM Pro-Con Seminar  
James Rand and Gregory J. Roger  
"Knee Prosthetics: Retain Versus Replace Patella"

### SCIENTIFIC SESSIONS: Total Knee

Moderators: Aki Hoshino  
TBA

1:40 PM Paper #93  
V. C. Mow, Gerard A. Ateshian, S. D. Kwak, W. W. Colman, J. H. Henry,  
R. P. Grelsamer  
"Anatomy Of The Human Retropatellar Articular Cartilage Surface: A Study Of  
Curvature Properties"

1:50 PM Paper #94  
Julian Feller, John Bartlett, Derek Lang  
"Patellar Resurfacing Versus Retention In Total Knee Arthroplasty"

2:00 PM Paper #95  
Philippe Beaufils, M. Hossenbaccus, J. P. Levai, J. P. Bouraly, DIOMED Group  
"Patellar Prosthesis Positioning With Reference To The Prosthetic Trochlea In  
TKR—A Roentgenographic Study"

2:10 PM Paper #96  
Marc F. Simondi, F. Lavaste, P. Beaufils, J. P. Bouraly  
"A Finite Element Model For The Assessment Of Joint Stresses In Two Typical TKR  
Designs"

2:20 PM Paper #97  
Arsi Harilainen, Jerker Sandelin, Pekka Ylinen, Veijo Vahvanen  
"Survival Analysis And Predictors For Failure In Unicompartmental PCA Knee  
Replacement"

2:30 PM Paper #98  
Hayden G. Morris, Rodolfo Capanna, Domenico Campanacci, Mario Campanacci  
"Endoprosthetic Reconstruction Of The Distal Femur And Knee After Resection For  
Bone Tumours"

2:40 PM Discussion

2:50 PM COFFEE BREAK

3:20 PM Instructional Course  
John Bergfeld, K. M. Chan, and Lamberto Perugia  
"Orthopaedics Around The End Of The Century—Economical Limits—  
Geographical Differences"

3:50 PM Awards Presentation  
Poster Awards, IAA John Joyce Award, IAA/Linvatec Scholarship Presentation

5:00 PM Program Closes

### COMPARTMENT PRESSURES DURING ARTHROSCOPY: AN INVESTIGATION USING A SWINE MODEL

Evan F. Ekman, and Gary G. Poehling

PURPOSE: The purpose of this study was to objectively evaluate the risk of compartment syndrome as a complication during arthroscopy.

CONCLUSION, SIGNIFICANCE, SUMMARY: Compartment syndrome as a complication of arthroscopy, particularly with the use of mechanical infusion systems, has been reported. Little or no experimental data is available. This study shows that when elevated compartment pressures occur in this model, extravasated fluid dissipates within a safe time period, minimizing the risk of compartment syndrome and subsequent neuromuscular damage.

METHOD: Twelve live pig hind limbs (6 swine) were used. One additional pig was used as a sham. After anesthesia and portal placement for mechanical fluid infusion, 2 standardized capsulotomies were created to allow free extravasation of fluid. We dynamically monitored intra-articular pressure, intra-compartmental pressure in the anterior (leg), deep posterior (leg), and quadriceps (thigh) compartments, and electrophysiologic function of the tibial and peroneal nerves. Data collection began at the onset of fluid infusion and continued after infusion ceased until elevated compartment pressures fell below 20 mm hg. There were 2 variables: intra-articular pressure (100, 150, or 200 mm hg) and time of fluid infusion (30, 60, or 90 minutes). Nerve and muscle biopsies were obtained 13–16 days post-op.

RESULTS: No significant correlation between infusion time and elevated compartment pressures or time to resolution could be made. While intra-articular pressure did correlate with two of the three compartment pressures, it did not correlate with time to resolution of the elevated compartment pressures. Most importantly, elevated compartment pressure resolved quickly after stopping fluid infusion and releasing the tourniquet (mean 28.5 minutes, range 0–100 minutes, n=36 compartments). Although EMGs on 2 of 12 samples showed 1+ fibrillations (1–4) scale, this was seen in the sham with tourniquet alone (no fluid infusion). NCVs demonstrated no evidence of permanent impairment. Finally, nerve and muscle biopsies showed no evidence of myonecrosis or permanent nerve dysfunction.

DISCUSSION: The data shows that using the model, the risk of developing sequelae from compartment syndrome during arthroscopy is minimal, even when there are significant fluid extravasation and elevated compartment pressures.

## OSTEOCHONDRAL FRACTURE FIXATION: AN EXPERIMENTAL STUDY WITH PGA IMPLANTS

*Kumta Shekhar M., M.D., K.M. Chan, FRCS,  
K.M.H. Yip, FRCS, K.S. Leung, FRCS, and P.C. Leung, FRCS*

Conventional metal implants may be unsuitable for the stabilization of osteochondral fractures as they may interfere with joint function and eventually require implant removal. We therefore compared the use of biodegradable implants with conventional metal ones in an animal experimental study.

**MATERIALS AND METHOD:** An osteochondral fracture was surgically created in the distal femur of adult rabbits. Biodegradable Polyglycolic Acid Pins 1.5 mm in diameter were used to stabilize this fragment in one group of 36 animals, while in another group 1.5 mm Kirschner wires were used. The animals were sacrificed at intervals ranging from 3 to 24 weeks. Satisfactory union of the fragments was noted in 92% of the cases with PGA implants as compared to only 50% of the metal implants. No implant migration was noted in the PGA implants while 100% migration was noted in cases fixed with K wires. Histological studies showed that in 80% of the cases fixed with osteochondral fractures the fragment was viable. In the metal group 33% of the osteochondral fragments underwent fragmentation and necrosis with a pannus covering the articular surface. There were no adverse reactions to the biodegradable implants.

In conclusion the use of biodegradable implants may allow stable fixation of osteochondral fractures without interference with joint function.

## X RAY MICROFOCUS, SEM, FLUORESCENT AND LIGHT MICROSCOPY TO EVALUATE THE BONE-BIOMATERIAL INTERACTIONS

*A. Delcogliano, C. Fabbriani, S. Franzese, C. Sagarriga Visconti,  
A. Caporaso, G. Maccauro, G. Lorini and C. Cappabianca*

**PURPOSE:** To compare, experimentally, various osteoconducting biomaterials, used as bone substitutes, with autogenous bone graft.

**SUMMARY:** In 60 NZW rabbits a bone lesion (1.2 × 0.5 cm) was produced in the right tibia. In Group A the lesion was filled in with tricalcium phosphate (TCP) and hydroxyapatite (HA), in Group B with HA + collagen Type I + chondroitin-4-sulfate, and in Group C with autologous bone. In the control Group the lesion was left empty. The rabbits were labeled sequentially with tetracycline, calcein and alizarin and sacrificed at 5, 8 and 12 weeks. The samples were subjected to standard and microfocus x-ray evaluation and then prepared for histological fluorescence analysis and SEM.

In Group A, 5 weeks after surgery the lesion was filled with fibrous tissue and newly formed bone. At 8 and 12 weeks newly formed bone filled the lesion completely. In Group B at 5 weeks there was a conspicuous inflammatory process with foreign body cells around the biomaterial. At 8 and 12 weeks, the inflammatory process had ended and the bone defect was filled in. In Group C at 8 weeks the lesion had completely healed. In the control Group at 12 weeks fibrous tissue was still present inside the lesion. Microfocus x-rays showed that in Groups A and B, at 5 weeks, there was a radiotransparent halo around the biomaterials. Already at 8 weeks in Group C and at 12 weeks in Groups A and B microfocus x-rays showed that the lesion had been completely filled in.

**CONCLUSIONS:** Our data suggest that biomaterials would be able to favor bone ingrowth, but this process is slower than that involving autogenous bone. Furthermore, the similar results obtained with morphologic and x-ray microfocus confirm the validity and reliability of this noninvasive assessment.

**SIGNIFICANCE:** The biomaterials studied can be used in orthopaedics to fill in bone defects. These biomaterials can be used also around prostheses to favour bone ingrowth, and in the ACL reconstruction with patellar tendon, to fill patella bone lesion. Real time microfocus x-ray may be considered a very inexpensive method for evaluating bone-biomaterial interface "in vivo" without sacrificing animals.



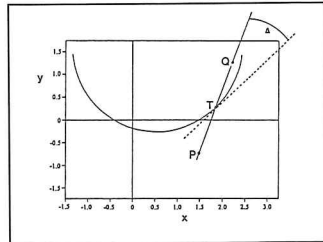
## EVALUATION OF ROTATION AND TRANSLATION AS COMPONENTS OF KNEE FLEXION

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We describe a technique of sagittal plane analysis that evaluates knee flexion in terms of rotation and translation. This method permits the pattern of motion to be expressed in numeric form.

Sequential radiographic images of five normal knees were produced between full extension and 120° flexion using fluoroscopic techniques. The trajectory of the mid-point of the tibial plateau (T) was calculated using a computer image analysis system with reference to a coordinate system defined by the position of the femur. In each case, a curve representing knee motion was produced using these points. The orientation of the tibial plateau at each point on this curve was used to investigate the type of motion at that point. If joint movement were pure rotation, the mid-point T of the tibial plateau (PQ) would be tangential to this curve. If there were an element of translation, there would be an angular discrepancy ( $\Delta$ ) between actual orientation of the tibial plateau and the tangent to the curve. The angular discrepancy between tibial plateau and tangent was calculated and plotted against flexion angle. In each case, a similar plot was produced, that demonstrated a deviation from pure rotation towards translation as the knee flexed. The gradient of the slope provided a reproducible index of its extent.

The overall pattern of knee motion may therefore be represented in terms of a single number that quantifies deviation from pure rotation. This permits an objective assessment of function and provides a valuable tool for future research.



## EFFECT OF INITIAL TENSION ON REMODELING PROCESS OF A TRANSPLANTED TENDON GRAFT

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During remodeling process of a transplanted graft, many factors are considered to affect graft maturation such as graft materials, graft placement, fixation method, post-operative treatment or initial tension. Yoshiya et al reported that the revascularization and degeneration of collagen matrix were affected by tension. Without this report, there was no recent study concerning the effect of initial tension on remodeling process of a transplanted graft. The purpose of our study is to investigate the influence of initial tension on a graft in terms of cellular invasion, collagen synthesis and collagen fibril profile.

**MATERIALS AND METHOD:** The lateral half of rat patellar tendon was harvested and frozen for more than one week. It was thawed at room temperature and transplanted as an isograft. The graft was transplanted to the defect of a patellar tendon either with physiological tension or with no tension. After sacrifice, the grafts were examined morphologically. Rhodamine phalloidine was used for detection of the actin cytoskeleton. For the evaluation of collagen synthesis, antibody against aminopropeptide of collagen type III was used. Collagen fibril profile was observed by using transmission electron microscopy.

**RESULTS:** Although the initial tension didn't affect cellular repopulation, it affected shape and alignment of repopulated cells, alignment of newly synthesized collagen fibrils, collagen fibril profile, and reorganization of actin filaments. Moreover, newly synthesized collagen fibrils are co-distributed well with actin filaments in both groups.

**DISCUSSION:** Our in vivo study suggested that actin filaments within the repopulated cells were reorganized by sensing the initial tension of the graft, and alignment of synthesized collagen fibrils were regulated by the actin cytoskeleton through the same mechanism as Ingber reported in vitro.

## EXPLORING THE BIOLOGICAL ROLE OF LECTIN OLIGOSACCHARID INTERACTIONS IN THE MATRIX OF THE ANTERIOR CRUCIATE LIGAMENT

*Albrecht Zschaebitz, M.D., Holger Koepp, M.D.,  
Hans J. Gabius, Ph.D., and Eckart Stofft, M.D.*

Biochemical data indicate that specific interactions between branched oligosaccharide sequences and endogenous lectins regulate connective tissue metabolism. Till now, the functional importance of this biological information system on the structural integrity of cruciate ligaments has not been determined. Therefore, the aim of the present study was to analyze the distribution patterns of specific glycoconjugate sequences and their corresponding carbohydrate receptors in normal and inflammatory altered tendon tissue.

**MATERIALS AND METHODS:** Healthy anterior cruciate ligaments (n=17) were dissected up to 9 h. postmortem. Inflammatory altered biopsies (n=21) were arthroscopically resected in patients with definite or classic rheumatoid arthritis. Specimens were subsequently fixed by immersion in formaline (4%) and embedded in paraffin according to standard methods. Binding patterns of 13 neoglycoproteins and of the endogenous lectins gallophitin, sarcolectin, and serum amyloid protein (SAP) were analyzed on serial sections. Results were compared with the expression of matrix proteins (e.g. fibronectin, tenascin, collagens I-VI) detected with monoclonal antibodies.

**RESULTS:** In the extracellular matrix of normal specimens only few gallophitin-positive receptors were detected. Expression was significantly enhanced in superficial layers of RA specimens. Sarcolectin revealed a similar reaction. However, its staining pattern was more evenly distributed in inflamed biopsies. In contrast, SAP-binding structures showed no significant alterations. Receptors binding terminal  $\beta$ -mannose were primarily detected in perivascular tissue. Galactose-6-phosphate positive structures dominated in tendon sheaths. Binding intensity as well as staining area of both carbohydrates was dramatically enhanced during inflammation. Affinity to terminal galactose-( $\beta$ 1,3)-N-acetylgalactosamin was restricted to zones of outstanding destruction. Fibronectin, SPARC, and tenascin also revealed significant alterations in RA specimens; however, no correlations were found between their distribution patterns and allocation of endogenous lectins.

**CONCLUSIONS:** This investigation indicates that the expression of oligosaccharide units of glycoconjugates as well as the distribution of endogenous lectins are characteristically altered in chronically inflamed ligaments. The functional significance of these modifications on biomechanical stability remains to be elucidated.

## EFFECT OF TENSILE LOAD ON CULTURED CELLS FROM THE ANTERIOR CRUCIATE LIGAMENT OF RABBITS

*Takashi Toyoda, M.D., Hideo Matsumoto, M.D., Kyosuke Fujikawa, M.D.,  
Seiji Saito, M.D., and Kazuhiko Inoue, M.D.*

**PURPOSE:** It is generally recognized that tensile load is an essential factor to maintain the homeostasis of the anterior cruciate ligament (ACL). However, its detailed mechanism is still controversial. The purpose of this study is to investigate the effect of tensile load on metabolism of the ACL experimentally.

**MATERIALS AND METHODS:** Cells obtained from both the ACL and synovium of 29 Japanese white rabbits were cultured on wells which had flexible silicone rubber bottom. Tensile load was applied to the cells by deforming the bottom by 80 mmHg vacuum force, and change in shape of each cell was measured two-dimensionally using image analysis. The cells were stretched most in the peripheral part of the culture well, where the maximum increase in area was 17%. The cells were then subjected either to a cyclic (3 seconds on/3 seconds off) load, or to a continuous load by 80 mmHg vacuum force for 24 hours. Collagen and DNA syntheses by the cells under the load were quantified with incorporation of  $^3\text{H}$ -proline and  $^3\text{H}$ -thymidine, respectively. The types of collagen synthesized by the cells under the load were analyzed using ELISA. Change in shape and that in alignment of the cells after 24-hour loading were also investigated under the light microscope.

**RESULTS:** The cells from the ACL under the cyclic load aligned perpendicularly to the direction of load, while those under the continuous load did not. Collagen synthesis increased significantly ( $p<0.05$ ) only in the cells under the cyclic load. As to the collagen types, the type I collagen synthesis increased significantly ( $p<0.01$ ), while no significant change was observed in the type III collagen synthesis. No significant change in DNA synthesis occurred either under the cyclic or under the continuous load. The cells from the synovium had similar change in the alignment but not in the collagen or DNA syntheses.

**DISCUSSION:** There have been no reports in the literature regarding the effect of tensile load on the cell metabolism in the ACL. In this study, the cyclic tensile load caused increase in collagen synthesis, particularly that of type I, and also change in the cell alignment. It was suggested that the cyclic tensile load to the ACL cells is one of the important factors for the regulation of the collagen synthesis in the ACL.

## SENSORY INNERVATION OF THE ACL AND THE PATELLAR TENDON

*K. Golser, G. Sperner, P. Seykora, and C. Hauser*

**PURPOSE:** This study aims to present a selective investigation of nociceptive nerve fibres in the ACL, the patellar tendon and patellar tendon autografts.

**MATERIAL AND METHODS:** Protein Gene Product is a neurotransmitter, that gives information about the overall innervation regarding all types of nerve fibres. Substance P and Calcitonin gene related Peptide (CGRP) are nociceptive neurotransmitters, therefore their presence in the soft tissue indicate sensory nerve fibres, that are responsible for pain transmission and reflex mechanisms.

Specimens of normal ACL and patellar tendon were obtained from a 25 year old multiorgan donor within one hour after detention of blood flow, as well as 3 patellar tendon autografts during revision surgery after rerupture. Each specimen was analyzed by both quantitative double immunoflourescopy to detect nociceptive nerve fibres histologically, and Radioimmunoassay to measure the concentration of neurotransmitters in the tissue.

**RESULTS:** Normal ACL presented with isolated nerve fibres at the femoral attachment and several fibres in the midportion and the tibial attachment. Central third of patellar tendon showed a twice higher number of nociceptive fibres than the ACL.

In patellar tendon Autografts between two and four years after implant only one isolated substance P nerve fibres in one specimen could be detected. In two autografts not a single nerve could be found.

### CONCLUSION:

1. Central third of patellar tendon shows a higher number of nociceptive nerve fibres than the ACL. Therefore this tendon could be more important for the proprioception of the knee joint than the ACL. This fact could explain the excessive loss of muscle volume in the quadriceps after harvesting this structure for ACL reconstruction.
2. Patellar tendon autografts do not regain reinnervation by nociceptive nerve fibres during their remodeling process. Therefore these autografts should not be able to play an active role in proprioceptive reflex mechanisms of the knee joint.

## EFFECT OF FREEZING OR FREEZE-DRYING WITH $\gamma$ -IRRADIATION ON REMODELING PROCESS OF TENDON ALLOGRAFTS IN A RAT MODEL

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Juro Nagano, M.D., Akira Maeda, M.D.,  
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**OBJECTIVES:** Freezing or freeze-drying with  $\gamma$ -irradiation is currently used for preserving allogeneic tendon grafts to reduce immune responses or to prevent disease transmission. Although changes in the mechanical properties following such treatments have been reported, it is still unknown how they affect the grafts' remodeling. In this study, we investigated effects of freezing or freeze-drying with  $\gamma$ -irradiation on remodeling process of tendon allografts in terms of collagen turnover.

**MATERIALS AND METHODS:** Bilateral patellar tendons labeled with  $^{14}\text{C}$ -proline in Lewis rats were harvested and split in half as grafts. Four experimental models were used: frozen at  $-80^\circ\text{C}$  (FF); freeze-dried (FD); frozen and irradiated at 2.5 Mrad (FFR); and freeze-dried then irradiated (FDR). The graft was transplanted to the lateral half of the patellar tendon in Wistar rats. Seven rats from each group were sacrificed at 2, 4, and 12 weeks postoperatively. The amount of hydroxyproline was assayed by Procop's method. The radioactivity level was measured using a liquid scintillation counter. Then the percentage of radioactive collagen was calculated.

**RESULTS:** The results were summarized in the table. Radioactive collagen decreased with time in all groups. Radioactive collagen in FD and FFR transiently became lower at 4 weeks compared with that in FF. When FFR and FDR were compared, radioactive collagen in FDR was significantly lower than that in FFR at 4 and 12 weeks.

**DISCUSSION AND CONCLUSION:** The results suggested that freeze-drying transiently accelerated collagen turnover of transplanted grafts at 4 weeks, and that  $\gamma$ -irradiation accelerated collagen turnover in freeze-dried grafts more than that in fresh frozen grafts. As grafts are assumed to be mechanically attenuated temporarily by rapid biodegradation or accelerated collagen synthesis, postoperative regimen should be changed depending on kinds of treatment for tendon allografts.

**Table:** Percentage of radioactive collagen

post-op	FF	FD	FFR	FDR	
2 wks	62±10	59±13	57±20	44±14	
4 wks	38±14	19±8	27±9	12±4	
12 wks	19±6	20±9	15±7	6±1	(Mean±SD)

**MECHANICAL PERFORMANCE OF ENDOSCOPIC ANTERIOR  
CRUCIATE LIGAMENT FIXATION TECHNIQUES:  
COMPARISON OF AN *IN SITU*-SETTING, INJECTABLE BONE  
MINERAL SUBSTITUTE AND METALLIC DEVICES**

Stephen H. Liu, M.D., J. Michael Kabo, Ph.D.,  
Gerald A.M. Finerman, M.D., and Joseph Lane, M.D.

**INTRODUCTION:** The use of interference screws with bone-patellar tendon-bone graft represents the gold standard for anterior cruciate ligament (ACL) reconstruction. The difficulty and morbidity associated with screw retrieval coupled with the creation of bony defects following screw removal in revision ACL has spurred the development of unique and less invasive alternatives. In an attempt to minimize hardware usage and fixation site morbidity, several fixation alternatives have been advocated for ACL reconstruction. The purpose of this study was to determine the potential clinical utility of an injectable, *in situ*-setting, structural bone mineral substitute for graft fixation during an endoscopic ACL reconstruction. The fixation strength and graft slippage using this bone mineral substitute (BMS) was compared to that of interference screws and endobuttons.

**METHODS:** Endoscopic ACL reconstruction with 10 mm diameter bone-patellar tendon-bone (BPP) or 8 mm hamstring tendon (HT) grafts were performed in 98 porcine knees. 20 intact ACL served as controls. The bone mineral substitute (Norain SRS™, Skeletal Repair System™, Mountain View, CA) is an injectable, *in situ*-setting, structural carbonated apatite that is crystallographically and compositionally uniquely similar to the mineral phase of bone. It hardens within minutes of injection and reaches 90% of its 55 MPa ultimate compressive strength within 4 hours. The fixation techniques included the following groups: 1) interference screws (IS) in both tunnels (BPP-IS); 2) BMS in both tunnels (BMS); 3) BMS in the femoral and IS in the tibial tunnel (Hybrid); 4) endobutton (EB). Utilizing the MTS-812, specimen were subjected to either increasing cyclic load (ICL) tests through a clinically relevant range of loads or tensile loads to failure (UTS). The ICL provides the amount of the graft slippage as a function of applied load (RD—residual displacement). The ultimate tensile strength (UTS) provides the reconstructions' ultimate strength. The mode and location of failure were documented for each specimen.

**RESULTS:** Data were analyzed with one way ANOVA and Kruskal-Wallis procedure for multiple comparisons. The graft slippage (RD) at 200N provides a measure of the functional behavior of the reconstruction. It presents the amount of slippage which could render the reconstruction non-functional. 3 mm and greater amounts of graft slippage have been correlated with unacceptable clinical results. The UTS and RD are 1265N and 0.1 mm for intact ACL, 587N and 1.3 mm for IS, 490N and 1.6 mm for BMS, 461N and 1.8 mm for Hybrid and 459N for endobutton. There were no significant differences ( $p < 0.05$ ) among the four fixation techniques for UTS, stiffness or energy absorbed to failure. No significant differences were found among IS, hybrid and BMS for RD, although the least RD was observed in the IS group. The IS group failed predominantly by bone plug pull out on either side. In the BMS group 70% exhibited primary failure on the tibial side. In the hybrid group, all failures occurred at the tibial screw fixation site. In the endobutton, all failures occurred at the tibial post fixation site.

**CONCLUSIONS:** These data demonstrate that BMS provided similar mechanical stability of an ACL reconstruction as did metallic interference screws. Hybrid specimen evaluation demonstrated that graft failure occurred at the tibial side (fixed with metallic screws) and not at the femoral side, clinically more difficult to access. The rheologic property of BMS permitting injectability allows introduction of a structural implant both for defect filling and graft stability via a significantly less invasive procedure. Additionally, this injectable, *in situ*-setting carbonated bone mineral substitute has been shown previously in a large *in vivo* canine study to provide an osteoconductive, biocompatible material for filling bone defects that can be remodeled into host bone.

**HEALING OF THE PATELLAR TENDON DONOR SITE AFTER THE REMOVAL OF THE CENTRAL ONE-THIRD—A BIOMECHANICAL AND BIOCHEMICAL COMPARISON BETWEEN 'CLOSE' AND 'OPEN' PROCEDURE**

*K. M. Chan, and C. K. Li*

Bone-patellar tendon-bone graft have been regarded as the gold standard for anterior cruciate ligament reconstruction. Complications such as fracture patella, rupture of patellar tendon and patellar tendinitis were reported from clinical studies after the use of the tendon graft. The aim of this study is to assess the healing of the patellar tendon donor site after the removal of its central one-third, comparing the 'close' and the 'open' method.

**MATERIAL AND METHOD:** Skeletal matured New Zealand rabbits were used as the animal model. In the 'close' group the patellar tendon was repaired side by side with 4-0 vicryl while the 'open' group was left alone. Rabbits were sacrificed in groups of fourteen at 2 weeks, 6 weeks, 6 months and 9 months post operation. Mechanical testings were performed on the bone-patellar tendon-bone complexes while biochemical tests were performed on the patellar tendons. The results were tabulated as follows:

**Table 1. Mechanical Testing**

	<b>Failure Load</b>	<b>Cross-sectional Area</b>	<b>Ultimate Stress</b>	<b>Stiffness</b>	<b>Energy Absorbed before Failure</b>
2 weeks Close	55.28%	157.11%	39.25%	65.40%	50.97%
2 weeks Open	69.47%	118.42%	58.32%	66.52%	60.03%
9 months Close	95.69%	125.17%	78.55%	77.48%	94.28%
9 months Open	92.92%	112.29%	82.83%	89.26%	89.46%

**Table 2. Biochemical Assay**

	<b>Water Content</b>	<b>Collagen Content</b>
2 weeks Close	149.95%	71.39%
2 weeks Open	168.67%	68.06%
9 months Close	117.69%	89.23%
9 months Open	117.56%	89.13%

**RESULTS:** There were significant differences ( $p < 0.05$ ) between the 'close' and the 'open' group at 2 weeks post operation. However, there were no significant differences ( $p > 0.05$ ) at nine months post operation. The patellar tendon donor site was significantly improved ( $p < 0.05$ ) from 2 weeks to 9 months. In conclusion, the donor site was weakened at 2 weeks and it has not completely healed at 9 months. On the other hand, the performance of the 'open' group was better than 'close' group especially at two weeks post operation. These findings may have a bearing on the intensity of rehabilitation and training in the clinical setting.

**EXPERIMENTAL RADIOGRAPHIC, HISTOLOGIC AND HISTOCHIMIC STUDY OF HUMAN MENISCI CELLULARITY AND VASCULARITY**

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**PURPOSE:** The aim is to study the human menisci cellularity and vascularity through an experimental study to understand the reason for differences in meniscal sutures results.

**METHODS:** From 75 fresh human cadaver knees, 150 menisci were divided in 4 segments each and analysed using contrast to radiographics, hematoxylin-eosin and histochemical methods. The age varied from 3 days to 67 years, divided in different groups. The radiographic and histochemical index of meniscal vascularity (RIMV and HIMV) were determined for each meniscal segment, enabling more accurate assessment of vascularity. The index was determined for cephalocaudal and radial sections and compared. By the H&E method were studied the cellularity in the four segments of each meniscus.

**RESULTS:** The vascularization was greatest in anterior and posterior horns of both menisci and the area of popliteal hiatus was very poorly irrigated, mainly in the adults. The cellularity is poor, the collagen content predominant. However, some blood vessels could be identified throughout the entire meniscus. No significant differences were observed in the different age groups.

**DISCUSSION:** The method is different from the majority of the literature because the authors studied the meniscus cellularity and vascularity in 4 segments in very different age groups and observed that they change but not with too significant differences.

**CONCLUSION:** The RIMV and HIMV are good parameters to evaluate the meniscal vascularity. The findings of H&E method about the matrix and cellularity must be considered and make us think about why, in vivo, some segments with poor irrigation heal when sutured.

**SIGNIFICANCE:** The cellularity and vascularity of menisci can be the key to understand the behavior of the healing in meniscus repair.

## 25 HUMAN MENISCUS TRANSPLANTATIONS, A 2 TO 5 YEARS FOLLOW-UP

*Herman H. de Boer, M.D., Ph.D., and Ewoud van Arkel, M.D.*

**INTRODUCTION:** In the situation after total meniscectomy and compartment osteoarthritis of the knee, there is a therapeutic problem. To find out whether meniscal transplantations in humans are possible, whether the allograft will grow to the knee capsule and to analyse the short-term results, the present prospective cohort study was performed.

**MATERIALS AND METHODS:** Between 1989 and 1992 25 cryopreserved non-tissue-antigen matched human meniscus transplantations were performed. Average follow-up was 36 (24–60) months. There were 19 males and 4 females. The lateral meniscus was transplanted in 16 cases, the medial in 5 and in 2 both the lateral and medial meniscus were transplanted in the same knee. Average age was 41 (30–55) years. Evaluation of the results was based on the history, physical examination and the modified Lysholm and Tegner score in combination with laboratory and radiological findings. 12 patients had a post transplantation arthroscopy with needle biopsy of the donor meniscus. Enzymen histochemical reactions, proliferating cell nuclear antigen and Ki-67 studies were performed to evaluate viability and growth potential of the graft.

**RESULTS AND CONCLUSIONS:** In 3 cases the transplantation failed (at 12, 20 and 24 months) and the graft was removed. 10 patients had good and 10 patients had fair results. Histology showed revascularisation of the graft. The growth potential seemed to be virtually nil. Focal areas of degeneration were noted, with vital cells around the microvascular supply and at the synovial side. Failure was probably caused by malalignment, causing abnormal pressure on the graft, leading to impaired revascularisation and loosening of the graft.

## CRYOPRESERVED AND DEEP-FROZEN MENISCAL ALLOGRAFTS: AN EXPERIMENTAL STUDY

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Giuseppe Milano, M.D., Alfredo Schiavone Panni, M.D.,  
and Camilla Sagarriga Visconti, M.D.*

The purpose of this study was the long-term evaluation of the morphology, cell viability and biochemical features of cryopreserved and deep-frozen meniscal grafts.

**MATERIALS AND METHODS:** In this study we used 30 Tibetan goats. In 15 goats the medial meniscus was replaced with a deep-frozen meniscus (Group 1). In the other 15 goats a cryopreserved meniscus (Group 2) was reimplanted. We implanted the meniscal graft with two 5 mm bone plugs, maintaining the attachments of the anterior and posterior horns. Post-operative follow-up was 2 weeks and 1, 3, 6 and 12 months. The meniscal allografts were morphologically evaluated using light and transmission electron microscopy. Biochemical analysis consisted of determination of proteoglycan concentration and water content. The tibial plates were also both morphologically and histologically evaluated.

**RESULTS:** The gross morphology of both groups of transplants was well preserved. The allografts healed at the horn attachments with complete incorporation of bone plugs, and at the peripheral capsular tissue with a fibrovascular scar tissue. At 2 weeks and 1 month, histological evaluation of the Group 2 menisci revealed necrosis with a marked reduction of viable cells; at this time in the Group 1 cells were present only in the periphery of the menisci. One year after transplantation, the histological aspects of the menisci of both groups were fairly normal, although areas of hypocellularity were still present at their centers. The articular cartilage showed mild degenerative changes. Biochemical studies revealed that the water content of the Group 1 menisci increased from 6% to 12% between the third and sixth months; a smaller increase, from 3% to 8%, was noted in Group 2. Both groups displayed a decrease in proteoglycan concentration as compared with controls.

**DISCUSSION:** The results of this study indicated that the meniscal allografts healed to the peripheral border of the joint by four weeks. After a period of avascular necrosis the grafts were repopulated with host cells, presumably from the synovium, and at six months after transplantation these cells resembled normal meniscal fibrochondrocytes. There were few long-term morphological differences between the two groups of transplants. No degeneration of the articular cartilage was seen after 12 months. However, the biochemical changes in water and proteoglycans content observed raise the question as to the long-term fate of these allografts.

**CONCLUSION:** Meniscal allografts, after 12 months, prevent degenerative changes in articular cartilage and seem to be a functional replacement for the normal meniscus. On the basis of our findings, transplantation of viable cells does not seem to improve results, and thus the deep-frozen technique seems to be preferable since it is simpler, less costly and allows unlimited storage of the tissue with a decrease in the risk of transmission disease.

## AN EXPERIMENTAL STUDY ON PARTIAL AND TOTAL MENISCAL ALLOGRAFTS

*Yuji Tokunaga, M.D., Kyosuke Fujikawa, M.D.,  
and Hideo Matsumoto, M.D.*

**PURPOSE:** Both partial and total meniscal allografts were carried out experimentally using dogs, and the viability of meniscal allografts was investigated.

**MATERIALS AND METHODS:** Fifty-four mongrel dogs were used. They were divided into Group T and Group P. In Group T (18 dogs), the medial meniscus was totally removed and was replaced by that harvested from another dog. In Group P (36 dogs), two-thirds from the free margin of the medial meniscus was partially removed and was replaced by an allograft of the same size. The dogs were sacrificed at 2, 4, 8, 12, 24 and 48 weeks after operation, and the transplanted menisci were examined with light microscopy (LM), scanning electron microscopy (SEM) and transmission electron microscopy (TEM).

**RESULTS:** Union of the transplanted meniscus occurred histologically in 100% of Group T (9/9) and 72.2% of Group P (13/18) at 12 weeks or more. SEM examination revealed that the collagen fibers were randomly oriented initially and gradually became aligned in both Groups, but the realignment occurred more slowly in Group P. However, in both Groups, even 48 weeks postoperatively, the alignment of the collagen fibers was dissimilar to that observed in the normals. TEM examination showed that the density of the collagen fibers increased with time in both Groups, but it occurred more slowly in Group P.

**DISCUSSION AND CONCLUSIONS:** Few experimental studies have been carried out previously on partial meniscal allograft. From this study, the following conclusions were made:

1. A longer time was required to obtain union in partial allograft than total allograft.
2. Although union occurred with both partial and total allografts histologically, its micro-structure was different from that of the normal meniscus even 48 weeks after the operation.

## TREPHINATION AND SUTURING TO AVASCULAR MENISCAL TEARS—ANIMAL AND CLINICAL STUDIES

*Zhongnan Zhang, M.D., Ph.D., James Arnold, M.D.,  
Tom Williams, Ed.D., and Biff McCann, M.D.*

Injured meniscus should be preserved as frequently as possible due to its vital function to the knee joint. Suturing and trephination have been developed to deal with injury in avascular area of meniscus. What is the role of trephination or suturing in repair of the injury and what is the best method to encourage revascularization of avascular tears of the meniscus? Animal and clinical studies were undertaken to compare trephination plus suturing with suturing alone.

**METHODS, RESULTS, AND DISCUSSION:** Trephination plus suturing compared with suturing alone were investigated of longitudinal injuries to the avascular area of the medial meniscus in 20 goats. Samples were studied at 3, 8, and 25 weeks respectively. [<sup>3</sup>H]-Thymidine was injected into the joint 72 hours before the sample was taken. All 20 tears treated by trephination plus suturing were totally (4 samples) or partly healed (16 samples). Average tensile strength was 40.4 kg/cm<sup>2</sup> of the healing tissue at 25 weeks. Activity of DNA synthesis and the tissue ingrowth decreased with time. Normal and mature collagen fibers were noted at 25 weeks. Three of the injuries treated by suture alone were partly healed and the remainder showed no gross evidence of healing ( $p < 0.01$ ). DNA synthetic activity was found in the chondrocytes of only the sutured menisci. The mature collagen in the lesion at 25 weeks may possess structure and properties of a normal meniscus. Clinically, thirty-six patients with the meniscal tears underwent arthroscopic trephination plus suturing (T-S group) and 28 patients had suturing alone (S group). The average age is 22 years and average follow-up is 25 months. One re-tear has occurred in T-S group and 7 re-tears in S group ( $p = 0.001$ ). Suturing alone may stabilize the tear and stimulate the cell's proliferation for the healing process, but not enough to heal the injury without blood supply. Trephination with suture rather than suturing alone may significantly improve the healing of the tear and be a choice for surgeons to treat this lesion.

## LASER CHONDROPLASTY: EFFECTS AND SIDE EFFECTS

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Manfred Bernard, M.D., and Prof. Peter Hertel, M.D.

This study was performed to determine the effects of lasers on the cartilage and adjacent structures during arthroscopic Laser chondroplasty. The Ho:YAG Laser, the Nd:YAG Laser (1064 nm and 1440 nm), the CO<sub>2</sub> Laser and the Excimer Laser were used for chondroplasty and abrasion arthroplasty in the knees of mature pigs, with an average weight of 100 kg. 72 knees were operated, 12 with each Laser system and 12 with conventional arthroscopic instruments. 3 animals of each group were sacrificed directly postoperatively, 2 weeks p.o., 6 weeks p.o. and 3 month p.o. All knees underwent MRI evaluation and gross pathological examination, then specimen for histological and scanning electron microscopic evaluation were taken. The findings were analysed and compared to each other.

The study shows the advantages and disadvantages of the applied Laser systems. It points out the effects and the adverse effects of the different Laser systems and explains why any laser systems must always cause unwanted effects.

It was found that all Laser systems used caused greater necrosis than the conventional operating technique. The Nd:YAG Laser, 1064 nm, caused the largest necrosis of all systems; the necrosis extended deeply into the subchondral bone. The Excimer laser showed to damage cartilage surfaces, far from the irradiated site. The operating times using lasers always were longer than those of the conventional operation. Further on could be shown, that the extent of the thermal damage could only be determined once a certain period of time had passed, for the vital reaction to occur. The necrosis always exceeded the macroscopically and microscopically evident tissue alterations.

MUTAGENIC RISK OF LASER APPLICATION  
IN ARTHROSCOPIC SURGERY

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**PURPOSE:** During the last decade different laser systems were proven to be powerful tools in arthroscopic surgery. The occurrence of mutagenic side effects in the joint has not yet been disproven. Therefore we aim to assess the mutagenic risk of laser irradiation by using a quantitative in vitro testing system.

**METHODS:** We used BALB/3T3 fibroblasts as experimental model. This cell line normally exhibits a high degree of contact inhibition. After transformation a local 3-dimensional growth called "focus" can be observed. The Lambda-Physik LPX 325 lcc at wavelengths of either 248 nm or 308 nm was used to irradiate the cells. Energy density, frequency and irradiation time were varied. Untreated cells and Roentgen-irradiation with 1 Gray served as negative and positive controls. Transformation rates were calculated from the number of foci and the original cell counts. Results were compared using the Chi-square test.

**RESULTS:** The overall transformation rate from the negative control was  $2.7 \times 10^{-5}$ . For the wavelength 308 nm a transformation rate of  $3.6 \times 10^{-5}$  was calculated and differed from the negative control not significantly ( $p < 0.91$ ). In contrast irradiation at 248 nm resulted in a significant transformation rate ( $1.3 \times 10^{-4}$ ,  $p < 0.0481$ ). At Roentgen-irradiation with 1 Gray a highly significant transformation rate of  $1.2 \times 10^{-3}$  was found ( $p < 0.00001$ ).

**DISCUSSION:** While laser irradiation at 248 nm results in a considerable transformation rate, the induction of foci by Roentgen-irradiation is approximately tenfold higher. However, for the wavelength of 308 nm a significant transformation was widely excluded. Although this result cannot be applied to other laser systems, it can be assumed that wavelengths of 308 nm and higher which are being used in arthroscopic laser surgery do not have an essential mutagenic risk. Therefore our data represent an important contribution to the safety of laser use in arthroscopic surgery.



REACTIONS OF MENISCAL TISSUE AFTER LASER APPLICATION—AN IN VIVO STUDY

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PROBLEM DESCRIPTION: In many clinical and in vitro studies the effect of laser radiation on meniscal tissue was examined. Clinical studies relied on clinical criteria like swelling, effusion, pain, etc. to evaluate the laser effects. In vitro studies show the laser effect only in the moment of cutting the tissue. But the effect of laser radiation on biological tissue depends on the vital reaction of the tissue. So, the real extent of tissue damage caused by laser irradiation can only be examined in long-time in vivo studies. This is the purpose of this study.

MATERIALS AND METHOD: 72 knees of pigs underwent arthroscopic meniscal cuts in the anterior horn of the medial meniscus. The pigs were divided into 6 groups. The first 5 groups were operated with 5 different laser systems: Neodym:YAG 1440 nm wavelength, Neodym:YAG 1064 nm wavelength, Excimer, Holmium:YAG and CO<sub>2</sub>. The sixth group was the control group and was operated with mechanical instruments. From each group, the menisci of the pigs were examined macroscopically and by light-microscope after survival periods of 0, 2, 6, 12 weeks.

RESULTS:

1. All laser systems caused a greater damage of the meniscal tissue than mechanical instruments.
2. This damage was a biological response of the tissue, characterized by a necrotic zone surrounding the meniscus cut.
3. This necrotic zone could not be seen intraoperative but only 2, 6 and 12 weeks after operation. The diameter of the necrotic zone ranged between 1.5 mm and 9 mm.
4. Meniscus cuts with mechanical instruments showed no necrotic zone in the surrounding tissue.
5. Laser cuts in the meniscus caused a better healing response than cuts with mechanical instruments.
6. The quality of this healing response depended on the different laser systems: Nd:YAG 1064 nm, Ho:YAG and CO<sub>2</sub> laser caused only an incomplete healing, because the tissue repair happened only by tissue growing from the synovial edge into the defect. Nd:YAG 1440 nm wavelength led to tissue growing from the synovial edge and to growing of original meniscal tissue, thus reducing the necrotic zone. Excimer laser led to a complete healing of the cut defect and the necrotic zone.

DISCUSSION: Arthroscopic surgeons should be aware that the damage of meniscus tissue caused by a laser is much greater than intraoperatively can be seen and is much greater than caused by mechanical instruments. The healing response of the tissue is stronger after laser application than after use of mechanical instruments. But this healing is with one exception—the Excimer laser—only an incomplete healing of the tissue. Results of in vitro studies, concerning the tissue damage by lasers, are inappropriate to describe laser effects on living tissue.

*Problema del laser e menisco, cut laser  
Alargue e normal etc.*

OSTEO-ARTHRITIC CHANGES FOLLOWING MENISCECTOMY, ALLOGRAFT MENISCAL TRANSPLANTATION AND AUTOGRAFT TRANSPLANTATION

Gregory Keene and Dennis Edwards

The use of meniscal allografts has recently received favourable response. The meniscus is thought to be immunologically privileged when transplanted into a meniscus deficient knee, to protect the knee from osteo-arthritic changes. This paper aims to assess osteo-arthritic change within the sheep knee joint following meniscectomy, meniscal autograft transplantation and meniscal allograft transplantation. The stifle joint of 13 sheep (26 joints) were used for this study.

11 joints had a total medial meniscectomy and 11 had a transplant medial meniscus (6 allografts and 5 autografts). 4 joints served as controls. The surgical procedure was identical in all cases (transplants performed using bone plugs). Sheep were then allowed unrestricted motion for a period of 2 years and were then sacrificed. The joints were then harvested and preserved in Formalin prior to radiographic investigation. Standardised radiographs were obtained using a specially constructed frame. This frame actually loaded the anatomically bent joint to half body weight. Anterior/posterior and lateral radiographs were obtained. These radiographs were independently and blindly assessed by 3 observers using a standardised scoring system. The normal joints showed no evidence of osteo-arthritic change. Those joints with a meniscal transplant (autograft or allograft) or a meniscectomy had a significantly higher score than the normals. There were no statistically significant differences between the transplant groups and the total meniscectomy group, although the allograft and total meniscectomy groups had worse scores than the autograft group.

This study questions the clinical impression that meniscal allograft transplantation protects the joint from short term degenerative change. The transplanted meniscus may not be immunologically privileged as previously suggested and may have a limited place in protecting the knee from short or long term damage.

*- No hay estadísticas de la diferencia entre meniscectomía, allograft y autograft.  
- El menisco es un inmunoprivilegiado.  
- En allograft se previene la artrosis.  
- Pregúntale por tanto en diez minutos sobre el efecto autograft y si es un buen etc.*

## HISTOLOGICAL ANALYSIS OF THE CORACOACROMIAL LIGAMENT: CORRELATION BETWEEN AGE-RELATED CHANGES AND CUFF TEARS

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The purpose of this study was to analyze the age-related changes of the coracoacromial ligament and of the undersurface of the acromion and to correlate these degenerative changes with rotator cuff tears.

**MATERIALS AND METHODS:** We obtained 80 shoulders of 40 cadavers. The ages at death had ranged from twenty-six to eighty-two years (average  $58.4 \pm 15.6$  years). After a thorough macroscopic examination of the rotator cuff and of the morphology of the acromion, the coracoacromial ligament with the tip of the coracoid process and with the entire insertion into the undersurface of the acromion were removed and processed for histological examination. The statistical significance of any difference was determined by Student's *t*-test. Values of less than 0.05 were considered significant.

**RESULTS:** We observed a type I acromion in 34 cases, a type II in 20 cases and a type III in 26 cases. The rotator cuff was normal in 66 specimens; there was an articular-side partial tear in 4 cases, a bursal-side partial tear in 6 cases and a full-thickness tear in 4 cases. Aging was correlated with increasing incidence and severity of cuff tears. We noted age-related degenerative changes of the coracoacromial arch as focal disruption and fibrillation areas of the coracoacromial ligament, degeneration of the acromial bone-ligament junction and acromial spur formation. Anterior acromial spur was not correlated with the morphology of the acromion. We observed an increased incidence of bursal-side and complete cuff tears when the acromion was curved or beaked. Grade 1 and 2 degenerative changes of the undersurface of the acromion were also present when rotator cuff was normal. Bursal-side and complete cuff tears were associated with Grade 2 and 3 degenerative changes of the acromion in 100% of cases. Articular-side cuff lesions were not correlated either with acromial morphology or with degenerative changes of the coracoacromial arch. The association between cuff tears and acromial spur was more evident in presence of a type II or type III acromion.

**DISCUSSION:** Our results would suggest that incidence and severity of rotator cuff tears are correlated with aging and with the morphology of the acromion. Rotator cuff tears that involve the bursal side are often associated with changes of the coracoacromial ligament and of the undersurface of the acromion. However, the degenerative changes of the coracoacromial arch are always correlated with aging, also in presence of a normal rotator cuff. Articular-side partial rotator cuff tears do not cause damage of the undersurface of the acromion. Also acromial spur formation is correlated with aging and is significantly associated with cuff lesions when acromion is curved or beaked.

## USEFUL PHYSICAL SIGNS FOR DIAGNOSIS OF THE PAINFUL THROWING SHOULDER

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Before making a plan of surgical or conservative treatment for painful throwing shoulder, an accurate diagnosis is important. To make the accurate diagnosis, reliable clinical findings which indicate specific pathological lesions are necessary. The purpose of this study was to determine reliable clinical findings to diagnose painful throwing shoulders.

**MATERIALS AND METHODS:** Forty-three competition baseball players who were detected and treated by arthroscopy were reviewed retrospectively, and the relationship between 12 clinical items and the pathological lesions of the shoulder was assessed by multivariate analysis. On the basis of operative findings and video tape records, the pathological lesions of the 43 patients were classified into four groups; superior labral detached lesions (SLD;  $n=18$ ), Bankart lesions (BL;  $n=4$ ), articular side partial rotator cuff tears (APRCT;  $n=14$ ), and subacromial bursitis (SAB;  $n=34$ ). Twelve clinical items were selected from the history and examination findings. The seven items from the history were age at operation, age at starting baseball, duration of playing baseball, duration of disease, painful phase of throwing, site of pain, and traumatic episode while throwing. The five clinical signs assessed were the impingement sign, pain on abduction and external rotation, the anterior apprehension sign, the supra-spinatus resistance test (SSP test), and the procaine injection test into subacromial bursa (procaine test).

**RESULTS:** Six of 12 clinical items were significantly related to the pathological lesions. The clinical item with a positive relationship to SLD lesions was a traumatic episode, while that with a negative relationship was a positive procaine test. The clinical items with a positive relationship to BL were a traumatic episode and a positive anterior apprehension sign, while those with a negative relationship were the SSP test and the procaine test. Clinical items with a positive relationship to APRCT were the duration of playing baseball, a traumatic episode, the impingement sign, the SSP test, and the procaine test. Clinical items with a positive relationship to SAB were the SSP test and the procaine test, while there was a negative relationship with the existence of a traumatic episode. Using these clinical items, the diagnostic accuracy for SLD lesions was 78%, that for BL was 82%, that for APRCT was 93%, and that for SAB was 74%.

**CONCLUSION:** We can make a diagnosis of painful throwing shoulder with a high degree of accuracy and apply an appropriate treatment immediately.

**MR ARTHROGRAPHY IN THE ASSESSMENT OF ANTERIOR  
SOFT TISSUE DAMAGE OF THE SHOULDER WITH  
TRAUMATIC ANTERIOR INSTABILITY—COMPARISON  
WITH DOUBLE-CONTRAST CT ARTHROGRAPHY**

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**PURPOSE:** To compare the diagnostic performance of MR arthrography (MRA) with that of CT arthrography (CTA) in the evaluation of soft tissue damage of shoulders with traumatic anterior instability.

**PATIENTS AND METHODS:** Thirty-five patients with recurrent anterior shoulder dislocation/subluxation and 5 patients with initial anterior shoulder dislocation who underwent arthroscopic surgery were examined with MRA and CTA. Anterior labral damage was graded into four categories: Grade 1, normal; Grade 2, labral tear or detachment without displacement; Grade 3, displaced labrum; Grade 4, no labrum detected. The MR images were compared with the arthroscopic findings.

**RESULTS:** The sensitivity of MRA for labral abnormalities was 92% and the sensitivity of CTA was 77%. There was a significant correlation between the degree of labral damage (grade 1-4) assessed by MRA and the damage observed by arthroscopy ( $r=0.66$ ,  $p<0.0001$ ) and between the labral assessment by CTA and the arthroscopic findings ( $r=0.61$ ,  $p=0.0013$ ). Detached labrum was better depicted by MRA than by CTA: 92% of detached labrum was depicted by MRA, whereas 36% respectively, by CTA. Displaced labrum, on the other hand, was equally detected by MRA (69%) and CTA (70%).

**CONCLUSION:** As the extent of anterior soft tissue damage was visualized more precisely by MRA than by CTA, MRA seems to be a promising imaging technique for preoperative assessment of shoulders with traumatic anterior instability.

**A SIMPLE AND SECURE ANCHORING SYSTEM FOR  
CASPARI'S TRANSGLENOID MULTIPLE SUTURE  
TECHNIQUE: THE USE OF A BIODEGRADABLE  
POLY-L-LACTIC ACID BUTTON**

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To avoid the unreliable tying of sutures over the infraspinatus fascia when using Caspari's transglenoid multiple suture technique (the Caspari technique), we developed an anchoring system using a biodegradable poly-L-lactic acid (PLLA) button and tested it clinically. The purpose of this study was to clarify the clinical effectiveness of this modified Caspari's technique.

Twenty-eight patients who were treated by this modified Caspari technique and who could be followed up for more than 2 years postoperatively were investigated. Twenty-four patients had Bankart lesion and 4 had detachment of the superior glenoid labrum. The mean age at operation was 22.1 years and the mean follow-up period was 26.5 months. The mean number of sutures was 7.3 (5-10).

A PLLA button (8×8×1.2mm) with two holes was fabricated from ultra-high-strength PLLA rods by cutting and shaving. After multiple sutures were performed by the routine Caspari technique, the suture bundles were tied together over the button on the posterior scapular neck while applying traction on the sutures. The arm was immobilized in a Velpeau bandage for 3 weeks.

According to Rowe's rating scale, the clinical outcome was excellent in 15 patients (53%), good in 10 (36%), and poor in 3 (11%). The two failures were due to an excessively early return to sporting activity by noncompliant patients. Transient damage to the suprascapular nerve occurred in two patients. No complications related to use of the PLLA button were observed such as intraoperative breakage during tying, loose fixation, radiological bone absorption, local swelling, or abnormal laboratory findings.

Thus, tying the suture bundles over the scapular bone using this PLLA button provided simple and reliable fixation when performing the Caspari technique. The possibility that the period of postoperative immobilization could be shortened was also suggested.

## THE USE OF HOLMIUM:YAG-LASER IN ARTHROSCOPIC SUBACROMIAL DECOMPRESSION—A PROSPECTIVE STUDY

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**INTRODUCTION:** The Holmium:YAG-Laser has many potential advantages over the CO<sub>2</sub>-Laser, the Neodymium:YAG laser and the Excimer laser, which we used first in 1988. Its principle advantages include minimal mechanical trauma to cartilage, greater access to tight or restricted areas of the joint, its ability to function in a saline medium and to resect cartilage with minimal necrosis and direct contact procedures. Our Laboratory studies have shown that above a threshold radiant exposure of approximately 50 J/cm<sup>2</sup>, the Holmium:YAG-Laser can consistently ablate articular cartilage and meniscal fibrocartilage. Since good results were attained during arthroscopic surgery of the knee, a prospective study was begun to critically evaluate the results of laser-assisted arthroscopic subacromial decompression (ASD) and compare them with the results of a conventional arthroscopic procedure.

**MATERIAL/METHODS:** We compared the results of 52 patients consisting of two groups: (1) ASD was performed with the Holmium:YAG-laser (22 watts) and without electrocautery (group L), (2) conventional ASD using shaver and electrocautery (group S). All patients had an impingement-syndrome Type II or III (partial tear only) (Neer-Classification). Group S consisted of 18 cases and group L 34 cases. Subjective, objective and functional results were assessed using the Constant Score: 15 pts for pain, 10 pts for daily activity, 10 pts for positioning, 40 pts for painless active motion and 25 pts for abduction strength which was measured with an electronic spring balance. Each shoulder was scored pre-operatively and post-operatively at specific intervals—10 days, 6 weeks, 3, 6 and 12 months.

**RESULTS:** Group S consisted of 15 men and 3 women and group L 28 men and 6 women. The mean age was 46.5 (range, 28–74) years in group S and 49.5 (range, 33–69) years in group L, the follow-up period in this group averaged 25.8 months (range, 22–38 months), 14.3 months (range, 6–20 months) respectively. The postoperative scores in group L after using Holmium:YAG laser were higher in all criteria than group S. The average score increased from 54.7 to 79.8 in group L and from 50.3 to 68.7 in group S. Pain relief, daily activity and painfree active motion scores all increased steadily from 4.1 pts to 10.28 pts, from 12.9 to 18.0 pts, from 27.7 to 35.4 pts in group L and from 4.2 to 8.8, from 10.5 to 16.1, from 24.58 to 31.0 in group S. The increase of abduction strength measured with an electronic spring balance was significantly higher in the group of patients treated with Holmium Laser ( $p < 0.05$ ) (10.5 to 16.0 in group L and 7.0 to 12.8 pts in group S). Postoperative radiographs were analyzed for acromial type, presence of acromial spur and soft-tissue calcifications. There was no significant relationship between postoperative acromial type I or II and the shoulder score. Using the *Imhoff-Balgrist Score* and *questionnaire*, the patients judged the percentages of relief of pain and functional improvement at follow-up. The relief of pain averaged 88 per cent and the functional improvement, 79 per cent.

**COMPLICATIONS:** There were no complications in both groups. In *group S* a revision acromioplasty was necessary in two patients after 6 months and 4 weeks. In *group L* there was only one failure with a revision acromioplasty in spite of a partial tear supposed by the MRI postoperatively.

**DISCUSSION/CONCLUSION:** The use of the Holmium:YAG laser engenders a relatively bloodless field, with the result that the coracoacromial ligament can be resected cleanly and precisely to avoid scarring. Using a higher laser energy for bone removal, acromioplasty can be performed to remove osteophytes from the anterior acromion. Osteophytes at the insertion of the coracoacromial ligament are also resected. Special attention is given to caudal osteophytes of the acromioclavicular joint, which are smoothly resected in the same manner with the shaver and the laser. The use of the laser eliminates hemorrhaging, which frequently restricts visibility severely. Marked differences in favor of the laser group with respect to pain, activity and movement were apparent as early as the first week. These trends in the individual criteria were even more pronounced in the overall scores for both groups. The maximum differences between the two groups occurred in the electronically measured abduction power. Here the values obtained in the patients operated on with the Holmium:YAG laser were significantly better than those obtained with shaver decompression only ( $p < 0.05$ ). The speed with which the shoulders in the laser group were restored to their full range of motion was due to the mildness of the postoperative pain, the lack of adhesions and the near absence of swelling. Arthroscopic acromioplasty with the Holmium:YAG-laser resulted in the faster achievement of ultimate relief. The cicatrized subacromial bursa can be cleanly stripped away and the bleeding stopped. After resection of the acromion, its resected surface is virtually sealed by the laser. This sealing of the undersurface of the acromion, the bursa and the deltoid muscle constitute one of the prime advantages of this minimally invasive technique. Arthroscopic acromioplasty with the Holmium:YAG-laser is an alternative to conventional ASD in patients who have stage II and selected stage III impingement syndromes. However, the laser ASD is technically demanding.

## REVISION SURGERY AFTER UNSUCCESSFUL ARTHROSCOPIC SUBACROMIAL DECOMPRESSION (ASD)

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**PURPOSE:** To identify the causes for unsatisfactory outcome after ASD, to introduce a diagnostic algorithm and to present the results of revision surgery in these patients.

**PATIENTS, METHODS:** From 1990 to 1993 14 patients out of a group of 131 patients with ASD had to be reoperated 8 (3–14) months after the first operation. Revision surgery was carried out if impingement symptoms had persisted despite conservative treatment over at least 3 months. Transscapular X-rays and MRI were routinely obtained before revision surgery. All revisions were performed by the same surgeon as an open procedure. Intraoperative findings were photodocumented. The patients were followed up for 28 (24–39) months. Results were evaluated clinically and radiologically.

**RESULTS:** The revision was rated "successful" by 10 patients. In these cases the "Constant Score" improved significantly from 54 (47–62) to 79 (61–87) points. This was due to improvement of the items "pain" and "range of motion". Insufficient resection of the acromion (8), rupture of the rotator cuff (3) and osteophytes of the AC-joint (2) were confirmed during reoperation. These lesions had been identified preoperatively by X-ray or MRI examination. If no mechanical causes could be found and eliminated, bursectomy and further resection of the undersurface of the acromion were carried out in 4 patients. Subjective results were poor and the score did not improve in these cases.

**CONCLUSIONS:** Sufficient resection of bone during ASD and the exclusion of patients with complete rotator cuff tears will reduce the failure rate of the procedure. Transscapular X-ray and MRI show the mechanical reasons for failed ASD. Reoperation is only successful if mechanical causes for failure can be identified and treated.

## ARTHROSCOPIC DEBRIDEMENT AND ACROMIOPLASTY VERSUS MINI OPEN REPAIR IN THE MANAGEMENT OF SIGNIFICANT PARTIAL THICKNESS ROTATOR CUFF TEARS

*Stephen C. Weber, M.D.*

Partial tears of the rotator cuff, especially of the articular side, have received attention only with the recent ability of MRI and arthroscopy to diagnose these lesions. Several early reports showed nearly 100% success in managing these lesions with arthroscopic debridement with or without acromioplasty.

This series compares 32 patients with significant partial thickness rotator cuff tears managed with debridement and acromioplasty versus 33 patients with mini open repair.

Follow-up was from two to seven years. Preoperative MRI was not useful, but positive preoperative arthrography was useful for articular side tears. Bursal side tears were 12% of the population; the remainder were articular side tears. All were at least 50% or more of the thickness of the tendon. A significant number of the arthroscopic group had fair results by UCLA score. Three reruptured the remaining cuff with time in spite of adequate acromioplasty. Healing of the partial tear was never observed at second look arthroscopy. While post operative pain was significantly greater and recovery slower with open repair, no patient was reoperated and rerupture of the repair did not occur.

The outstanding results of prior studies of cuff debridement was not duplicated in this series of cuff debridements with long term follow-up. Recognition and repair of these significant partial tears may be advisable for the long term function of the shoulder despite short term improvement in morbidity with arthroscopic treatment.

## THE ROTATOR INTERVAL LESION— AN ARTHROSCOPIC APPROACH

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The rotator interval defines the space between the supraspinatus (SSP) and subscapularis (SSC) tendons. Anatomically, it includes a sling mechanism, stabilizing the *intraarticular* portion of the long head of biceps tendon (LHB), which is formed by fibers of the SSP and SSC tendons and by the coracohumeral (CHL) and the superior glenohumeral ligament (SGHL). A rotator interval lesion is defined anatomically or functionally as a lesion of the *intraarticular* portion of the LHB between its labral origin and the entrance to the bicipital groove with no associated full thickness rotator cuff tear.

**PURPOSE:** To illustrate an arthroscopically detected pathomorphological entity of the rotator interval as a pattern of dysfunction of the LHB.

**MATERIAL AND METHODS:** From October 1992 to August 1993 arthroscopy was performed in 119 patients with diagnosed anterior instability and in 67 patients with diagnosed outlet impingement. The mean age at the time of surgery was 48.5 years (26–68). There were 32 male and 16 female. Preoperatively, a standardized physical examination and a specific x-ray series was performed. Ultrasonography, CT-scan and MRI were facultative diagnostic tools for grade III impingement or subtle instability.

**RESULTS:** A rotator interval lesion was found in 26% (n=48). A traumatic etiology was present in 38% (n=18) with a mean age of 45 years (27–61) versus a nontraumatic group of 62% (n=30) with a mean age of 49 years (27–68). A dislocation of the *intraarticular* portion of the LHB was observed in 89% of these shoulders. None of them were diagnosed preoperatively as a LHB resp. rotator interval pathology in terms of a LHB instability. A pathology of the SGHL was seen in 52%, an associated labral pathology was detected in 85%.

**CONCLUSION:** Arthroscopy has revealed to be a precise diagnostic tool in detecting a rotator interval lesion which presents a pathology of the LHB. The secondary *intraarticular* instability pattern of the LHB with glenohumeral impingement is a subtle finding that may be diagnosed only arthroscopically. This lesion is easily missed during open surgery because it is obscured by the clavipectoral fascia and by a facultative intact CHL. Routine arthroscopy provides an easily detectable diagnosis of an otherwise occult pathomorphological entity.

## ARTHROSCOPIC RELEASE OF REFRACTORY CAPSULAR CONTRACTURE OF THE SHOULDER

Answorth A. Allen and Patrick Wong

**PURPOSE:** To describe a technique and report results of arthroscopic capsular division for the treatment of acquired contracture of the shoulder.

**CONCLUSIONS:** Arthroscopic capsular release is an effective treatment technique to restore motion to the stiff shoulder which is refractory to closed manipulation under anesthesia.

**SIGNIFICANCE:** Arthroscopic capsular release allows controlled and precise division of capsular contractures with minimal operative morbidity.

**SUMMARY OF METHODS, RESULTS, DISCUSSION:** 30 patients with refractory contracture of the shoulder underwent arthroscopic capsular release combined with closed manipulation. 11 cases were either primary adhesive capsulitis or adhesive capsulitis associated with diabetes mellitus, 6 were secondary to trauma, and 13 were acquired following surgery. All patients had painful passive limitation of motion which could not be overcome by manipulation under anesthesia. The joint capsule was divided with electrocautery and then closed manipulation was performed. In 18 cases an anterior release was performed, in 4 cases a posterior release was performed, and in 8 cases a combined global anterior-posterior release was required. Postoperative immediate assisted range of motion was instituted. At a minimum 2 year follow-up 27 of 30 patients reported good-excellent pain relief and the average *motion gains* were: forward flexion = 49° increase; external rotation = 25° and 60° increase when tested in adduction and abduction respectively; and internal rotation = 9 levels and 30° increase when tested in adduction and abduction respectively. There were no surgical complications.

The stiff shoulder is a difficult treatment problem and closed manipulation alone is not always successful. Open surgical release is painful and has a morbidity associated with extensive surgical dissection. Arthroscopic capsular release allows controlled and precise division of capsular contractures which then permits closed manipulation to regain motion with only minimal force. This technique has less morbidity and appears to be reliable even in postoperative stiff shoulder treatment.

## ARTHROSCOPIC ACROMIOPLASTY FOR ROTATOR CUFF TEARS: A FRENCH MULTICENTRIC STUDY OF 210 CASES

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We followed 210 cases of rotator cuff tears treated by arthroscopic acromioplasty in four French centers: Strasbourg, Nancy, Lyon and Paris.

All patients were evaluated by means of the Constant score and radiographic imaging, consisting of subacromial A-P view and lateral view. The mean age was 61 years and the mean follow-up period was 26.6 months (12-93). The global Constant's score was 38.2% with particularly poor score for pain: 2.3/10 and strength: 2/25 pts. There were 41% of supraspinatus tears, 40.2% of supra and infraspinatus tears, 10.5% of 3 tendons tears and 8.1% of supraspinatus and subscapularis tears. The long head of biceps (LHB) was altered or disrupted in 77% of cases, luxated or subluxated in 44% of cases.

The acromioplasty was associated to lesion debridement in 88% of cases and to a tenotomy of the LHB in 19% of cases.

Global objective results shown by the Constant score added up to 67.3% and was 79.7% with pondered values for age and sex. 73% of cases attained excellent, very good and good results. The poor clinical factors were preoperative stiffness of the shoulder, postoperative painful crises, worker compensation, aduration of preoperative history of longer than 4 years and a young age.

The poor anatomical factors were an osteoarthritis, a lesion of the AC joint or a subacromial bursitis, a lesion of the LPB (or a luxation). The size of the tear was a major prognostic element: an isolated supraspinatus tear will have a much better result (72.4%) than a tear of 3 tendons (56.6%). Subscapularis lesions constituted an aggravating factor too.

The persistence of an aggressive acromion was a prejudiciable factor. Benefits of tenotomy of LHB are evident on follow-up and does not modify the subacromial space. However, the debridement of the rotator cuff tear was not useful.

In conclusion, arthroscopic acromioplasty is an excellent indication for old patients without professional activity, functionally less demanding than a younger patient.

## PROXIMAL LATERAL APPROACH TO ARTHROSCOPY OF THE ELBOW JOINT: CLINICAL ASSESSMENT OF A SAFER APPROACH

*Brian Day, W. Regan, and K. Stothers*

**PURPOSE:** To determine the safety and efficacy of standard and alternative approaches to arthroscopy of the elbow joint.

**METHOD:** Based on experience gained in a series of cadaveric dissections, a technique of elbow arthroscopy which emphasized safety in the anatomical approach was undertaken in 62 patients. The cadaveric study was undertaken to reevaluate the safety of the classical approaches to the elbow joint, and to assess a proximal lateral approach, made 1 to 2 cm proximal to the lateral epicondyle over the anterior surface of the humerus. Brachioradialis and distal brachialis are pierced to reach the lateral elbow capsule. The proximity of neurovascular structures to this portal was compared with the anterolateral portal. The approach was subsequently used in 62 patients who underwent elbow arthroscopy.

**RESULTS:** Cadaveric dissections showed that the proximal portal was significantly safer than the anterolateral portal in terms of the proximity of nearby nerves and vessels. The radial nerve was at risk with an anterolateral portal being between 0 and 4 mm from the sheath in extension and in contact in 56%. Even with flexion, the radial nerve was dangerously close (average 4.9 mm). Cutaneous nerves were also at risk and the anterior branch of the posterior antebrachial cutaneous nerve was in contact with the sheath in 43% of elbows. With the proximal lateral approach, the radial nerve was, on average, separated from the sheath by 4.8 mm in extension and 9.9 mm in flexion. Cutaneous nerves were also in less danger. The approach was used in 62 patients without any complications. Visualization of the elbow joint was better than that with the anterolateral portal. The literature has shown a significant number of radial nerve injuries associated with elbow arthroscopy. We conclude that the anterolateral portal is relatively unsafe and, based on our studies, the proximal lateral portal should be the standard approach to the anterior compartment on the lateral side.

**SHOE AND INSOLE EFFECT ON MEDICAL COMPLAINTS, OVERUSE INJURIES AND STRESS FRACTURES IN INFANTRY RECRUITS—A PROSPECTIVE, RANDOMIZED STUDY—PRELIMINARY RESULTS**

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**MATERIALS AND METHODS:** 250 recruits programmed to start basic infantry training were randomly divided into 3 groups: 100 received a custom made insole of polyurethane (Orthofeet, USA), 50 received a specially constructed hiking shoe (AT-100 New Balance, Korea) and 100 served as a control group using the standard army boot. Prior to the course all recruits had a medical examination and a series of Anthropometric measurements. Before and twice during the course, a full orthopaedic examination was performed. On commencing and on ending the course the recruits had a physical performance test. All visits to the unit clinic were recorded, all visits to the doctor were recorded and pain syndromes were recorded and graded by the 5 point scale by two orthopaedic surgeons. Stress fractures were diagnosed by bone scan and x-ray. Only symptomatic cases were sent for nuclear investigation. Statistical evaluation was done using the Chi<sup>2</sup> test.

**RESULTS:** 30% of soldiers sought medical advice in the control group, 18% in the insole group, and 22% in the new shoe group. The doctor was approached by 21% of the control group, 15% of the insole group, and by only 6% of the new shoe group. Objective medical examination disclosed 87 advanced (grade II or higher) pain syndromes in the control group, 53 in the insole group and 16 (paralleling 32 by number) in the shoe group. These appeared in 59 soldiers of the control, 50 of the insole and 18 (paralleling 36 in number) in the shoe group. Stress fractures (SF) Grade II-III-IV were diagnosed in 19% of the control group, 14% in the insole and 4% of the shoe group (one of whom was asymptomatic). These included 32 fractures (grade II-III-IV) in the control group, 20 in the insole group, and 3 (paralleling 6 in number) in the shoe group. When adjusted for severity the numbers were 43.5 for the control group, 25.5 for the insole group and 4 (paralleling 8 in number) in the new shoe group. Potential dangerous stress fractures were diagnosed in 14 of the control group, 12 of the insole group, and 2 (paralleling 4 in number) of the new shoe group. Grade III-IV of the same were recorded in 7 of the control group, 2 of the insole group and 0 of the new shoe group.

**STATISTICAL EVALUATION:** There was no statistical significance in the reduction of complaints between the new shoe group, the insole group and the army boot group. Doctors' visits were significantly reduced ( $p < 0.03$ ) in the new shoe group, though not in the insole group. The insole did reduce the findings on the objective medical examination ( $p < 0.01$ ) and so did the new shoe ( $p < 0.000$ ). Stress fractures were reduced by the new shoe significantly ( $p < 0.001$ ), while the insole showed only a tendency in SF reduction ( $p < 0.065$ ). When SF were adjusted for severity, both the new shoe ( $p < 0.001$ ) and the insole ( $p < 0.01$ ) showed a significant reduction in stress fractures.

**CONCLUSIONS:** There seems to be a clear positive effect of the insole and the new shoe in prevention of overuse injuries in infantry recruits. This is more apparent in the more severe injuries and most outstanding in the more severe stress fractures.

**NON-INVASIVE ANKLE DISTRACTION: RELATIONSHIP BETWEEN FORCE, MAGNITUDE OF DISTRACTION, AND NERVE CONDUCTION ABNORMALITIES**

*P.A. Dowdy, B.V. Watson, A. Amendola, and J.D. Brown*

**PURPOSE:** To evaluate the relationship between distraction force, magnitude of joint opening, and the development of nerve conduction abnormalities using non-invasive ankle distraction.

**METHODS:** Seven healthy volunteers (14 ankles, 4f, 3m) with no history of ankle or foot pathology were set up on the operating table for ankle distraction using a non-invasive ankle distractor. In-line traction of 0 to 50 lbs. in 5 lb. increments was applied to the ankle. A direct lateral x-ray was obtained at each distraction force. The joint space was measured on the lateral x-rays using electronic microcalipers. Surface recordings of the superficial peroneal, deep peroneal, and sural nerves were obtained.

**RESULTS:** The ankle joint space increased progressively from avg. 3.1 mm with no force applied to avg. 4.2 mm with 50 lb. distraction force applied. The maximum joint distraction averaged 1.3 mm. The sensory amplitudes for the deep and superficial peroneal nerves were diminished/absent with increasing time and force of distraction. The decreased amplitudes were most marked after 1 hour of distraction with 30 lbs. or greater distraction force. This correlated with symptoms of paresthesias. The amplitudes quickly returned to normal values with the weight being released from the ankle. The sural nerve was minimally affected.

**CONCLUSIONS:** The non-invasive ankle distractor safely increased ankle joint space by one-third. Distraction with 30 lbs. or more for 1 hour is associated with reversible nerve conduction changes. Based on these findings, we recommend using the non-invasive ankle distraction apparatus with up to 30 lbs. of traction applied to the foot for up to 1 hour. Greater force, applied for longer periods, is associated with nerve conduction abnormalities.



## ARTHROSCOPIC TREATMENT OF OSTEOCHONDRAL LESIONS OF THE TALAR DOME

Andre Frank and P. Cohen

**PURPOSE:** To review our experience and evaluate arthroscopic treatment of osteochondral lesions of the talar dome with a follow-up period of 2 to 10 years.

**CONCLUSION:** Arthroscopic surgery can yield the same good results as open surgery with minimal morbidity.

**SIGNIFICANCE:** When surgery is indicated an arthroscopic excision of the talar lesion is a good alternative to an open procedure.

**MATERIALS AND METHODS:** 19 patients who had arthroscopic surgery between 1984 and 1991 for an osteochondral lesion of the talar dome were reviewed and divided into 2 groups: 7 patients (7 males with an average age of 19.5 years) had a recent osteochondral fracture with a free loose body in the joint. These 7 fractures located at the antero-lateral part of the talar dome were excised.

12 patients (7 males and 5 females with an average age of 29 years) had a local osteonecrosis with an osteocartilaginous sequestrum. There were 10 postero-medial and 2 antero-lateral lesions. Access to the posterior part of the lesion could be achieved only by articular distraction using a distractor. These lesions were treated by excision of the sequestrum and curettage of the necrotic bone.

The 19 patients were clinically and radiologically reviewed with a follow-up period of 2 to 10 years. Results were assessed according to the McCullough functional score.

**RESULTS:** There were 4 excellent, 11 good, 2 fair and 2 poor results. On radiographic examination, we noticed that, even at the longest follow-up, the bone healing was still incomplete. A CT arthrotomography was performed in the 4 unsatisfactory cases. The defects are filled with fibrocartilage but in 2 cases the articular surface over a too large defect is very irregular. Patients treated for an osteochondral fracture obtained significant better results than those treated for local osteonecrosis.

**DISCUSSION:** Most authors agree that only the symptomatic lesions should be treated surgically. Arthroscopic techniques and instrumentation permit intraarticular operation with the same accuracy and precision as surgery. The same results are obtained with minimal morbidity and short hospitalization. Nevertheless if the excision of the necrotic bone leaves a too large defect we think that a surgical bone grafting may improve the long-term prognosis.

## AN UNRECOGNIZED APONEUROTIC LAYER ANTERIOR TO THE PATELLA

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Steven Shifflett, M.D., and Dante Pinto, M.D.

**PURPOSE:** To accurately describe the soft tissue anatomy anterior to the human patella.

**CONCLUSION:** A previously *undescribed* aponeurotic layer was documented between the superficial transverse arciform fascia and the deep longitudinal rectus femoris fibers anterior to the patella in over 80% of 22 fresh cadaver knees.

**SIGNIFICANCE:** The standard anatomic descriptions of this region are *inaccurate and need to be corrected*. The clinician should be aware of the details of the soft tissue anatomy, in that *three* potential bursal spaces commonly exist anterior to the patella.

**METHODS:** The soft tissues anterior to the patella were carefully dissected in a layer by layer fashion in 22 fresh adult cadaver knees. The details of extant anatomy were documented photographically, and in 2 cases by sagittal and transverse microscopic sections.

**RESULTS:** A previously undescribed distinct fascial/aponeurotic layer was documented deep to the superficial transverse arciform fascia (fascia lata) and anterior to the rectus femoris fibers investing the anterior surface of the patella in 19 of 22 knees. The presence of this layer thus defines three potential bursae anterior to the patella. Because of the oblique orientation of the fibers of this layer, we have tentatively named it the "intermediate oblique layer". The typical anatomic structures found anterior to the patella in sequence are: skin, subcutaneous tissue, subcutaneous prepatellar bursa, superficial transverse arciform fascial layer (fascia lata), intermediate prepatellar bursa, *intermediate oblique layer*, deep prepatellar bursa, and longitudinal rectus femoris fibers investing into the anterior surface of the patellar bone.

**DISCUSSION:** Contrary to the standard American and English anatomic texts (including Grant's, Gray's, Pansky's, and Hollinshead) and periodic literature (including Reider, B., et al.: The Anterior Aspect of the Knee Joint in Anatomic Study. *J: Bone Jt. Surg.* 63(A): 351-356, 1981), a distinct aponeurotic layer exists between the superficial transverse arciform fascia and the deep longitudinal rectus femoris fibers anterior to the patella. It was surprising to us that a macrostructure of the knee should be undefined in the latter half of the 20th Century. A knowledge of the existence of this structure extends beyond the mere academic, in that *three* potential prepatellar bursal spaces commonly exist which can be of importance to the clinician.

## GENERAL SOFTENING OF THE KNEE JOINT ARTICULAR CARTILAGE IN PATIENTS WITH CHONDROMALACIA OF THE PATELLA

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Articular cartilage is composed of cartilage cells, extracellular matrix and interstitial fluid. Physical interactions between these structural components are complex and essential for mechanical characteristics of the tissue. Chondromalacia of the patella is a disease of unknown origin causing local softening and fibrillation of patellar cartilage, while elsewhere in the knee joint cartilage surfaces usually remain intact. The purpose of the present study was to evaluate the structural properties of knee joint articular cartilage in patients with chondromalacia by measuring the stiffness of cartilage with a novel arthroscopic instrument.

**MATERIALS AND METHODS:** The instrument comprises of a handle and a measurement rod ( $\varnothing$  5 mm, length 150 mm) which is inserted into the knee joint during arthroscopy. In the distal end of the measurement rod there is an inclined flat surface with a plane-ended indenter ( $\varnothing$  1 mm) in the center. Inside the rod cover the indenter joins to a bending beam. The force applied to the indenter is measured through bending of the beam by a pair of strain gauge transducers. The principle of the stiffness measurement is to generate locally a constant 300  $\mu$ m deformation to articular cartilage with a cylindrical indenter and to measure with strain-gauge transducers the force by which the cartilage resists the compression produced by the indenter. This force is a measure of cartilage stiffness. During arthroscopy, stiffness of cartilage was measured from 23 patients (9 women, 14 men; age  $29 \pm 9$  years, mean  $\pm$  SD) having chondromalacia of the patella with varying degree, but showing normal appearance of the other cartilage surfaces. As a control group we had 23 patients (14 women, 9 men; age  $26 \pm 7$  years, mean  $\pm$  SD) who had arthroscopically intact knee joint, or a meniscal tear, but no cartilage lesions. Stiffness was measured from eight different locations at the knee joint: medial and lateral facets of the patella, the patellofemoral surface of femur, and both condyles of femur and tibia. In the patella the stiffness was measured outside the lesion, where the appearance of cartilage was normal.

**RESULTS:** Cartilage of the chondromalacia patellae patients was softer in the medial (59% of the control value,  $p < 0.001$ , Mann-Whitney U-test) and lateral (76%,  $p = 0.01$ ) facets of the patella, in the medial (84%,  $p = 0.05$ ) and lateral (89%,  $p = 0.034$ ) facets of the patellofemoral surface of femur, and in the medial (75%,  $p = 0.005$ ) and lateral (72%,  $p = 0.008$ ) plateaus of tibia. In the weight-bearing areas of the femoral condyles, no change in cartilage stiffness was observed.

**CONCLUSIONS:** The present data suggest that in patients with chondromalacia of the patella, cartilage alterations are located not only in the site of patellar lesions, but more generally also in those areas of the knee joint that visually appear normal. Softening of the tissue indicates a change in the structural components of articular cartilage, and may reflect the first signs of degeneration in these cartilage areas.

## ANTERIOR KNEE PAIN SYNDROME: PREVENTION BY USING A KNEE SUPPORT WITH A PATELLAR GUIDING RING—A PROSPECTIVE AND RANDOMIZED STUDY

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**AIM:** To study role of a knee support in prevention of anterior knee pain syndrome (AKPS) during a 2 month course of intense physical education. To our knowledge this is the first study performed in this direction.

**MATERIALS AND METHODS:** 81 men and women, aged 18–24, and planned to have an intensive 2 month course in physical education had a series of Anthropometric and Physiometric measurements, filled out a detailed questionnaire, and had a physical fitness test and an Orthopaedic examination.

The group was then divided randomly into a study group who received knee supports and a control group. AKPS as disclosed by Orthopaedic examination was recorded before, during and at the end of the course.

**RESULTS:** Variabilities were assessed by the Chi<sup>2</sup> test, *t* test and repeated measures ANOVA.

1. Physical fitness improved with no difference between the groups.
2. Thigh muscle force improved with no difference between the groups.
3. Valus of the heel on standing (pronation) showed no relation to the occurrence of AKPS.
4. Joint laxity showed a non-significant ( $p = 0.24$ ) relation to occurrence of AKPS.
5. Physical activity prior to the course caused a higher occurrence of AKPS ( $p = 0.07$ ).
6. Using the knee support reduced significantly ( $p < 0.001$ ) the occurrence of AKPS. AKPS occurred in 14.8% of the study group and in 56.8% of the control group.

### CONCLUSIONS

1. Physical activity enhances AKPS.
2. A knee support with a silicon patellar rind worn preventively during physical activity reduced significantly the occurrence of AKPS.
3. Knee support does not reduce development of physical fitness nor thigh muscle force.

## THE TREATMENT OF PATELLA RECURRENT DISLOCATION: RESULTS AFTER 30 YEARS FOLLOW UP

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Recurrent patellar dislocation is a very common disorder, with multiple and variable etiologies. More than 100 different operations have been described for surgical correction of this condition, but the treatment of this pathology is still not completely clear. In fact the initial success of these procedures in preventing recurrent dislocation of the patella is well accepted, but, at long term follow-up, many realignment procedures have presented contradictory results. This depends on the fact that most of these studies are difficult to interpret because they apply one specific procedure to different situations, and the outcome criteria used are various and thus make it difficult to compare results. Furthermore, the development of subsequently degenerative arthritis of patellofemoral joints has been demonstrated in the literature and raises doubt about the evolution of realignment procedures and even what their real advantages are compared to conservative treatment. Purpose of this study was to compare the clinical and radiographic outcomes of patients with comparable bilateral recurrent patellar dislocation treated surgically only on one side, to clarify the precision of the surgical indication with respect to basic pathology, correctness of execution and degree of correction.

**MATERIAL AND METHODS:** We could select retrospectively only 16 patients affected by bilateral recurrent patella dislocation, which were treated only on one side between 1948 and 1973. Both knees were affected by the same osteoarticular deformity and the conservative treatment in one knee was a patient request. All 16 patients underwent a Roux realignment technique. The average follow-up of this group was 30 years (20–45). The results were evaluated on the operated and unoperated knee. Crosby and Insall clinical schedule was used for assessment of pain, ROM, sports activity, and feeling of patellar instability. A-P, lateral and Merchant view x-rays were performed at follow up for evaluation of osteoarthritis and height of the patella according to Blumensaat method. CT was performed at 20 degrees of flexion for evaluation of congruence angle following Merchant's criteria and for the measurement of the distance between anterior tibial tuberosity and trochlear groove (ATT-TG). Osteoarthritis was quantified as light (-), moderate (+), marked (++) and grossly marked (+++). Analysis of pre and post-operative outcome was executed, as was comparison of the results obtained in operated and unoperated knees using a Student *t* test statistical analysis.

**RESULTS:** Clinically we found 3 excellent, 9 good, 1 fair and 3 bad results on the operated side, while in the unoperated knee we had 6 excellent, 8 good, 1 fair and 1 bad results. Osteoarthritis, detected with x-ray and CT, was grossly marked in 8 cases, marked in 3 cases, moderate in 1 case and light in 4 cases in the operated knees, compared to 8 grossly marked, 3 moderate, and 5 light in the conservatively treated knees. The height of the patella in the operated knees was in 2 cases normal, in 7 high and in 7 low, while in the unoperated knees was in 3 cases normal, in 12 high and only in 1 case low. Congruence angle in the unoperated knees was lateralized in 9 cases and normal in 7 cases. In the surgically treated knees was normally in 10 cases, medially placed in 3 cases and lateralized in the remaining 3 cases. ATT-TG was negative in 9 cases, normal in 1, and positive in 6 cases on the operated knees. On the unoperated side the value was positive in 9 cases and normal in 7 cases.

**DISCUSSION:** In only one case we found recurrence after surgical treatment. In the conservatively treated side disappearance with time of the feeling of instability was observed. At long term, also if retrospectively analyzed, no clinical and radiographic significant difference between surgically or conservatively treated knees was found. The clinical results obtained in both groups were generally positive, despite the radiographic features and the severity of degenerative modifications. Roux technique has given positive results in cases where there was minor preoperative osteoarticular alteration of patello-femoral joint and when it has not iatrogenically caused a low patella, responsible for failure in the long term. The absence of differences in clinical and radiographic results between operated and unoperated knees is fundamentally due to the complete lack of adaptation of the procedure to the various and multiple physiopathological bases of patellar instability. According to this long term result, conservative treatment remains the first choice. When surgical treatment is necessary, a selective realignment technique depending on the gravity of articular dysplasia is recommended.

## LUMBAR ARTHROSCOPIC DISCECTOMY

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and Ricardo Raúl Jañez, M.D.

Anatomic investigation in 10 corpses and treatment with LAD in 33 patients, follow-up 5 years.

**OBJECTIVE:** Achieve a surgical technique of minimum invasion that allows the treatment of all kinds of intervertebral disk hernia with full visualization, permanent irrigation, instrumental accuracy and low morbidity-mortality.

**MATERIAL AND METHOD:** The surgical technique and the instrumental have been systematized experimentally in 10 corpses. LAD has been in 33 patients (average age 40) 25 men and 8 women, 21 with 4th disk hernia and 12 with 5th disk hernia, all of them with neurologic impairment from 7 months to a year. The surgical technique is in lateral decubitus, through paraspinous biportal, penetrating the flavum ligament, triangular working inside the rachis canal.

**CASES:** Protrusions 9 (27%), Extrusions 19 (57%), Migrations 4 (12%) and Medials 1 (3%)

**FOLLOW-UP TO 5 YEARS:** Under the criteria of complete restitution, residual symptomatology, work re-insertion and sports practice, we classify 31 cases as *GOOD* (93%), 2 as *REGULAR* (6%) and 0 as *POOR*.

**COMPLICATIONS:** Intraoperative accidents = 1 (3%) anesthetics, thromboembolism, infection, recidivism, caudaequina syndrome = 0.

**CONCLUSIONS:** Treating all types of hernias, lateral recess and inside of disk, we obtained in the 33 patients instrumental accuracy, full visualization, with advantages over other low invasion methods and low morbidity-mortality. The average hospitalization period: 12 hours and oral antibiotic therapy.

ARTHROSCOPIC OSTEOCHONDRAL AUTOGRAFT  
TRANSPLANTATION IN ANTERIOR CRUCIATE LIGAMENT  
RECONSTRUCTION: A PRELIMINARY CLINICAL STUDY

Vladimir Bobic, M.D.

**PURPOSE OF STUDY:** The high incidence of large chondral defects of femoral condyles associated with chronic ACL tears is widely known and requires treatment, which is difficult and controversial. In most cases the torn meniscus is repaired and ACL reconstructed but the chondral lesion is usually ignored. This preliminary report presents simple surgical technique for arthroscopic osteochondral autograft transplantation in ACL deficient knees. This technique addresses the important issue of articular cartilage defects in ACL deficient knees and possible prevention of premature joint degeneration.

**MATERIALS AND METHOD:** The series consists of 13 cases of arthroscopic osteochondral autograft transplantation in conjunction with ACL reconstruction using bone-patellar tendon-bone autograft, 9 primary and 4 revisions of failed synthetic grafts. Patients' ages ranged from 22 to 42 years. There were 11 male and 2 female patients.

On arthroscopy, prior to ACL reconstruction, full-thickness crater-like chondral defects larger than 10 mm in diameter, located on the typical weightbearing area of the medial femoral condyle, were considered for osteochondral autograft transplantation. Smaller lesions were 'microfractured' with an arthroscopic awl or drilled with a K-wire. Lesions in this series ranged from 10-28 mm in diameter. Donor site was selected prior to notchplasty and 3 to 5 osteochondral cylinders, 5 to 10 mm in diameter, 10 to 15 mm long, were harvested. In chronic ACL deficient knees with a narrow notch and large chondro-osteophytes, donor sites for multiple osteochondral cylinders were selected along the anteromedial and superomedial aspect of the notchplasty area. Otherwise, the donor sites were on the supero-lateral and antero-lateral aspects of the lateral femoral condyle.

Initially, autografts were harvested with modified standard 5 and 10 mm bone trephines. From 1994 thin-walled tubular instruments with fine cutting edges were specially adapted and were used routinely. The recipient site was prepared in a similar manner and the osteochondral cylinder press-fitted. The bone cylinder removed from the recipient area was routinely inserted in the donor area.

**RESULTS:** Standard radiographs at 6 weeks and one and two years postoperatively and MRI at 3 months confirmed excellent graft integration and a level surface in 11 cases. In the first two cases multiple concentric grafts were either too prominent or sunk-in. Six patients were arthroscopied after one year and findings recorded on slide film and video tape. Arthroscopy clearly demonstrated a normal shiny appearance and colour of the grafted area and a thin shallow halo at the interface of normal and grafted articular cartilage in each case. On close inspection all grafted areas appear slightly more prominent than the surrounding area, which is due to the different curve radius of the donor site. The donor site on the lateral femoral condyle was difficult to identify being covered with a soft fibrous tissue.

DISCUSSION AND CONCLUSION: This simple arthroscopic technique addresses the important issue of articular cartilage defects in chronic ACL deficient knees. If neglected, chondral defects of femoral condyles are likely to progress resulting in premature degeneration of the joint and compromise long-term success of the ACL reconstruction.

Improved surgical technique, purpose-developed instruments enabling minimal damage to harvested articular cartilage and press-fit insertion resulted in promising uniform results in 11 out of 13 cases with just over two years follow-up. Further cases done in the meantime (1992-1994) show excellent early results.

So far there is evidence of sound bone union and articular cartilage survival. A similar study, on the treatment of osteochondritis dissecans, confirms that the grafted area is macroscopically identical to the normal articular cartilage and that there is no histological degeneration. Long term follow-up of a larger number of cases and histological evaluation of biopsied chondral interfaces are the subjects of our continued study.

## TREATMENT OF OSTEOCHONDRITIS DISSECANS USING BIODEGRADABLE SCREWS AND PINS —A COMPARATIVE STUDY IN GOAT KNEES

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In the last decade, several different biodegradable devices were used to fixate the fragments in osteochondritis dissecans disease. They consist of poly-dioxanon (PDS), and other polymers or their composites. Only PDS is extensively applied, intra-articular, without negative side-effects. PDS, however, is only available in small, easy to bend, pins. From the other biodegradable polymers, used as pins and screws, reactive synovitis is described.

The aim of this study is to compare the intra- and extra-articular response to two different biodegradable and metal pins and screws used to fixate an artificially created, standardized, osteochondral fragment in goat knees. In 16 goats all 32 knees were operated on. In series of 8 knees, respectively compression moulded polyglycolic-poly-lactic-, as polymerized poly d,l(lactide) pins and screws and A.O. miniscrews and K-wires were used. In an other series of 8 knees only an osteochondral lesion was created. The goats were sacrificed in groups of 4, respectively 6, 12, and 18 weeks and one at 38 weeks postoperatively. Three remained for longer follow-up. Clinical, radiological, MRI and histological evaluation of the knees and histological evaluation of synovia and regional lymph nodes was done.

RESULTS: All the fragments and lesions consolidated radiologically and clinically. No synovitis was found. The MRI studies showed a considerable area of high signal intensity only around the biodegradable pins and screws, at 6, 12, and 18 weeks, and less pronounced at 38 weeks and 46 weeks. In histology, this area showed to be a fibrous capsule without necrosis or inflammation.

CONCLUSION: The biodegradable pins and screws seem to be suitable for fragment-fixation in osteochondritis dissecans, but long term follow-up is necessary to study the course of further degradation and tissue reaction.

## CORRELATIVE ARTHROSCOPIC AND HISTOLOGIC EVALUATION OF SYNOVITIS IN KNEE JOINTS

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Interpretation of synovial biopsies causes problems in most pathological laboratories. This may be partially explained by variations of inflammatory involvement within the same joint, resulting in different histological findings reflecting the same disease process. The purpose of this study was to evaluate the hypothesis that standardized arthroscopic resection procedures and histological staining methods will enhance correlation between microscopic and clinical features of inflammation.

**MATERIALS AND METHODS:** In 38 knee joints with rheumatoid arthritis the disease activity at specific areas was classified during arthroscopy. Subsequently, multiple specimens were dissected from exactly defined localizations and histologically processed. Different immunohistochemical techniques were applied to define inflammatory activity. Endoscopic and histological results were correlated by rating scales and variance analysis.

**RESULTS:** Arthroscopic examination revealed homogeneous inflammatory scores of synovium in 13 joints. In 21 patients a dramatic macroscopic variety of disease within the same joint was detected whereas 4 patients had normal appearing synovium throughout the whole joint. The highest inflammatory activity was normally seen close to cartilage or menisci. Compared to endoscopical gradings no association was found between inflammatory activity and proof of lymphocytes (CD 3, CD 4, CD 8, L 26, UCHL 1) respectively detection of macrophages using standard (immuno) histochemical techniques (CD 14, OKM 1, MAK 1, non-specific esterase, tartrate-resistant acid phosphatase). Grade of lining cell hyperplasia failed to be of diagnostic value. In contrast to literature, scoring of blood vessels only showed a weak correspondence. M 1-positive granulocytes were reliable markers for focal inflammatory alterations. Highly significant statistical correlations between disease activity confirmed by endoscopical grading were seen applying macrophage markers indicating cellular activity (ferritin accumulation, galactose affinity, peroxidase reaction).

**CONCLUSIONS:** As a rule, routine staining of synovial biopsies does not give sufficient information about the activity of rheumatoid arthritis. Applying histochemical techniques indicating activity of synovial macrophages, respectively granulocytes significantly improves accuracy of histological diagnosis compared to arthroscopic evaluation. Multiple biopsies from standardized localisations furthermore enhance reliability of this diagnostic method.

## ARTHROSCOPIC ASSISTED TREATMENT OF LATERAL TIBIAL PLATEAU FRACTURES IN SKIERS

*Peter J. Holzach, M.D., Peter Matter, M.D., and Jon E. Minter, D.O.*

The value of arthroscopic evaluation of the tibial plateau fracture site as well as the detection of associated soft tissue problems has been described by other authors. Treatment of tibial plateau fractures with the arthroscope has received only limited attention so far.

**MATERIAL AND METHOD:** A prospective study was performed on 16 patients with lateral tibial plateau fractures. All injuries were associated with alpine or cross country skiing. Inclusion in the study were those patients with a 2 mm or greater articular surface depression with radiographic findings consistent with the AO/ASIF classification of tibial plateau fractures, 41 B2.2/B3.1. A combined procedure was performed with arthroscopic visualization of the knee joint and utilization of a cannulated plateau elevator. All fractures were reduced with this device with subsequent autogenous bone graft and when indicated, transverse cancellous lag screw fixation. All but one patient appeared for a late follow up from 1 to 6.5 years and were clinically and functionally assessed by means of the modified OAK-knee scoring system, the AO-fracture documentation sheet C and by an x-ray documentation.

**RESULTS:** Of the 15 patients rated according to our knee scoring system, 14 patients were rated excellent. All patients expressed satisfaction with the operative procedure and returned to pre-injury levels of activity except for 2 patients with other limiting health or physical problems preventing resumption of skiing and related sports.

**DISCUSSION:** This procedure achieves the desired goals of accurate diagnosis, reduction and stabilisation of these fractures. This accuracy is demonstrated by not only specific inspection of the articular surface injury, but the concomitant soft tissue trauma as well. After treatment of this fracture becomes more common place with this technique, it is hoped that a more expansive role for treatment of more complex fractures may be encouraged.

**THE POSTERIOR HORN OF LATERAL MENISCUS  
ATTACHMENT TO THE ACL—A PROPER LIGAMENT  
WITH CLINICAL RELEVANCE**

*R.P. Jakob, R.W. Bühlmann, M. Kowalski,  
M. Rüegsegger, and D. Shelbourne*

A dense ligamentous connection running from the posterior horn of the lateral meniscus to the posterior and medial aspect of the tibial insertion of the ACL has been identified in arthroscopic and open knee surgery. The observation of this "meniscocrucial ligament" stimulated a literature search, an anatomy project and reflections on the function that can be attributed to this ligament:

- a) In the literature search supposing corresponding fibres could be found briefly mentioned in three anatomy references.
- b) In the anatomy project 29 cadaver knees were carefully dissected. The meniscocrucial ligament was present in two knees (7%), started at the posterior horn of the lateral meniscus anterior to the meniscofemoral ligaments and ran to the posterior and medial aspect of the tibial insertion of the ACL. Furthermore an intercruciate connection was found as a synovial membrane duplicate; it is present in all knees that also connected the posterior horn of the lateral meniscus with the ACL in 90% of the dissected knees. In 35% of the knees there could even be identified an extrasynovial fold (the menisco-crucial fold) connecting the posterior horn of the lateral meniscus with the ACL. The ligament of Humphry was present in 66%, the ligament of Wrisberg in 8%. They were never missing and were found together in 48%.
- c) The function of the meniscocrucial ligament may be the following:
  - 1) In most of the proximal ACL tears the ligament described remains intact. Due to its strength it is capable of disruption or rarely even osseous avulsion of the posterior horn of the lateral meniscus, thus interfering with the hoop tension of the meniscus function. This posterior horn avulsion was observed in 13% of 744 acute ACL tears and in 7% of 980 chronic cases of ACL instability in a prospectively documented series of one of the authors. Although not proven we assume the ligament to be responsible for this type of meniscal pathology.
  - 2) It may account for the higher incidence of lateral meniscal tears in ACL ruptures.
  - 3) It may facilitate the distal stump of the ACL to lean against the PCL to find a vascular bed and a neo-attachment leading to "partial stability" 6–8 weeks after fresh ACL tears.

Different from the ligaments of Humphry and Wrisberg where the function and clinical relevance are yet to be clearly defined, we draw attention to a structure that remained unattended so far (with the exception of the brief mentioning above), that we can now clearly define in its anatomy and frequency, and where we are able to propose its possible function and pathology.

**THE EFFECT OF IMMOBILIZATION ON MENISCAL HEALING:  
AN EXPERIMENTAL STUDY IN THE DOG**

*P.A. Dowdy, A. Miniaci, S.P. Arnoczky, P.J. Fowler, and D.R. Boughner*

**PURPOSE:** To determine the effect of post-operative immobilization on the healing of meniscal repairs in dogs.

**MATERIALS AND METHODS:** A 1½ cm longitudinal, full-thickness incision was made in the vascularized portion of the medial meniscus in 20 adult canines and anatomically repaired using vertically oriented sutures. Post-operatively, the animals were either placed in a long-legged cast (n=9) or mobilized immediately (n=11). The animals were sacrificed at 2 weeks (6 dogs), 4 weeks (6 dogs), and 10 weeks (8 dogs). Five medial menisci from the non-operated side were used as controls. The menisci were processed for histologic analysis using light and polarized light microscopy. Collagen content was measured using a digital image analysis system and the percent collagen in the repair tissue in each postoperative treatment group compared.

**RESULTS:** In the 2 week group, there was no statistically significant difference in the percentage of collagen between those animals immobilized in a cast versus those that had early mobilization (11.6±5 vs 10.6±5,  $p=0.62$ ). Similarly, there were no significant differences for the 4 week group (20.5±10 vs 25.7±10,  $p=0.15$ ). However, for the 10 week group, those animals that were mobilized had significantly greater percentage collagen in the healing meniscal incision than those that were cast immobilized (44.6±10 vs. 27.0±11,  $p<0.0001$ ). There was no significant difference in the percent collagen between the mobilized 10 week group and contralateral control menisci. All other groups had decreased percentage collagen in the healing incision compared to controls.

**CONCLUSIONS:** Prolonged immobilization decreases collagen formation in healing menisci. These results suggest that patients undergoing meniscal repair either be immediately mobilized post-operatively or immobilized for short periods of time only.

## ACL AND COMPRESSION FORCE ON THE MENISCAL POSTERIOR HORNS

Montserrat Garcia, Juan Jose Vazquez, and Ramon Cugat

The aim of the study was to evaluate the variations in compression force on the meniscal posterior horns (MPH) in relation to the status of the ACL and its insertions.

Fourteen frozen knees were Genucom stability tested and arthroscopically examined to assess the anatomical condition of the ACL and the menisci. All possible combinations of femoral anterior, anatomic and over-the-top insertions and tibial anterior, anatomic and posterior insertions were studied. Results were obtained using micro-load cells and Fuji Prescale Film, to measure the force on the MPH.

The main findings were that while the knee flexes, compression force decreases in the medial meniscal posterior horn (MMPH) and increases in the lateral meniscal posterior horn (LMPH). With partial ACL rupture, pressure decreases in both MPH. The joint is looser with total ACL rupture than with a partial rupture, producing less disperse force peaks in the LMPH than in the MMPH. ACL injury or a failed graft produces force peaks due to greater sliding of both articular surfaces, creating a point of contact different to that of the anatomy, causing articular result with instant stress. Anatomic compression force evolution was not reproduced in any of the graft insertions during flexion. In all combinations the force decreased. Increasing the pre-tension graft increases the force without modifying response. Anisometrically inserted grafts produce variations in length during flex-extension. While anterior insertion increases tension, a posterior decreases it.

## CONSEQUENCES OF MENISCAL TEARS ON ACL RECONSTRUCTIONS

Michel Bercovy and Eric Weber

The aim of this prospective controlled study is to evaluate the influence of the meniscal lesions on the objective results of ACL reconstructions. The outcome assessment is based on the measurement of the Stiffness of the knee which provides a better physical objective information on the Lachman "endpoint" than either the laxity measurement or the clinical examination.

**MATERIAL AND METHOD:** The Force/displacement (F/dl) curve of the knee is measured with a dynamometric device on x-rays between 0 N and 300 N. The Stiffness (S) and Compliance are calculated on the F/dl curve preoperatively and every year after the operation. The accuracy of this method is 98.5%, the PPV is 99%, the NPV 98%. 1502 examinations have been made on 191 Acute tears (AT), 171 Chronic Instabilities (CI) and 480 normal knees and 60 isolated meniscectomies (Control group). The ACL reconstructions have been either BPTB or an Extra Articular Fascia Lata Plasty (Lemaire). 4 meniscal situations have been analyzed: normal meniscii: M+ (n= ); sutured meniscii (n= ); pathologic in-situ meniscii (n= ); meniscectomy M- (n= ).

**RESULTS:** Stiffness (S) is given in  $10^4$  N/m

Normal knees:  $S = 13.8$ —Acute ACL tears:  $S = 2.5$ —Chronic instability:  $S = 3.4$  ( $p = 0.001$ )

Meniscectomy with normal ACL:  $S = 14.0$

Meniscal tears in Acute ACL tears 9%—in Chronic Instability 66% ( $p = 0.0001$ )

BPTB: M+, Sutured and pathologic in-situ:  $S = 6.3$ . ( $p = 0.91$ —There is no significative difference between these 3 groups)

BPTB: M-:  $S = 4.9$ .

The difference between group M+ and M- is significative above 200 N ( $p = 0.001$ ).

There is no deterioration of the BPTB between 12 and 37 months whatever the meniscal tear.

Lemaire plasty at 24 months follow-up: M+ = 4.8; M- = 3.0 ( $p = 0.03$ )

Lemaire plasty at 60 months follow-up: M+ = 3.5; M- = 2.5 (n.s.)

**CONCLUSION:** The meniscectomy decreases the stiffness of the knee after every ACL reconstruction. After the BPTB reconstruction, the stiffness is inferior in case of meniscectomy, but is stable with the passage of time up to 37 months. With the Lemaire Plasty, the stiffness decreases rapidly, but much more if a meniscectomy is performed. In regard to the stiffness of the knee, a meniscal suture or the conservation of a pathologic meniscus are better solutions than the meniscectomy if the clinical situation is not affected.



INHERENT "KNEE LAXITY" INFLUENCES THE INCIDENCE OF THE MENISCAL TEAR IN ACUTE ANTERIOR CRUCIATE LIGAMENT INJURY

A. Maeda, S. Horibe, Y. Shiozaki, and K. Shino

PURPOSE: To clarify the influence of the inherent "knee laxity" on the incidence of the meniscal tear in acute anterior cruciate ligament (ACL) injury.

METHOD: Eighty-six patients with acute unilateral ACL injury underwent open or arthroscopic evaluation within one month after the initial injury. None of them had episodes of re-injury from the initial injury to surgery. They were 42 men and 44 women with a mean age of 25 years, ranging from 14 to 48. For knee laxity measurement, antero-posterior laxity of the contralateral normal knees in all 86 patients was measured at 20 degrees of flexion with "Knee Instability Tester", our custom-made apparatus. As a parameter of inherent "Knee Laxity", total laxity of the contralateral normal knee, or antero-posterior displacement of the proximal tibia with respect to the femur at 200 N of antero-posterior force was used. Total laxity of the contralateral normal knee was 12.1±3.6 mm (mean±SD). Based on the values of total laxity, the patients classified into three groups. Patients with total laxity over 15.7 mm (> mean + SD) were classified to lax group (n=15) and less than 8.5 mm (< mean - SD), stiff group (n=18). Patients with total laxity between 8.5 and 15.7 mm were classified to normal group (n=53). Then, the incidence of the meniscal tear for each group was calculated.

RESULTS: Thirty-four patients (40%) had meniscal tear (medial, 10; lateral, 21; both, 3). In lax group, only three cases (20%) had meniscal tear, while 21 cases (40%) in normal group, and 10 cases (56%) in stiff group. Statistically significant difference in the incidence of the meniscal tear was found between lax and stiff groups (chi-squared test, p<0.05). There was little difference in the incidence of the medial meniscus tear among the three groups (lax group, 13%; normal group, 17%; and stiff group, 11%), while there was remarkable difference in that of the lateral meniscus tear (lax group, 13%; normal group, 26%; and stiff group, 44%).

DISCUSSION: This was the first report showing the correlation between the inherent 'knee laxity' and the incidence of the meniscal tear in acute ACL injury. The results of this study suggests that 'less lax knee' potentially has more risk of meniscal tear at the time of ACL injury than 'more lax knee'. In 'more lax knee', larger energy absorption may cause low incidence of meniscal tear combined with ACL injury.

CONCLUSION: Knee laxity itself influenced the incidence of the meniscal tear in acute ACL injury.

Handwritten notes: + intra-articular pmt. exposure, exposure, flex + mobilized, 7 mm int, 11 mm ext, - Arthroscopy findings + lateral meniscus.

FACTORS AFFECTING HEALING RATE OF ARTHROSCOPIC MENISCAL REPAIR

Shintaro Asahina, M.D., Takeshi Muneta, M.D., Haruyasu Yamamoto, M.D., and Kohtaro Furuya, M.D.

The purpose of this study is to clarify the factors affecting healing rate of arthroscopic meniscal repair by evaluating the meniscal status by second-look arthroscopy. Seventy-one out of 120 patients who underwent arthroscopy-assisted meniscal repair were evaluated by second-look arthroscopy with an average interval of 19 months (range, 6-63 months). Six possible factors which may have affected the healing of repaired menisci were chosen and statistically analyzed (Chi-square test) between the healed group and failure group.

Of the 71 meniscal repairs, 48 had completely healed, 8 had partially healed, and 15 had not healed. There was no statistical differences in sex, age, tear site of the medial or lateral meniscus and anterior laxity of the anterior cruciate reconstructed knee measured using KT-1000 between the healed group (n=48) and the failure group (n=23). Negative correlations with the healing rate were observed in patients who underwent central one-third zone (white-white) repair (p<0.01) and who had locked history of the menisci (p<0.01).

Some cases in the failure group showed the medial menisci actually torn in about the central 1/2 of the posterior segment which could not be fully visualized under arthroscopy. Since we routinely prepare MR images before surgery, there were no cases that we considered would fail according to the tear location. Preoperative MRI may be useful to more accurately detect tear location in the posterior segment of the medial meniscus.

## ISOLATED RUPTURES OF THE MCL—3 WEEKS IN PLASTER VS. EARLY MOBILIZATION

*Bengt Balkfors, M.D., Peter Thuresson, M.D., and Nils Westlin, M.D.*

**MATERIAL AND METHOD:** In this prospective study 60 patients with acute isolated rupture of the medial collateral ligament (MCL) were randomized to treatment in a cylinder plaster cast for three weeks or early mobilization. Both groups were permitted full weight bearing immediately and were given the same amount of support from a physiotherapist. They were examined by an experienced orthopaedic surgeon and a physiotherapist at inclusion into the study and at 3 weeks, 1, 2 and 4 months, and 1 year thereafter. All 60 patients have been followed for at least 1 year.

**RESULTS:** The plaster group had a significant ( $p < 0.001$ ) reduction of ROM at the 3 week control but regained mobility at the later controls. There were no significant differences between the two groups regarding residual valgus instability, muscle atrophy, muscle strength in Cybex test, sick leave, functional score (Lysholm) or activity level (Tegner).

**CONCLUSION:** This 1 year follow-up has not shown any advantages with a plaster cast for three weeks as a treatment for isolated MCL injuries. There was the early disadvantage of a transient reduction of ROM in the plaster group compared to the early mobilization group.

## ANTERIOR KNEE INSTABILITY IN PROFESSIONAL SOCCER PLAYERS

*Ramon Barredo, M.D. and Ernesto Guerra, M.D.*

**PURPOSE:** To determine possible "asymptomatic" ruptures of Anterior Cruciate Ligament and the possible articular damage this may cause in knees of professional soccer players with no history of injuries or previous surgery.

**SUMMARY OF METHOD:** 120 male professional soccer players with ages ranging between 20 and 30 years (mean 23) were considered. The following exams were done on both knees:

1. physical exam (anterior drawer, Lagman, pivot shift, quadriceps measure, range of motion);
2. plain x-rays (AP wwb, Lat. at 30 degrees of flexion);
3. KT 1000;
4. MRI (in knees with positive signs of ACL injury).

When in KT 1000 knees showed 3 mm anterior displacement, they were diagnosed as ACL ruptures. X-rays showing osteochondral damage in patella, medial or lateral compartment will be considered as articular damage. In the MRI, confirmation of ruptures, chondral damage and associated injuries (meniscus tears) was sought.

**RESULTS:** In the KT 1000, 14 knees were diagnosed as having ACL ruptures with anterior displacements between 3 and 5 mm (mean 3.6). At MRI, ACL ruptures were found in 12 of the 14 cases. With regard to associated injuries, meniscus tears were found in 5 knees (4 medial, 1 lateral). The x-rays showed osteochondral damage in 5 of the 14 knees: 4 medial compartment, 1 lateral compartment, 1 combined and 2 patella femoral compartment. These changes were confirmed at MRI. In the 14 ACL ruptured knees, no motion limitations or quadriceps atrophy was found.

**CONCLUSIONS:** "Asymptomatic" ACL Rupture is a condition that should be considered in athlete's knees. This may be caused by multiple, although small, traumas, producing progressive ACL disruptions until ligament gives way. Furthermore, the excellent muscular condition compensates for the progressive instability. This condition, however, should not be ignored simply because it is "asymptomatic", since irreversible changes which can lead to knee arthrosis are taking place. Routine physical exams for athletes should therefore include the ACL integrity test.

One question remains: When should these athletes be subjected to surgery?

## PARTIAL ACL LESIONS: CLINICAL AND VASCULAR ANATOMIC CORRELATION

*Rene Jorge Abdalla, M.D., Moisés Cohen, M.D.,  
Carlos Gorios, M.D., and Luis R. Nakashima, M.D.*

The aim of this study is to correlate the natural history of partial ACL lesions to the vascular anatomy, focusing on the results in case of eventual damage.

**MATERIAL AND METHODS:** Clinical—23 patients with partial ACL lesions diagnosed by arthroscopy were subdivided into 2 groups: closed sheath type (11) and open sheath type (12); both underwent conservative treatment, with 74-months average follow-up.

**EXPERIMENTAL:** 20 cadaver knees were submitted to a contrasted radiographical study, 10 specimens with the sheath and 10 without it were removed from ACL. In 10 ligaments with sheath we performed biomechanical testing, pure atial traction (elongation), and subsequent radiographical reexamination.

**RESULTS:** Clinical—using the I.S.K. score we found in the closed sheath type 45.4% normal, 45.4% subnormal and 9% abnormal. In the open sheath type 0% normal, 33% subnormal, 16.6% abnormal and 50% severely abnormal.

**EXPERIMENTAL:** The sheath is responsible for the greater part of ACL irrigation, the interstitial vascularization is poor. Elongation promotes variable damage to vascularity: vascular rupture 60% (mainly at the tibial portion); vascular narrowing and stretching in 30% and no damage in 10%.

**DISCUSSION:** Existing literature shows few studies about long-term partial lesion follow-up, none of them related to vascularization. Our classification in closed and open sheath has shown significance in prognosis and final results. This is confirmed by the experimental part of our study.

**CONCLUSION:** Closed sheath type leads to better results. The sheath should be preserved and protected. There is variable vascular damage directly related to the prognosis.

**SIGNIFICANCE:** The ACL sheath plays an important role in the partial ACL lesion.

## INCREASED TIBIAL TRANSLATION FOLLOWING PARTIAL SECTIONING OF THE ACL

*R.L. Hole, M.D., E. Kamaric, M.S.,  
D. Lintner, M.D., and J.B. Moseley, M.D.*

**PURPOSE:** To determine the increase in anterior translation of the tibia following incremental sectioning of the ACL and if these increases are clinically detectable.

**CONCLUSION:** A clinically detectable increase in anterior translation occurs after 75% of the ligament is dysfunctional.

**SIGNIFICANCE:** Partial tears of the ACL most likely represent a complete or near-complete disruption of the ACL.

**METHODS:** Six fresh cadaver lower extremities were examined in randomized, blinded fashion with the ACL intact, after sectioning of the posterolateral bundle (PLB), PLB and half of the anteromedial bundle (AMB), and the entire ligament. Lachman, drawer, pivot shift, endpoint and the examiners' impressions of the ligaments' status were assessed. At each stage of sectioning, KT-1000 arthrometry (30 lbs.) and biplanar radiography were performed to quantify translation.

**RESULTS:** KT-1000 and biplanar radiography documented a progressive increase in translation with each increment of sectioning (KT: 0.6, 3.3, 8.0 mm; BR: 0.68, 7.23, 11.44 mm, respectively, relative to intact). This was significant only after sectioning the PLB + 50% AMB and the entire ACL. Examiner accuracy was 89% in the intact and 78% in the completely sectioned ACL's. Accuracy was only 11% in the specimens with the PLB sectioned. Seventy percent of these errors were calling the partially sectioned ligament intact. Accuracy was 44% when the PLB + 50% AMB were sectioned. These errors were nearly equal in calling the ACL "intact" and "complete". The endpoint remained firm in >50% after complete sectioning.

**DISCUSSION:** Sectioning of the PLB causes a small increase in anterior tibial translation which is clinically undetectable. The most common error was calling the partially sectioned ACL "intact". Our previous study found similar results after sectioning of the AMB. The presence of a clinically detectable increase in anterior translation indicates that at least 75% of the ACL is disrupted, and most likely represents a "functionally complete tear".

## ANALYSIS OF THE SO-CALLED END POINT OF LACHMAN TEST

*Ken-ichi Murase, M.D., Kazuhiro Ohtuka, M.D., Hirokazu Kakihana, M.D., and Masaaki Itou, M.D.*

As physical examinations for the anterior cruciate ligament injury, there are anterior drawer test, Lachman test and rotatory instability test such as N-test. But in fresh injury, only a Lachman test can be performed due to pain in many cases. In such cases, characteristics at the end point of the test play a great role in diagnosis as well as tibial displacement. In this study we attempted to detect the characteristics by accelerometer and evaluated its clinical significance.

**MATERIALS AND METHOD:** Subjects were 28 normal knees, 16 injured knees consisting of 6 fresh cases and 10 old cases, and 18 ACL reconstructed knees. A small disk shaped acceleration sensor was applied on the tibial tuberosity. Movement during Lachman test was drawn as waves on the thermal array recorder through the body amplifier. Furthermore the ratio of amplitude on the first phase and that of the second phase of waves was calculated as bumping rate.

**RESULTS:** The waves detected by the accelerometer were divided into two patterns. One was spike waves consisting of two to four phases and the other was a mountain-shaped sinusoidal waves (Fig. 1).

All cases with palpable hard end point during Lachman test corresponded to the spike wave and cases with soft end point to the sinusoidal wave. All normal knees showed the spike wave. In deficit knees, 12 out of 16 knees showed the sinusoidal wave and 4 knees showed the spike wave. Arthroscopic findings of these four cases with spike waves were as follows: reattachment of the stump to the origin of posterior cruciate ligament in two cases and partial rupture at the central portion of ligament in another two cases.

Regarding reconstructed knees, 16 out of 18 knees showed spike waves and remaining two knees showed a sinusoidal wave. In the latter two cases, instability remained after operation (Fig. 2).

There were differences in spike wave showing hard end point among three groups. Bumping rate was 89 (59-120) in normal knees, 68 (37-88) in 4 injured knees showing spike wave, and 72 (30-100) in reconstructed knees with spike wave.

### CONCLUSION:

1. The characteristics of end point during Lachman test was first detected clearly by a method using accelerometer.

2. Hard end point was shown in all of normal knees. In injured knees, 75% of cases were soft end point, but remaining 25% were hard end point depending on injured pattern.
3. According to the results of bumping rate, there was a tendency to be a slight difference in the characteristics of hard end point among normal, injured and reconstructed knees.

**ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION,  
A ROENTGEN STEREPHOTOGRAMMETRIC  
ANALYSIS OF THE EFFECTIVENESS OF GRAFT  
FIXATION WITH INTERFERENCE SCREWS**

*F. Nyquist, M.D., I. Önsten, M.D., and P. Thuresson, M.D.*

Several factors affect the success of ACL-reconstruction. One of the crucial factors is the method of surgical fixation.

In previous studies different methods of graft fixation have been used on artificial bone or cadavers.

The aim of this study was to find an *in vivo* method of analysing graft fixation with interference screws.

**MATERIALS AND METHOD:** Roentgen Stereophotogrammetric Analysis (RSA) is a well established method for studying micromotion within the skeleton.

Nine consecutive patients, 8 men, 1 female, age 28 (range 19–43) with ACL-insufficiency and functional instability despite neuromuscular rehabilitation were selected for ligament reconstruction.

The autograft was prepared from the midportion of the Patellar ligament with a 25 mm bone block at each end. The bone blocks were trimmed to fit a 9 mm tunnel. A small antero-medial arthrotomy was used.

Before fixation of the graft, ten 0.8 mm Tantalum RSA-markers were implanted into the distal end of the Femur and ten into the proximal Tibia. The bony ends of the graft were prepared with two 1.0 mm markers each. For fixation of the graft two 8/25 mm RCI-modified ACL-screws were used.

No postoperative knee fixation was used and all patients were mobilized according to an accelerated rehabilitation program including full weight bearing and full range of motion.

**RESULTS:** RSA mapping was performed postoperatively and at three months postoperatively (89–119 days).

Migration of the bone blocks was found to be 0.383 mm (SD±0.305 mm) in the Tibia and 0.286 mm (SD±0.202 mm) in the Femur.

The conclusions are that the RSA technique can be used for studying graft fixation *in vivo* and that migration of the bone blocks after fixation with interferences screws is minimal.

**USE OF BIOABSORBABLE INTERFERENCE SCREWS IN  
ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION:  
MID-TERM RESULTS**

*David A. McGuire, M.D., F. Alan Barber, M.D.,  
Burton F. Elrod, M.D., and Lonnie E. Paulos, M.D.*

Anterior cruciate ligament reconstructions by bone-patellar tendon-bone grafts with bioabsorbable interference screw fixation is under laboratory and clinical investigation. The technique used in this study for reconstruction with bioabsorbable screws is identical to the technique used and defined for the cannulated, headless, titanium interference fit screws. To date there are 204 patients, 103 bioabsorbable, 101 metal, enrolled in the study at four investigational sites. Comparisons made with Lysholm scores, Tegner Activity Scale, and instrumented arthrometer at one year (b=80, m=68) and at two years (b=21, m=18) produced no significant differences between groups. Preliminary results have indicated the bioabsorbable screw provides fixation equal to that of the metal screws. The single parameter of bioabsorption will provide an excellent alternative without some of the disadvantages of metal screws. Advantages of the bioabsorbable screw include MRI compatibility for postoperative follow-up of graft placement and meniscal repairs, and radiograph translucency for assessment of graft incorporation.

**TWO-DIMENSIONAL KNEE KINEMATICS AFTER ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION: THE ROLE OF ISOMETRIC GRAFT REPLACEMENT**

*Walter R. O'Brien, M.D., Niklaus F. Friederich, M.D.,  
Werner Müller, M.D., and Charles E. Henning, M.D.*

**PURPOSE:** The purpose of this study was to determine if anterior cruciate ligament (ACL) reconstruction restored normal knee kinematics and to determine the importance of isometric graft replacement.

**MATERIAL AND METHODS:** Knee kinematics were studied two-dimensionally in fourteen cadaveric specimens using a radiographic technique. Lateral radiographs of the intact knee were taken with the tibia prone and the knee positioned at full extension, 30, 60, and 90 degrees of flexion. The radiographic protocol was repeated with the ACL cut and then after ACL reconstruction. The ACL was reconstructed using the central one-third of the patellar tendon and graft isometricity was measured using a pneumatic-driven, constant-tension isometer. Post-reconstruction radiographs were obtained and knee laxity was measured with the graft secured at full knee extension and then again with the knee flexed 90 degrees.

**RESULTS:** ACL reconstruction restored normal knee kinematics only if the graft was isometrically positioned. Non-isometric grafts failed to duplicate normal kinematics. The degree of abnormal kinematics was related to the degree of non-isometric graft placement. Overconstraint and underconstraint of knee laxity was related to the degree of non-isometric graft placement and the knee flexion angle at which the graft was secured.

**CONCLUSION:** Isometric graft placement appears to be important during ACL reconstruction in order to restore normal knee kinematics and duplicate normal knee laxity throughout a full range of motion. If the graft is not isometric, the knee will be overconstrained or underconstrained which may lead to graft failure, knee instability, and osteoarthritis.

**DRILL HOLE POSITION IN ENDOSCOPIC ANTERIOR CRUCIATE LIGAMENT (ACL) RECONSTRUCTION—RESULTS OF AN ADVANCED ARTHROSCOPY COURSE**

*D. Kohn, M.D., T. Busche, M.D., and J. Carls, M.D.*

**PURPOSE:** To evaluate the capability of experienced arthroscopists of correct tunnel placement in endoscopic ACL reconstruction.

**METHODS:** An advanced arthroscopy course was held for 48 experienced arthroscopists (> 500 operative knee arthroscopies). After live video transmission from the OR, lectures and ACL reconstruction in a plastic model, they participated in a cadaver lab. 24 cadaver knees were operated on endoscopically. Full videoarthroscopic equipment including a drill-guide system was provided. The ACL was replaced by a BTB-patellar tendon graft via endoscopic technique. Later all knee specimens were opened, photodocumented and graft position was evaluated according to recent orthopaedic literature.

**RESULTS:** In 4 specimens both tunnel positions were correct and the graft did not impinge. In 12 knees, the femoral tunnel was "unacceptable". It was too far anterior (10) or had broken through the posterior femoral cortex (2). In 6 knees the tibial tunnel was "unacceptable". Its exit was located partly in the posterior intercondylar area (4) or too far anterior (2). "Acceptable" positions of the tunnels were achieved on the femoral side in 8 and on the tibial side in 8 specimens. The positions were "excellent" femorally in 4 and tibially in 10 specimens. Graft impingement despite a correct tibial tunnel placement occurred in 6 knees with insufficient notchplasty.

**CONCLUSION:** Even after intensive theoretical instruction, practical exercises on a plastic model and the use of the latest equipment, the majority of arthroscopists will get problems with location of the drill-holes, size of the notchplasty and graft impingement in the first human knee they operate.

Placing the femoral tunnel correctly is the major problem. Endoscopic ACL-reconstruction cannot be mastered after attending a course alone.

**SIGNIFICANCE:** Endoscopic ACL reconstruction has a considerable learning curve. Supervision and expert help are necessary during the first clinical cases to avoid misplacement of the tunnels and graft impingement.

## A FLUOROSCOPIC METHOD FOR INTRAOPERATIVE AND POSTOPERATIVE CONTROL OF ACL-POSITIONING—PROXIMAL INSERTION

*Manfred Bernard, M.D., Peter Hertel, M.D.,  
and Heinrich Hornung, M.D.*

**PROBLEM DESCRIPTION:** The best proximal insertion point for a substitute of the ACL is an anatomic insertion. The anatomic landmarks of this insertion point are well known. But it is sometimes difficult to find out these anatomic landmarks during operation. So it is desirable to have an objective method to control the insertion. This study was undertaken because a description of a method does not exist, how you can exactly localize the projection of the anatomic ACL-insertion in an x-ray picture.

**MATERIALS AND METHOD:** We dissected 10 human cadaveric knees with intact ACLs. The most ventral, dorsal, distal and proximal borders of the insertion area were marked with 4 K-wires. The K-wires were shortened exactly on the bone-border of the intercondylar space. Then the knees were x-rayed in strictly lateral position. So, the shortened ends of the K-wires determined in the x-ray-picture the projection of the ACL-insertion. The centre of this marked area was called point K. Then we determined 4 distances in the x-ray picture:

distance t: that is the sagittal diameter of the lateral condyle, measured along the Blumensaat-line.

distance h: that is the maximal height of the notch.

distance a: that is the distance between K and the dorsal border of the condyle, measured along t.

distance b: that is the distance between t and K, measured on a perpendicular line on t.

So, distance a is a partial stretch of t and distance b is a partial stretch of h. Because of varying projection factors and varying sizes of the knees, absolute values of these distances are not helpful. That is the reason why we expressed a and b as a proportion of t and h.

**RESULTS:** Distance a is a 24.8% of distance t. Distance b is 28.5% of distance h. The maximal deviation of a and b was 2.2% and 2.5%. So you can say: In a strictly lateral x-ray picture the distance of K from the dorsal border of the condyle is 24.8% of the whole diameter of the condyle; and the distance of K from the roof of the notch is 28.5% of the notch-height.

**DISCUSSION:** This method is independent of the size of the knee and of the distance between x-ray-unit and the knee. The only condition is the strictly lateral x-raying of the knee. This method is easy to handle and reproducible. It can be used intraoperative, if the operator is not sure about the right insertion or if the anatomic landmarks cannot be seen exactly. It can be used postoperative for documentation of the right position of the substitute. It can be used to find out a possible reason for rupture of a transplant (insertion too far ventral) before revision operation.

## A PROSPECTIVE, RANDOMIZED STUDY COMPARING 3 SURGICAL PROCEDURES FOR TREATMENT OF ACUTE ANTERIOR CRUCIATE LIGAMENT TEARS: 5-YEAR RESULTS

*T. Grøntvedt, L. Engebretsen, P. Benum, O. Fasting,  
A. Mølster, and T. Strand*

The treatment of acute ACL tears is controversial. Long term follow-up studies of non-operative treatment have shown poor results in young and active patients. The goal of this study was to compare primary repair (repair group) with augmented repair using the Ligamentum Augmentation Device (LAD group) or bone-patellar tendon-bone grafts (patellar tendon group).

**MATERIAL:** 150 patients with acute ACL tears were randomized 50 in each group, and operated on within 10 days after injury. The rehabilitation protocol was identical for each group. The patients were followed prospectively using Tegner activity level and Lysholm functional score, clinical evaluation and KT-1000 arthrometer test at 1, 2 and 5 years.

**RESULTS:** 141 (94%) patients completed the follow-up. All 3 groups reduced their activity and functional level the first year. During the rest of the follow-up, the repair group had the lowest activity and functional level, while the patellar tendon group had the highest. Judged by the Lachman, pivot shift and KT-1000 stability tests, 56% of the ligaments in the repair group had failed at 2 and 5 years. In the LAD group, 13% of the patients had unstable knees at 2 years, increasing to 33% at 5 years. The patellar tendon patients were all stable at 2 years, whereas 8% were considered unstable at 5 years. Initially, there was a significant decreased range of motion in the patellar tendon group as compared to the other two. This problem seems to decrease with time, and at 5 years there were no significant difference between the groups.

**CONCLUSIONS:** This study shows that repair alone no longer should be done. There also is an unacceptable high incidence of reruptures in repairs augmented with the LAD. The patellar tendon augmented repairs produced the best results in all aspects.

## CLINICAL AND RADIOLOGICAL COMPARISON OF ONE AND TWO INCISION TECHNIQUE FOR ARTHROSCOPIC ACL RECONSTRUCTION WITH PATELLAR TENDON

*Nicola Santori, Lamberto Perugia, Pier Paolo Mariani, and Ezio Adriani*

**AIMS:** Purpose of this study is to verify whether is possible to identify any clinical difference between these two techniques and whether the radiological assessment of the interference screws (IS) axis has any influence on the final clinical outcome.

**MATERIALS AND METHODS:** We analyzed two randomized blinded groups at two years follow-up: group 1 (37 patients) double and group 2 (24 patients) single incision. Patients were evaluated with the IKDC form, with KT 2000 and x-rays in both AP and lateral projection. We measured the angles of the IS with the femoral axis, as proposed by Lemos, and the distance between the IS axis and a point, that we called A, identified at the intersection of the intercondylar notch with a line parallel to the posterior cortex of the femur on the lateral view. Correlations between this angle and the clinical results were performed. Statistical analysis were done with the *t* test and chi square. The level of significance was taken as  $p < 0.05$ .

**RESULTS:** In group 1 we obtained with the IKDC form 0% A, 60% B, 27% C, 13% D. In group 2 we had 7% A, 59% B, 27% C, 7% D. No statistical differences were present. Average Lemos angles in AP were 33.81 in group A and 70.16 in group B and 38.45 in group A and 26.36 in group B on the lateral projection. The distance between point A and the IS axis were -0.62 in group A and -0.64 in group B. Correlation between clinical outcome and radiographic angles didn't show any significant correlation.

**CONCLUSIONS:** We didn't recognize any statistically significant difference between the two groups in the clinical results. The radiological misurations didn't show any difference for what concern the posterior placement of the femoral tunnel. A different inclination of the femoral tunnel is present between the two techniques.

## LONG TERM RESULTS OF ACL-RECONSTRUCTION— A TWO STAGE FOLLOW-UP STUDY

*Christian Fink, C. Hoser, K. P. Benedetto, and P. Burkart*

Treatment of the ACL injury requires not only immediate restoration of knee function but has to prove its effectiveness over the years. In this study a group of patients has been followed up to 13 years after undergoing ACL surgery.

**METHOD:** 53 patients who underwent ACL reconstruction with patellar tendon autograft were examined at 5–7 years (1989). Of these patients 51 could be reexamined in 1994 (10–13 years) by the same two examiners. A similar protocol including OAK score (in 1994 additional IKDC), KT 1000 measurements, subjective and functional assessment was used. X-rays were taken at both times and compared to the preoperative standard.

**RESULTS:** At 5 years post op 42.3% of the patients had an "excellent" result according to the OAK score, 36.5% were rated as "good" and 21.2% as "fair". 5 years later the results were 52.2%, 34.8% and 13%, respectively. The patients scored less in the stability category (1989: 73.1% "excellent", 11.5% "good", 15.4% "fair"; 1994: 63% "excellent", 26.1% "good", 10.9% "fair") but higher in the other OAK parameters (pain, swelling; ROM; function). Subjective evaluation showed better results at the ten year examination (1989: 25% "very good", 40.4% "good", 21.2% "fair", 6% "bad"; 1994: 34.8% "very good", 43.5% "good", 19.1% "fair").

**CONCLUSION:** ACL reconstruction using patellar tendon showed consistent results over a 10 year period. Decrease in static stability recognized between the two stages of follow-up was found to be compensated by functional improvements and modifications in sports activities.



**DONOR SITE PROBLEMS AFTER PATELLAR TENDON  
HARVESTING FOR ACL RECONSTRUCTION:  
TENDON DEFECT CLOSURE OR NOT?**

*Lamberto Perugia, Pier Paolo Mariani,  
Ezio Adriani, and Gaetano Maresca*

**PURPOSE:**

1. To evaluate with ultrasound the patellar tendon healing after its central one-third use for ACL reconstruction in two groups of patients in which the tendon donor site was left open or was sutured.
2. To compare clinically, radiographically and with isokinetic study these two groups in order to evaluate the incidence of patellofemoral problems.

**MATERIALS AND METHODS:** Sixty-one (22 men and 39 women) arthroscopically assisted ACL reconstructions using the BTB autograft with half tunnel technique were performed by a single surgeon and the same postoperative protocol was followed. In 25 cases the tendon defect was closed (group A), in 36 was left open (group B). The patellar tendon behaviour after its removal was evaluated in these two groups with ultrasound study at 3, 6, 9, 12 months. The vertical position of the patella was measured in the follow-up lateral view at 45° of flexion and compared to the opposite normal knee. A clinical evaluation was performed during all the follow-up period and the patellofemoral problems (pain, stiffness and patellofemoral crepitus) were specifically evaluated and recorded using a modified Larsen-Lauridsen rating scale.

Isokinetic evaluation was performed at 6 months and the quadriceps index of the two groups was recorded. The statistical analysis of results was performed with the chi square test. The level of significance was taken as  $p < 0.05$ .

**RESULTS:** The ultrasound study showed that patellar tendon healing progresses initially with a compensative hypertrophy which is evident both in width and thickness. The width is greater in the group B ( $p < 0.01$ ). In group A we observed in the cross sections a characteristic picture with two ropes separated by a low signal bridge that we defined "binocular pattern". High signal areas are still present at 1 year in the open group. This area is fulfilled of scar tissue. Tendon hypertrophy is greater in females ( $p < 0.05$ ). Clinical, radiographic and isokinetic evaluation didn't show significant statistical differences between open and closed groups.

**CONCLUSIONS:** We conclude that defect closure after patellar tendon harvesting doesn't modify patellar femoral problems incidence.

**ACL RECONSTRUCTION WITH THE PATELLAR  
TENDON—AUGMENTATION OR NOT?**

*Peter Thuresson, M.D., Bengt Balkfors, M.D.,  
Olof Johansson, M.D., and Rolf Sandberg, M.D.*

**MATERIAL AND METHOD:** 130 patients scheduled for ACL reconstruction were randomly selected for surgery with a patellar tendon-bone-tendon graft as described by Brückner and Broström et al with or without augmentation with a polypropylene band (LAD) as described by Kennedy et al. The medial third of the patellar tendon was harvested together with periosteum from the patella and a short strip from the quadriceps tendon and the transplant, still attached to the tibia, was tunneled through the medial tibial and the lateral femoral condyles. The augmented knees had an LAD band stitched to and embedded into the autogenous tissue. The first 82 patients have been followed for more than 2 years. Two of the patients were not available for the 2 year follow-up and 2 patients had sustained contralateral ACL injuries.

**RESULTS:** The augmented group had a larger extension deficit 1 month postoperatively but a smaller extension deficit at the 2 year follow-up. There was more joint swelling in the augmented group 2 weeks and 1 month postoperatively. No statistically significant differences between the two groups regarding muscle atrophy, stability or the Lysholm and Tegner scores were found.

**CONCLUSION:** This 2 year follow-up has not shown any clear advantages or disadvantages with an LAD band in ACL reconstruction using the medial third of the patellar tendon.

## THE VALUE OF COLD COMPRESSION AFTER ACL RECONSTRUCTION

*Dennis J. Edwards and Gregory Keene*

The use of cold compression devices to reduce postoperative pain, swelling, blood loss and the analgesic use is currently in vogue but controversial. This paper aims to assess such a device (Cryocuff) when used postoperatively in a series of patients undergoing arthroscopic anterior cruciate ligament reconstruction by a single surgeon.

Seventy two patients were prospectively and randomly allocated to one of three groups.

1. No Cryocuff—control group—22 patients
2. Cryocuff filled with room temperature water—24 patients
3. Cryocuff filled with ice water—26 patients

Groups were well matched for age, sex and additional surgical procedures.

The surgical procedure, anaesthetic, pain protocol and postoperative care were standardised for all patients. An independent observer measured the blood loss, quantity of injectable and oral analgesics, range of motion and the visual analogue pain scores during admission. The power of the study was determined by a statistician during the study design and the results were analysed by the students *t* test and the coefficient of variation.

This prospective randomised controlled double blind study failed to demonstrate any significant difference for the parameters measured between each of the three groups. The use of a cold compression device after arthroscopic ACL reconstruction is *not* supported by this study.

## CROSS-SECTIONAL AREA MEASUREMENT OF THE SEMITENDINOSUS AND PATELLAR TENDON USING MRI—AS AN AID FOR SELECTING AUTOGENOUS GRAFT FOR ACL RECONSTRUCTION

*Masayuki Hamada, Konsei Shino,  
Tomoki Mitsuoka, and Hiroaki Kinoshita*

Autogenous ACL reconstruction using central third of the patellar (PT) or doubled semitendinosus tendon (SMT) is frequently performed. As previous experimental studies showed that the remodeling of intraarticularly-transplanted grafts is far from optimal, their mechanical properties are considered to be inferior to those of the normal ACL. Hence, larger diameter grafts are preferable, while it is not always easy to procure large diameter graft. The purpose of this study was to measure the cross-sectional area (CSA) of the autogenous PT and SMT grafts using MRI, and to evaluate their appropriateness for ACL grafts.

**MATERIALS AND METHODS:** Sixty patients who had undergone autogenous ACL reconstruction (PT,9; SMT,51) were selected. Preoperatively, MRI of axial T1-weighted images were obtained with a 1.5 Tesla imager. Then, CSAs of SMT and PT grafts were measured. To evaluate precision of the measured data with MRI, CSAs of those tendons were measured intraoperatively using a custom-made area micrometer.

**RESULTS:** The mean CSA of central third of PTs was  $36.9 \pm 9.8$  mm<sup>2</sup> ranging from 20.0 to 77.1, while that of the doubled SMT grafts was  $20.5 \pm 4.8$  mm<sup>2</sup> ranging from 9.2 to 35.0. There was a slight correlation in CSA between PT and SMT grafts of each individual. The CSA of the tendons measured with MRI was closely correlated with that directly-measured using the area micrometer.

**DISCUSSION:** This study clearly demonstrated large variability of CSA among PT and SMT grafts as well as smaller CSA of doubled SMT grafts compared to that of the normal ACL (31.3 mm<sup>2</sup> by Woo). Therefore, in case of patients with thin or narrow PT, use of the other autogenous or allogeneic tissues should be considered. Tripled or quadrupled graft should be preferred at the time of using SMT.

**CONCLUSION:** Preoperative measurement of the cross-sectional area of the tissues for ACL graft with MRI is mandatory for successful autogenous ACL reconstruction.

**MORPHOLOGICAL CHANGE OF THIGH MUSCLES  
AFTER ACL RECONSTRUCTION USING THE  
SEMITENDINOSUS AND GRACILIS TENDONS**

*Kotaro Ikeda, M.D., Toru Fukubayashi, M.D., Mamoru Niitsu, M.D.,  
Shigeru Hioki, M.D., and Koichiro Hayashi, M.D.*

Quantitative volume measurements of quadriceps femoris and hamstrings after anterior cruciate ligament (ACL) reconstruction were performed with the magnetic resonance imaging (MRI).

**MATERIALS AND METHODS:** Twenty competitive or recreational level athletes who underwent ACL reconstruction with semitendinosus and gracilis tendons were investigated at 1 year after operation. From the consecutive 15 axial slices of the MRI, the muscle volume of all components of quadriceps and hamstrings were measured separately using pattern analyzer. At the same time, peak torque of leg extension and flexion were measured with Cybex III isokinetic machine at the speed of 60 and 180 deg/sec.

**RESULTS:** The muscle volume of quadriceps femoris and hamstrings showed 2-10% decrease in comparison with the control side. Though the tendinous portions were extirpated, the semitendinosus and gracilis muscles still preserved 59.1% and 67.5% of the control side volume, and exhibited good muscle contraction at the Tagging Snapshot. Slight hypertrophy of the semimembranosus and biceps femoris muscles were observed in half of the cases. There was no regeneration of extirpated tendons, but remaining muscle belly seemed to function without degeneration. These morphological changes of thigh muscles were slightly related to the peak torque of knee extension and flexion.

**LIMITS OF INITIAL MECHANICAL FIXATION FOR  
TWO TYPES OF BONE-TENDON-BONE GRAFTS  
FOR ACL RECONSTRUCTIONS**

*Stephen H. Liu, M.D., J. Mike Kabo, Ph.D.,  
B. Ferrel, B.S., and Bryant Wiley, M.S.*

**INTRODUCTION:** Anterior cruciate ligament reconstruction requires strong initial fixation to stabilize the graft during the initial postoperative healing period. The use of bone plugs combined with interference screw fixation has optimized the initial stability of the reconstruction. The purpose of this study was to investigate the mechanical performance of two types of bone-tendon-bone grafts in a porcine knee model: bone-patellar tendon-bone and bone-hamstring tendon-bone.

**METHODS AND MATERIALS:** 123 porcine knee specimens were divided into the following reconstruction types: a) intact ACL, b) Bone-Patellar Tendon-Bone (BPB), and c) Bone-Hamstring Tendon-Bone (BHB) constructs. BPB specimens were prepared in the usual fashion. The BHB specimens used hamstring tendons wrapped and sutured around bone cores obtained from the tibial tunnel. Both BPB and BHB grafts were fixed with interference screws using endoscopic technique. The specimens were either pulled to failure monotonically or subjected to incrementally higher loading cycles. Failure force (UTS), stiffness (S), and energy to failure (E) were determined for all types of tests conducted. Residual displacement (RD) was also determined from the cyclic loading tests as a combined measure of graft stretch and fixation slippage.

**RESULTS:** Means and standard deviations for the measured mechanical parameters appear in the table below. Significance was determined using a One-way ANOVA with the Bonferroni correction for multiple comparisons. Significance was chosen at the  $p < 0.05$  level. Measured parameters were all significantly reduced for both types of reconstructions as compared to the intact ACL. The table indicates mechanical parameters for the BHB groups that were significantly different from the BPB specimens. Stiffness was significantly reduced for all of the hamstring tendon specimens. Failure force was also significantly lower for the BHB group. Higher residual displacement was observed with the BHB specimens.

Graft Type (N)	Test	UTS, N	S, N/cm	E, N-cm	RD @200N cm	vs BPB P<.05
ACL (25)	pull	1359±355	1160±398	913±425	—	UTS/S/E
ACL (14)	ICL	823±99	1229±415	339±222	0.082±0.078	UTS/S
BPB (26)	pull	597±230	267±121	437±285	—	N/A-control
BPB (27)	ICL	546±213	418±156	521±398	0.129±0.087	—
BHB (17)	pull	370±102	164±76	563±306	—	S
BHB (14)	ICL	437±151	199±63	638±384	0.368±0.156	UTS/S/RD

DISCUSSION: The reduced fixation of the BHB specimens is due in large part to the lack of integral bonding between the bone plug and the hamstring tendon. Failure occurs by slippage of the tendon with the bone core and screw remaining in situ. The BHB graft fixation relies on compression of the tendon between the bone plug and the bone tunnel. Although the BHB reconstructions indicate reduced initial fixation as compared to the BPB specimens, it is emphasized that the magnitude of the forces imposed on the reconstruction postoperatively are unknown. Further, there is clearly reduced morbidity associated with the preservation of the extensor mechanism. These tradeoffs may dictate increased protection during the initial postoperative rehabilitation period.

### HAMSTRING MUSCLE STRENGTH AFTER ARTHROSCOPIC-ASSISTED ACL RECONSTRUCTION WITH THE SEMITENDINOSUS AND GRACILIS MUSCLES (STG)

*Riko Nakajima, M.D., Yuichiro Maruyama, M.D.,  
Hiroyuki Nakajima, M.D., Katsuo Shitoto, M.D.,  
and Yasuo Yamauchi, M.D.*

1. We began by examining hamstring muscle weakness after ACL reconstruction with STG with reference to the gymnast's complaint which was difficulty in the 1 foot standing position at the finish.
2. A retrospective study of all patients who underwent ACL reconstruction with STG for more than 1 year, including 4 males and 13 females, mean age of 20.8 years was undertaken.
3. Where the mean side to side difference was 2.56 mm in KT-1000, hamstring muscle strength of the involved side was decreased at 90-110 degrees in knee flexion. Few significant differences of muscle power were found at 45-60 degrees. This was clearer in both subjective and objective in prone rather than sitting position which emphasizes hamstring muscle strength. Further, in the 1 foot standing position (with extended hip joint), the active range of knee flexion in involved side showed a difference of about 15 degrees against contralateral limb.
4. Our conclusion is that the feature of each autograft should be taken into consideration by the specificity of the athletic movement. So, we suggest it is better to utilize other types of autograft, not STG, for example in fighting sports like wrestling which needs power or for gymnasts or ballerinas who need good posture.

## A BETTER TECHNIQUE OF RECONSTRUCTING THE ACL USING HAMSTRINGS

*Ponky Firer*

**PURPOSE:** To assess prospectively new fixation techniques for ACL reconstruction using semitendinosus and gracilis.

**METHOD:** 50 patients, 12–18 months follow-up. After harvest and tunnel drilling both tendons are looped to form "4 strand ligament". Looped ends held in femoral tunnel with a toggle which penetrates femoral tunnel from "outside" by 2 cms, saving 4 cms of tendon length. The free ends which protrude from tibial tunnel are fixed. One end from each semitendinosus and gracilis are first fixed with a new ligament washer and screw. The other two ends are tensioned suitably and fixed with separate washer. Because of pulley effect of toggle equal tension is obtained in each limb of each tendon.

**RESULTS:** Range of extension: Only 1 patient had more than 3° loss of full extension. Stability: Jacob Lachman side to side differences: 0–3 mm = 42 cases; 4–6 mm = 5 cases; 6 mm = 3 cases. KT 1000 statistically equivalent results. No loss of fixation occurred as no loss of stability in first 2 months.

**CONCLUSION AND SIGNIFICANCE:** This method gives predictably stable fixation of hamstring ACL reconstruction. Length of donor tendon is relatively increased by use of toggle, by not requiring the graft to pass through the femoral tunnel for fixation. Equal tension is obtained in the 4 limbs. A 4 strand ligament gives satisfactory mechanical properties. Even short grafts can be successfully used and adequate fixation for early rehabilitation can be obtained with this technique.

## NERVOUS STRUCTURES IN THE ANTERIOR CRUCIATE LIGAMENT (ACL)

*Michael A. Scherer, M.D., Gerhard Metak, M.D.,  
Karin Herfeldt, D.V.M., and Günther Blümel, M.D.*

**INTRODUCTION:** Considering the fact that an ACL-reconstruction not only contributes to the mechanical stability of the knee joint but also serves as a sensorial receptor in the feedback mechanism of the ACL-reflex, one may wonder whether even a more or less degenerated ACL-stump still shows "nervous competence" after rupture. Should this be the case, a surgical resection—instead of an integration in the reconstruction—would, from the very beginning, reduce the prospects of success, i.e. a reinnervation of the reconstruction.

**OBJECTIVES OF THE STUDY:** Is it possible to find nervous structures in ruptured ACL's? If yes, are there any correlations between positive evidence and the posttraumatic interval? If yes, is it possible to derive an especially favourable time for the reconstruction?

**MATERIALS AND METHODS:** For the purpose of a prospective study, biopsies of ACL-stumps were taken from 35 patients for whom a reconstruction of the ACL was planned. The biopsies were stained with the avidin-biotin-complex method against neurofilament 200. A total of 596 immunohistochemically stained serial sections—checked by 3 independent investigators—were evaluated. The time between trauma and index operation was 1 day up to a maximum of 7 years.

**RESULTS:** Nerve fibres and nerve endings could be detected in 17 of the 35 biopsies. The nerve fibres in 5 of the 17 positive biopsies were located in the synovial membrane, in 2 cases they were subsynovial and in 16 cases intraligamentary. Evidence of nerve endings could always be found intraligamentary. In 14 of the 17 biopsies, the nerve endings are very close to the blood vessels. The most important observation, however, consists of the fact that there is no statistically significant negative correlation at all between the evidence of nervous structures and the posttraumatic interval.

**CLINICAL CONSEQUENCES:** Regarding the conception mentioned above (that the ACL is a mechanical stabilisator and a sensorial receptor), the evidence of nervous structures in cruciate ligament stumps up to 7 years after the injury renders the resection of these stumps obsolete. Regardless of the time of operative care, cruciate ligament stumps should be integrated in the reconstruction.

## NERVE SUPPLY OF ANTERIOR CRUCIATE LIGAMENTS AND ACL-ALLOGRAFTS

Bernd Fromm, M.D., Jürgen Graf, M.D., and Wolfgang Kummer, M.D.

This study was undertaken to demonstrate the sensory innervation pattern of anterior cruciate ligaments (ACL) and ACL-allografts.

**MATERIALS AND METHOD:** 57 kryopreserved bone-ACL-bone allografts were transplanted in a rabbit model. Survival time was between 3 and 52 weeks, the nonoperated contralateral ACL served as control. Evaluation was immunohistochemical with monoclonal antibodies to neurofilaments (for mechanoreceptive afferents), substance P (for nociceptive afferents) and tyrosine hydroxylase (for vasomotor efferents).

**RESULTS:** Show a complete absence of all nerve fibres up to the 6th postoperative week. At 12 weeks scarce nerve fibres could be detected at the margins of the transplants. At 24 weeks there were plenty of fibres present. All fibres had their own distinct pattern of distribution.

**DISCUSSION:** For the first time, two different sensory nerve fibre classes (mechanoreceptive afferents and nociceptive afferents) could be demonstrated in ACLs and ACL-allografts. In kryopreserved ACL allografts, this innervation pattern is restored 24 weeks after transplantation. These findings hint an active participation of the ACL and ACL-allograft in neurophysiologic control mechanisms of the knee joint.

## IN VIVO DIRECT MEASUREMENT OF LOAD APPLIED TO ACL GRAFTS

Konsei Shino, Masayuki Hamada, Masao Tanaka,  
Yukiyoshi Toritsuka, and Yoshito Matsui

It is still unknown how much ACL grafts are loaded during rehabilitation following ACL reconstruction. The purpose of this study was to directly measure load applied to ACL grafts during exercises included in the postoperative rehabilitation.

**MATERIALS AND METHODS:** Under continuous epidural anaesthesia, 5 patients with ACL deficiency underwent arthroscopic ACL reconstruction with drill hole technique using bone-free semitendinosus autograft or fresh-frozen allograft. After fixing the grafts' femoral end, the sutures in their tibial end were passed through the tibial drill hole, then tied to a load cell fixed to the distal calf via an ankle brace with Velcro straps. Tensile loads were measured in the following conditions and knee flexion angle was recorded simultaneously.

### RESULTS:

1. *Passive extension* The mean maximum load increase was 18 N.
2. *Active knee extension* The mean maximum load increase was 18 N, while the patients attained to  $23 \pm 3$  degrees.
3. *Full weight bearing gait (following recovery from the anaesthesia)* The mean peak load was 84 N, while they could extend the knee up to  $21 \pm 13$  degrees of flexion. The mean maximum load increase was 54 N (7.5% of body weight).

**DISCUSSION:** This study demonstrated that the load increase in the ACL grafts produced by the foot strike was consistently lower than 100 N, if the patients walk with the knee slightly flexed. When pull-out strength of currently-used graft fixation techniques is taken into consideration, early weight bearing and aggressive range of motion exercise after ACL reconstruction can be concluded to be reasonable.

## MOTION ANALYSIS OF ACL DEFICIENT KNEES IN WALKING, JUMPING AND HOPPING

Masahiko Imamoto, M.D., Hideo Matsumoto, M.D.,  
Kyosuke Fujikawa, M.D., Tsuyoshi Takeda, M.D., and Nobuyuki Rokuuma

**PURPOSE:** Several studies have been carried out on instability in the anterior cruciate ligament (ACL) deficient knees. However, most of them were in vitro studies. In this study, movement of the ACL deficient knees during walking, hopping and jumping was measured and instability due to the ACL deficiency was investigated in vivo.

**MATERIALS AND METHODS:** Twenty-five ACL injured patients and 40 normal subjects (controls) were involved in this study. They were asked to participate in following activities: 1) walking at 4.5 km/h on treadmill, 2) jumping with both extremities from 50 cm height and 3) hopping with a single extremity about 1 m distance. A magnetic three-dimensional motion analyser was used for the measurements, setting the source on the thigh and sensor on the leg. Knee movement was then measured during the above mentioned activities, and the data were analysed using a personal computer.

**RESULTS:** In walking, a significant external rotation of the tibia with respect to the femur was observed in 36% (9/25) and internal rotation in 16% (4/25). No significant change was observed in the rest, 48% (12/25), compared with the normal subjects.

In jumping, 45% (18/40) of the normal subjects landed on both heels and the rest (55%, 22/40) on both toes together. 40% (10/25) of the ACL patients landed on the toe of the injured side and on the heel of the other side. When landed, significant external rotation of the tibia was observed in the injured side, in 8 of the ten patients. Another 28% of the patients landed on both toes and the rest, on both heels.

In hopping with the injured side, a significant external rotation of the tibia was observed in 36% (9/25) of the patients.

**DISCUSSION:** From the published studies in vitro, it was generally agreed that ACL deficiency causes excessive internal rotation of the tibia at near full-extension in the static condition. However, ACL deficient knees rather rotated externally on walking, jumping or hopping in this study. Thus, it suggested that the excessive internal rotation of the tibia due to the ACL deficiency might be compensated in some cases by the dynamic constraints, such as the muscles around the knee joint in the dynamic conditions.

## EVALUATION OF FUNCTIONAL KNEE BRACES USING DYNAMIC MOTION ANALYSIS

Werner E. Siebert, M.D., and Frank Sommerfeld

**PURPOSE:** This study discusses the dynamic aspects which affect a brace function under specific loading conditions.

**METHODS:** 20 ACL instability patients with an age range from 28-35 years were examined for anterior-posterior translation (APT). This was carried out with and without functional bracing using a KT 1000 arthrometer, ultrasonography and motion gait analysis with the one leg hop square test and a tread mill (2, 4 and 6 meters/sec speed). All patients had sufficient muscle restraint to both femur and tibia but not enough to prevent APT.

**RESULTS:** With the KT 1000 arthrometer we found that when bracing is used APT is reduced from 9.5 mm to 5.2 mm (45% reduction) using a 69 N load and from 11.8 mm to 7.1 mm (40% reduction) using a 87 N load. The reduction of APT from 8.3 mm to 3.7 mm (55%) under a 150 N load application was detected by ultrasonography. The reduction is up to 1 mm by motion gait analysis.

**DISCUSSION:** The functional brace protects the unstable knee by offering a strain shield effect of ACL or its replacement at a certain load. The performance of the brace depends on the magnitude of the shear load application across the knee joint.

**CONCLUSION:** The dynamic examination of the knee joint shows that this type of bracing reduces the APT at a certain applied load.

**SIGNIFICANCE:** This study underlines the importance of functional braces in unstable knee joints.

## RESULTS OF SURGICAL TREATMENT FOR ARTHROFIBROSIS OF THE KNEE AFTER ACL RECONSTRUCTION

*Paolo Aglietti, M.D., R. Buzzi, M.D.,  
R. De Felice, M.D., and G. Zaccherotti, M.D.*

From 1987 to 1993 we operated on 28 knees affected by arthrofibrosis secondary to ACL surgery. We reviewed 26 cases with a follow-up of 4 years (range 1.5–7). The average age at reoperation was 25 (range 18–48). The initial operation was performed in the acute phase in 19 cases and in the chronic in 9. The initial surgery consisted of 15 patella tendon and 6 semitendinosus-gracilis reconstructions, and 5 direct ACL repair. In 8 acute cases the collateral ligaments were also repaired. The interval between first operation and our intervention was 11 months (range 4–25). The range of motion before our operation was 14° (range 5–35°) of flexion contracture (measured from the zero position) and 111° of maximum flexion (range 80–140°). Six of the 26 cases had a localized arthrofibrosis, treated with an arthroscopic excision of an anterior fibrous nodule. The remaining 20 cases had a global arthrofibrosis which required lysis of the suprapatellar and parapatellar adhesions, anterior compartment debridement and (in 6 cases) a posteromedial or posterolateral release. The operation was done open in 10 and arthroscopic in 10 cases. A residual flexion contracture over 5° was present in 8% and a flexion deficit over 15° in 12% of the cases. The result was considered subjectively satisfactory in 85% and the symptoms were absent for vigorous activities in 65% of the cases. Anterior tibial displacement was within 5 mm at the KT-1000 manual maximum in 81% and the pivot-shift was negative in 85%. A significant patello-femoral crepitation causing symptoms was observed in 42% of the cases. The final IKDC evaluation was deemed satisfactory in 100% of the localized forms and 35% of the global forms ( $p=0.007$ ). Mild to moderate peripheral patello-femoral and tibio-femoral degenerative changes were present in 34% and 30% respectively. Using the method of Caton a lowering of the patella compared to the opposite knee of over 15% was present in 31%. In conclusion arthroscopic treatment of the localized forms gives excellent results while in the global forms a satisfactory overall result according to the very strict IKDC form was obtained in only 35%.

## SEPTIC KNEE JOINT—ARTHROSCOPIC IRRIGATION AND LONG-TERM RESULTS

*Kurt-Alexander Riel, Jakob Primbs, and Erwin Hipp*

The purpose of this retrospective study was to evaluate the effectiveness of arthroscopic irrigation to treat septic knee joints in respect to long-term results.

Since 1982 we used an arthroscopic irrigation system to treat patients with septic knee joints as described by R. W. Jackson. In acute cases treatment started with aspiration of the effusion to evaluate for cultures. Without awaiting the result treatment was continued with immediate joint irrigation under arthroscopic control. Three redon tubes (CH 14) were introduced for continuous irrigation and for intermittent distention of the joint cavity. In case of chronic joint infection additionally all foreign and synthetic material was removed. Systemic antibiotics were given. 47 out of 58 treated patients could be re-examined with a mean follow-up of 8 years. Re-examination showed that immediate arthroscopic lavage started at the onset of septic signs had best results (less signs of osteoarthritis, less synovitis, less pain while loading and less range of motion loss). 33 patients (80%) out of 42 patients with a treated acute septic knee joint had excellent functional recovery, whereas all 5 patients with chronic septic knee joints showed poor results. Additionally, in 3 of these 5 patients with chronic septic knee joint after irrigation a further procedure was necessary due to recurrent septic knee joint.

This study indicates that acute septic arthritis has to be treated by immediate drainage, decompression, sufficient irrigation, and of course by appropriate antibiotics. In chronic cases open debridement and synovectomy is necessary.



**THE BICEPS FEMORIS COMPLEX AT THE KNEE:  
ITS ANATOMY AND INJURY PATTERNS ASSOCIATED  
WITH ACUTE ANTEROLATERAL-ANTEROMEDIAL  
ROTATORY INSTABILITY**

*Robert F. LaPrade, M.D., and Glenn C. Terry, M.D.*

**PURPOSE:** To present the anatomic relationships of the biceps femoris complex at the knee, emphasizing its clinically relevant components, and report the incidence and anatomic location of biceps femoris injuries in the acutely injured knee with anterolateral-anteromedial rotatory instability (ALRI-AMRI).

**CONCLUSION:** There are 5 parts to the long head of the biceps femoris and 6 parts to the short head of the biceps femoris, and injuries to these structures influence limits-of-motion testing in anterior cruciate ligament deficient knees.

**SIGNIFICANCE:** This data establishes, in part, the relationship of the biceps femoris complex to anterior translation instability.

**METHODS:** We dissected 30 cadaver knees to view and describe the biceps femoris muscle. Next, we surgically evaluated 82 consecutive, acutely injured knees with ALRI-AMRI for the incidence and anatomic location of biceps femoris injuries.

**RESULTS:** The main components of the long head of the biceps femoris are a reflected arm, a direct arm, an anterior arm, and a lateral and an anterior aponeurosis. The main components of the short head of the biceps femoris are a proximal attachment to the long head's tendon, a capsular arm, a biceps-capsuloosseous iliotibial tract confluens, a direct arm, an anterior arm, and a lateral aponeurosis. Fifty-nine knees (72%) had injured components. Twenty-nine knees (35.4%) had multiple components injured. There were 3 injuries to the reflected arm of the long head. The 89 injuries to the short head were in the capsular arm (n=44), biceps-capsuloosseous iliotibial tract confluens (n=24), anterior arm without fracture (n=11), anterior arm with a Segond fracture (n=8), and direct arm (n=2). A statistically significant correlation ( $p=0.01$ ) was found between increased anterior translation with the knee at 25° of flexion demonstrated by the Lachman test and injury to the biceps-capsuloosseous iliotibial tract confluens.

**POSTERO-POSTEROLATERAL INSTABILITIES OF  
THE KNEE: EXPERIMENTAL STUDY OF AN  
EXTRAARTICULAR SYSTEM TO PROTECT THE GRAFTS**

*J.-L. Meystre, and P. Trouilloud*

The autologous tendinous grafts still provide the most reliable results for the reconstruction of the knee ligaments. For the difficult cases of postero-posterolateral instability including tears of the PCL and of the popliteus complex, many techniques exist, but most publications state the fact that laxities progressively reappear in the course of the rehabilitation. The biological conditions should be favorable for the healing of the grafts. They are mainly extrasynovial and the local vascularization is excellent, but the mechanical conditions are difficult. The strains are important on the PCL, the lateral compartment is very mobile and the active muscular control is precarious.

The PCL and the popliteus complex must be reconstructed. The grafts must be protected, actively by an adequate rehabilitation and passively by an efficient system which does not impinge on the functional therapy.

We present here the biomechanical study of the technique we have used for the last 8 years. A protective synthetic ligament is inserted between the back of the fibula head and a transcondylar tunnel starting midway between the femoral insertions of the LCL and of the popliteus tendon. It is extraarticular and does not interfere with the PCL graft. Is it biomechanically acceptable and efficient?

In our cases, the pathological movement are, in fact, rotations, the axis of which is displaced on the medial side of the knee: The medial ligaments are intact and the medial congruent compartment is stabilized by the load. Consequently, our lateral protective ligament has a better lever in order to control these instabilities.

**MATERIAL AND METHOD:** The synthetic ligament corresponds to the tendinous complex of the popliteus, including its fibulopopliteal fibres. It is physiologically loose, actively tightened by the popliteus muscle. What are the consequences of its replacement by a tight ligament?

Dynamic x-rays permitted a rough evaluation which could be specified by the means of a computerized mathematical model. During flexion, the trajectory of the condylar insertion of our ligament is close to a circle arc centred on its fibular insertion, except for a short anterior curve corresponding to the automatic rotation near to full extension.

How far is this ligament able to stabilize on its own the posterior and posterolateral laxities? We have tried to answer this question by studies on corpse knees. We obtained measures of the laxity in relation to flexion angle and established three series of graphs for each knee: firstly for intact articulations, secondly after successive cutting of each posterior and posterolateral ligamentary component and finally after the putting in place of the ligament.

**RESULTS:** The ligament does not significantly interfere with the articular functions. The graphs after successive section of the posterior and posterolateral ligaments are similar to those published by different authors. We were especially interested in comparing these curves with the ones established after insertion of the fibulofemoral ligament, without any other reconstruction. They are very similar to those concernin the normal knees. The anteroposterior laxity is the same between 0° and 80° (about 2 to 3 mm). It increases a bit above 80°, reaching 5 mm at 120°.

DISCUSSION AND CONCLUSION: A quasi normal function was restored by the protection ligament on its own. Abnormal movements that could injure the autologous grafts during the first weeks of rehabilitation were eliminated. As the mobility of the operated knee increases, the protection lessens, permitting the progressive introduction of the strains necessary to the remodeling of the grafts. This fibulofemoral ligament seems to be biomechanically acceptable and efficient to protect our grafts. We used it for 12 patients operated since 1986. It definitely improved the results of our posterior + posterolateral reconstructions.

## ON THE SIGNIFICANCE OF THE POPLITEAL SYSTEM FOR THE KNEE JOINT

Gerhard Metak, M.D., Michael A. Scherer, M.D.,  
Christian Kaddick, Ph.D., and Günther Blümel, M.D.

INTRODUCTION: Stäubli and Birrer (*Arthroscopy* 6:209-220) emphasized the clinical significance of the popliteal system and described lesions in 95% of the acute ACL-ruptures and in 85.7% of the chronic lesions. The scarce literature about this kind of injury supports the conservative as well as the operative therapy.

OBJECTIVE: Investigation into the significance of a lesion of the popliteal system for the stability of the knee joint and its impact for the final result of an ACL-reconstruction.

MATERIAL AND METHODS: The tendon of the m. popliteus was severed in 9 female Merino sheep under general anaesthesia—an additional patellar tendon reconstruction of the ACL was performed on 3 of the animals. 1 year post op, the sheep were painlessly killed, the knee joints were put to translational and destructive biomechanical tests, and finally serial cuts were histologically investigated. The results of n=75 intact knee joints served as a control group. The accident was simulated *ex vivo*, and the translational parameters were determined before and after severance of the popliteal tendon *ex vivo* (n=8).

RESULTS: At the time of the injury it is not possible to diagnose the isolated lesion of the popliteus in the animal—either clinically or instrumentally. The *ex vivo*-simulation leads to almost identical results concerning translation. Contrary to that, 1 year post op the posterior translation, the ap-translation and the modified compliance index show higher values than the control group (5% significance level), revealing a progressive loosening of secondary stabilizers and an increased laxity. Histologically, all sheep revealed a spontaneous healing of the lesion, though without restitution *ad integrum*. 1 year post op the cross-sectional diameter of the injured tendon was still increased, the ultrastructure had visibly changed to a lower grade of organisation (scar), and the number of cells of the whole tendon had increased on the 1% significance level.

DISCUSSION: To our knowledge, this investigation is the first to support Stäubli's postulate that a lesion of the popliteal system might have a significant impact on unsatisfactory results concerning ACL-reconstructions. In spite of the spontaneous healing—the justification for the supporters of the conservative therapy—a significant deterioration of the stability of the joint can be demonstrated in the experimental animal as soon as 1 year post op.

### CLINICAL CONSEQUENCES:

1. The (isolated) lesion of the popliteus is beyond posttraumatic clinical and instrumented diagnosis;
2. Unattended lesions lead to an increased translational instability of the knee joint and thus to an increased strain on the menisci and the ACL-reconstruction.

## DOES PCL INSUFFICIENCY INDUCE THE STRUCTURAL CHANGE OF ACL COLLAGEN FIBERS?

*Mitsuo Ochi, M.D., Kenji Kobayashi, M.D.,  
Yoshio Sumen, M.D., and Yoshikazu Ikuta, M.D.*

**PURPOSE:** It is generally accepted that isolated posterior cruciate ligament (PCL) injuries do well when treated nonoperatively. However, arthroscopic examination on the knees with PCL insufficiency showed that the anterior cruciate ligament (ACL) loses its tension. We hypothesized that the microstructure of ACL should be affected by loss of normal tension usually functioning on ACL and that the ACL collagen fibers would change.

**MATERIALS AND METHODS:** A small biopsy sample has been taken from the proximal third and anteromedial aspect of the ACL when patients with PCL insufficiency have been surgically operated on and have consented to a biopsy. The patients were 11 males and 3 females and the age ranged from 17 to 31 years with a mean of 24 years. The interval from injury to operation ranged from 1 month to 12 years with a mean of 22.1 months. The posterior instability on the mid-point displacement ratio ranged from 7.4% to 48% with a mean of 22.8% (normal ratio: more than 50%). Five normal ACLs were taken from knees, amputated due to malignant tumors. Specimens were prepared for transmission electron microscopic examination. Under 65,000 magnification, three parameters such as the diameter of collagen fibers, the collagen packing density (percentage of sampled area occupied by collagen fibers), and the number of collagen fibers in a certain area were calculated using an automatic image analyzer.

**RESULTS AND DISCUSSION:** The mean diameter of ACL fibers in the PCL insufficiency group was significantly larger than that in the control group and the collagen packing density in the PCL insufficiency group was significantly smaller than that in the control group. There was also a significant difference in the number of collagen fibers in a certain area between two groups.

Thus, the changes of the three parameters were marked, suggesting that the tensile strength of the ACL in PCL insufficiency knees becomes weak, since it is accepted that differences in mechanical properties arise from differences in the density of collagen fibers within subfasciculi or from differences in the distributions of fibril diameters. It should be recognized that the selection of a conservative treatment for isolated PCL injury induces morphological change of other ligaments including ACL, probably resulting in weakness of the ligaments.

## MENISCAL INJURIES IN THE ISOLATED PCL DEFICIENT KNEE

*Melbourne D. Boynton, M.D., Barry R. Tietjens, MB. Ch.B.,  
and William G. Raasch, M.D.*

**PURPOSE:** The natural history of the isolated posterior cruciate ligament (PCL) deficient knee is not completely understood. Most authors have described the degenerative medial meniscal tear as the most common meniscal injury associated with PCL disruption. The purpose of this study is to characterize meniscal pathology that may occur in the isolated PCL deficient knee.

**METHODS:** From the records of 228 patients that we have seen with PCL injuries, we identified 37 patients with an isolated PCL deficient knee who underwent arthroscopy because of meniscal symptoms after the PCL tear. Detailed standardized schematic records of meniscal pathology and articular surface changes made at the time of arthroscopy were analyzed for this study.

**RESULTS/DISCUSSION:** Four patients had tears of both medial and lateral menisci. Twelve patients had tears of only the medial meniscus and 21 patients had tears of the lateral meniscus. Of the 25 lateral meniscal tears seen in arthroscopy, 18 (72%) were vertical longitudinal tears. The other seven lateral meniscal tears were radial tears (3/25, 12%) or comminuted flap tears (4/25, 16%). Only four of the 16 (25%) medial meniscal tears were vertical longitudinal tears. Seven medial meniscal tears (44%) were degenerative type tears. Three (19%) were radial tears with a horizontal cleavage extension, one was a flap tear and one was an early cleavage tear. All the knees with degenerative tears had degenerative articular cartilage changes of the medial femoral condyle and tibial plateau.

Twelve patients remembered a second injury after their PCL injury that resulted in meniscal symptoms requiring arthroscopy. The most common pattern of meniscal injury in the twelve patients who had a second knee injury was a longitudinal tear of the lateral meniscus (7/12).

The time from the PCL injury to the arthroscopy for meniscal symptoms was highly variable (mean 7.8 years, range 4 months to 25 years). The mean time from injury to arthroscopy for degenerative meniscal tears was 12.0 years versus 4.4 years for the knees with vertical longitudinal tears.

**CONCLUSION/SIGNIFICANCE:** Unlike other studies that associate PCL injury with degenerative tears of the medial meniscus, our study found vertical longitudinal tears of the lateral meniscus, that are typically repairable lesions, to be more common in the PCL deficient knee.

**BIOMECHANICAL EFFECTS OF AN ALTERNATIVE TIBIAL ATTACHMENT SITE IN BONE-PATELLAR TENDON-BONE GRAFT RECONSTRUCTION OF THE PCL**

*John A. Bergfeld, M.D., and Richard Edelson, M.D.*

To compare the biomechanical effects of standard graft placement through tibial tunnels in PCL reconstruction versus a new technique of direct screw attachment of the tibial bone plug to the posterior aspect of the tibia at the normal insertion site of the PCL.

**METHODS:** Twelve paired fresh frozen human cadaveric knees were mounted at 90 degrees of flexion and neutral rotation in a specially designed jig. Using a MTS TestStar machine, absolute posterior tibial translation was measured after applying a 20 lb posterior force at a rate of 5 mm/sec. Posterior displacement was measured at baseline, after transecting the PCL and the meniscomfemoral ligaments, and following PCL reconstruction. Within each pair, one knee was randomly assigned to a standard two tunnel PCL reconstruction with autogenous bone-patellar tendon-bone (BPTB) graft and interference screw fixation on both the femur and the tibia (group A). The other knee underwent a new type of PCL reconstruction with autogenous BPTB graft secured to the anatomic PCL insertion on the posterior tibia with lag screw fixation using a modified posterior approach (group B). Graft fixation was carried out with 20 lbs of tension. Reconstruction data was compared to baseline and transection data.

**RESULTS:** The mean increase in posterior displacement from baseline ("abnormal laxity") for group A was 4.7 mm (±1.4 mm) vs. 1.8 mm (±1.3) for group B. The difference in posterior displacement between groups A and B (2.9 mm) was statistically significant ( $p>0.005$ ). The force displacement curves for group B more closely approximated the normal baseline force displacement curves than group A.

**CONCLUSIONS:** Posterior fixation of the tibial bone graft at the normal tibial insertion site (group B) of the PCL significantly decreases abnormal posterior tibial translation ("abnormal laxity") at the time of reconstruction. An additional finding was that group B resulted in more normal appearing force displacement curves than the standard tibial tunnel technique (group A).

**COMPLICATIONS OF PCL RECONSTRUCTION BY USING ANTERIOR AND POSTERIOR INTERMUSCULAR APPROACH**

*Karl Peter Benedetto, W. Hackl, C. Hoser, and C. Fink*

Treatment of posterior cruciate ligament rupture is described controversial in literature. Functional results of conservative treated isolated PCL rupture have been quite good (Cain, Cross, Fowler, Parolie) but 40-50% of the patients complain about patellofemoral pain (Clancy, Dandy, Torg). Surgical treatment for posterior ++ or posterolateral instability has been advocated more recently (Jacob, Lobenhoffer). Surgical techniques are described as arthroscopically assisted or open reconstruction by using an anterior approach only and drilling the tibial canal for graft placement from anterior to posterior. Using the patellar tendon as autograft especially in revision reconstruction implicates the risk of neurovascular damage and difficulties in bringing the graft round the posterior tibia corner. Therefore we have been using the posterior intermuscular approach for direct screw fixation of patellar tendon and staple fixation of the LAD augmentation at the posterior tibial cortex.

The purpose of this study was to evaluate the intra and postoperative complications of using the posterior approach and posterior graft fixation.

In a prospective study the identical technique for PCL reconstruction has been carried out by the senior author since 1988 in 51 cases. For follow-up hospital charts (intra and postoperative) x-rays have been looked at and personal clinical examination using OAK, JKDC Score KT 1000 has been carried out by the junior authors.

COMPLICATIONS (n=51 cases)

RESULTS:

Skin Necrosis	1	Lesion of Tibial Nerve	1 (Transient)
Hämatoma (Revision)	1	Loosening of Staple	4
Hämatoma (Without Revision)	1	Loosening of Bone Fixation	1
Infection	0	Anterior-Posterior	(1-0)
Lesion of Popliteal Artery	0	Migration of Graft	1
Lesion of Popliteal Vein			

OAK SCORE (MINIMUM 2 YEAR FOLLOW-UP) n=34

	EXCELLENT		GOOD	FAIR	POOR
A	26/34	excellent	9/34	good	
B	30/40	excellent	4/34	good	
C	26/34		2/34		5/34 1/34
D	15/34		8/34		9/34 2/34
OVERALL	15/34		5/34		11/34 3/34

**CONCLUSION:** Additional posterior intermuscular approach can be recommended as safe regarding intraoperative complications and is highly recommended in revision reconstruction to avoid neurovascular complications. Direct screw fixation of patellar bone block is stronger than interference screw fixation (Bergfeld), and does not lead to graft avulsion and migration. If LAD is used additionally it should be stapled minimum 3 cm below joint line otherwise they may migrate being attached in the soft tissue.

**POSTARTHROPLASTICA ANALGESIA WITH  
INTRAARTICULAR MORPHINE**

*Inger Kjeldal, Birgitte Nielsen, and Stig Lau Hansen*

The present study was designed to determine whether local administration of opiates results in postoperative analgesia following knee arthroplasty, as recent studies have shown that, in the presence of inflammation or injury, the local administration of opioids will result in analgesia.

Twenty seven patients scheduled for elective knee arthroplasty were enrolled in the study and randomized prospectively to one of two groups. Patients in group A received 10 ml of normal saline and the patients in group B, 1 mg of morphine in a total volume of 10 ml of normal saline.

The VAS-score, postoperative pain medication and the level of residual spinal block were registered at 2, 4, 8 and 24 hours postoperatively.

A two-tailed Rank Sum analysis was used to compare pain score and pain medication for the two groups. The Spearman Rank-order Correlation analysis was used to measure an association between variables. No significant difference between the two groups was observed for pain-score or pain medication.

We conclude that no evidence for a peripheral opiate receptor mediated analgesia could be demonstrated in patients undergoing knee surgery under spinal anesthesia.

**POSTOPERATIVE KNEE ARTHROSCOPY ANALGESIA:  
TWO PROSPECTIVE, RANDOMIZED,  
DOUBLE-BLIND CLINICAL TRIALS DESIGNED  
TO EVALUATE THE EFFICACY OF  
INTRA-ARTICULAR MORPHINE**

*M.D. Richardson, J.A.L. Hart, A. Bjorksten, and K. McCullough*

A number of recent papers had described peripheral opioid receptors in skin and synovium which may respond to the use of intra-articular morphine. This paper described two prospective, randomized, double-blind clinical trials designed to investigate this.

Trial One compared a conventional local anaesthetic agent (100 mg Bupivacaine) injected intra-articularly with a control (Normal Saline) and 1mg of intra-articular (IA) morphine. No significant difference was noted in the first four hours between the groups with respect to visual analogue pain (VAS) scores. However, at 6 and 24 hours, the group of patients who received 1mg intra-articular morphine recorded lower pain scores and required less supplementary analgesia.

Trial Two was designed to assess a dose response relationship for intra-articular morphine comparing 5 mg intravenous (IV) morphine (control) with 1 mg and 5 mg intra-articular morphine. At early time points (1, 2 and 4 hours) similar VAS pain scores were recorded for both 5 mg IV and 5 mg IA morphine, significantly lower than the group receiving 1 mg IA morphine. At 6 and 24 hours, 5 mg of intra-articular morphine produced significantly lower pain scores and less analgesic requirements; these patients also had less sleep disturbance on the first post-operative night.

It was concluded from these two studies that 5 mg IA morphine injected intra-operatively was the most effective analgesic following knee arthroscopy.

**THE EFFECT OF INTRA-ARTICULAR INJECTION  
OF MSO4 AND BUPIVACAINE ON  
POST-ARTHROSCOPIC PAIN CONTROL**

*Clarence L. Shields Jr., Patrick A. Ruwe, and Irv Klein*

Opioids have recently been shown to produce antinociceptive effects by targeting local opioid receptors within the synovial cavity of the knee. Intra-articular bupivacaine is commonly used as a method of pain relief after arthroscopic surgery. This study sought to compare the effects of morphine, bupivacaine, and saline injected into the knee following arthroscopic surgery. In a double-blind, randomized trial, 124 patients received either bupivacaine (75 mg in 20 cc NaCl; n=23), morphine (2 mg in 20 cc NaCl; n=26), bupivacaine and morphine (75 mg bupivacaine, 1 mg MSO4 in 20 cc NaCl; n=25), bupivacaine and morphine (75 mg bupivacaine, 2 mg morphine in 20 cc NaCl; n=22), or saline (22 cc NaCl; n=28) at the completion of surgery. Postoperative pain was assessed with a 100 mm visual analog pain scale (VAS). Analgesic requirements were in the recovery room at 30 minutes, at 60 minutes, at hospital discharge, upon arrival home, at bedtime, upon arising in the morning following surgery, and at 24 and 48 hours postoperatively. Results showed that pain scores were significantly higher at 30 minutes, at discharge, and upon arrival home in patients receiving morphine alone compared to those receiving morphine 1 mg and bupivacaine. Analgesic requirements were also significantly higher at 60 minutes in patients receiving morphine alone. Patients receiving morphine in combination with bupivacaine did not demonstrate any improvement over those receiving bupivacaine alone. Overall, those patients receiving morphine alone or saline reported higher pain scores, received more supplemental analgesia, and demonstrated delayed progression to full weight bearing. Finally, preoperative VAS was correlated with VAS at discharge indicating that those patients with the most perceived preoperative pain were most likely to experience increased symptoms after surgery.

**THE EPIDEMIOLOGY OF OSTEOARTHRITIS OF THE KNEE:  
A FOURTEEN YEAR LONGITUDINAL STUDY**

*Hiroyuki Shiozaki, M.D., Yoshio Koga, M.D.,  
Go Ohmori, M.D., and Hideaki E. Takahashi, M.D.*

Osteoarthritis (OA) of the knee is the most common manifestation of joint disease. The purpose of this study was to investigate the prevalence, incidence and prognostic factors of knee OA.

**SUBJECTS AND METHODS:** A general population survey was conducted in the town of Matsudai, Niigata prefecture in 1979, 1986, and 1993 in subjects aged 40-65, 47-72, and 54-79 years old, respectively. Data were collected by a self administered questionnaire, physical examination, and weightbearing anteroposterior radiographs of the knees for each survey. Physical examination included the measurement of body weight and height, and body mass index (BMI) was calculated. Radiographs were graded 0-4 according to the modifications of the scale described by Kellgren et al, and were used to measure the femorotibial angle (FTA) as a parameter of the alignment of the lower limb. Subjects who had a previous knee injury or surgery were excluded from this study.

**RESULTS:** The data obtained from 858 female and 605 male subjects who participated in the latest survey were analyzed cross-sectionally. The prevalence of radiographic knee OA (grade  $\geq 2$ ) increased with age and was significantly higher in women than in men. Women had a slightly higher prevalence of symptomatic knee OA compared with that in men. BMI increased significantly with increasing severity of the radiographic grade of OA in women, but not in men. FTA also increased as the radiographic grade of OA progressed in both sexes. The incidence and risk factors for the development of knee OA were analyzed with 608 female and 97 male subjects with a follow-up of 14 years. The incidence of knee OA was significantly higher in women than in men. There was a significant relation between BMI and the development of knee OA, but no clearcut relationship of FTA with the development of knee OA was found.

**CONCLUSION:** Women had significantly higher prevalence and incidence of knee OA compared with those in men. Obesity was an important risk factor for knee OA. Varus deformity was thought to be a result of OA of the knee.

**DOES ABRASION ARTHROPLASTY ACCELERATE  
A REGENERATION PROCESS OF  
EBURNATED ARTICULAR SURFACE?**

*Shaw Akizuki, M.D., Yukihiro Yasukawa, M.D.,  
and Tsutomu Takizawa, M.D.*

In order to investigate the process of regeneration of eburnated articular surface and to know an effect of abrasion arthroplasty, we examined arthroscopical and histological findings of regenerated cartilage in each period of a longitudinal control study in patients with medial knee OA treated by tibial valgus osteotomy with or without abrasion arthroplasty.

**PATIENTS AND METHODS:** Patients of OA knee were divided into two groups. Group A was 50 knees treated by osteotomy with abrasion arthroplasty. Group B was 37 knees treated by osteotomy without abrasion arthroplasty. Average age and FTA of post surgery were not different between both groups. Regenerative conditions of cartilage between both groups were compared arthroscopically and histologically. The Outerbridge classification was used for arthroscopical grading from Grade 0 (normal) to Grade IV (eburnation).

**RESULTS:** Arthroscopy: Around 12 months after surgery in Group A, 26 (52%) of 50 knees showed Grade II, 21 knees showed Grade III and 3 (6%) knees showed Grade V appearance. On the other hand, 11 (30%) of 37 knees showed Grade II, 14 knees showed Grade III and 12 (32%) knees showed Grade IV appearance in Group B. There was a significant difference between Group A and B ( $p < 0.01$ ). Histology: About 50% of regenerated tissue showed hyaline-cartilage dominant tissue in both groups around 12 months after surgery. But, these tissues tended to change to fibro-cartilage dominant tissue gradually and almost all regenerated tissue showed fibro-cartilaginous appearance after 34 months from surgery.

**CONCLUSION:** We concluded that the abrasion arthroplasty with valgus tibial osteotomy might promote a regeneration of eburnated surface. However, retention of a quality of regenerated tissue as hyaline cartilage dominant tissue over time might be difficult.

**A NEW DESIGN OF MINIPLATE STAPLE  
FOR HIGH TIBIAL OSTEOTOMY**

*Dae K. Bae, M.D., Bo Y. Park, M.D., Oh S. Kwon, M.D.,  
and Moo S. Moon, Ph.D.*

**PURPOSE:** To demonstrate the superior biomechanical performance of the newly-designed 'Miniplate' staple over the conventional Coventry staple in proximal tibial osteotomy (PTO).

**MATERIAL AND METHOD:** The experimental specimen was porcine tibia. After the direct measurement of the geo-anatomy of the bone used, the bone mineral density was measured before staple insertion. For measurement of the maximum failure strength, a material testing system (Autograph ET-5, Shimatzu) was used with a numerical data processing system (IBM 80386, ASYST). Ten porcine tibiae were tested for measurement of the pull-out strength of the staple without osteotomy. But for measurement of the push-out strength which is a more physiological loading condition, eight specimens were osteotomized in the usual way of high tibial osteotomy, and by pushing the distal part of the specimen in the lateral direction, the force level at the moment the staple was ultimately pulled out was recorded.

**RESULTS:** The measured push-out strength of the Coventry staple and Miniplate are  $18.40 \pm 4.47$  kgf and  $119.95 \pm 19.06$  kgf, respectively. The pull-out strength of the Coventry staple and Miniplate are  $27.88 \pm 5.12$  kgf and  $182.47 \pm 32.75$  kgf, respectively. The conducted biomechanical test with porcine tibia revealed that Miniplate staple had at least fivefold higher pull-out/push-out strength than those when Coventry staples were used.

**DISCUSSION:** Based on the measured data, it was believed that the newly designed Miniplate staple can provide much better postoperative fixation in high tibial osteotomy biomechanically. Also early range of knee motion will be possible without application of long leg cast.

## PARALYSIS OF THE FOOT AND TOE EXTENSORS AFTER VALGUS TIBIAL OSTEOTOMY

*P. Hardy, J. Lemoine, A. Lortat-Jacob, and J. Benoit*

Postoperative paralysis of ankle and foot extensors is a not uncommon complication of valgus tibial osteotomies. Jackson found 27 cases out of 226 tibial osteotomies (12%).

The authors report on a prospective series of 15 patients operated for medial femorotibial osteoarthritis with genu varum. In all cases the genu varum was corrected by valgus tibial osteotomy (lateral distraction) using a swan-neck blade plate for bone fixation. The fibula was cut at the junction of the mid-third and distal third.

The study involved 9 men and 6 women with a mean age of 58 years (45-71 years). Investigations consisted of correction analysis by preop and postop pangonograms, serum creatinine phosphokinase (CPK), measurements of pressure in the anterolateral compartment of the leg, pre-, peri- and postoperative electromyography and postoperative arteriography.

Mean correction was 9.5° for a mean pre-operative genu varum of 6° and mean post-operative genu valgum of 3.5°. There was a consistent and late rise in CPK. The anterolateral compartmental pressure measurements were all normal or below normal. Postoperative arteriography revealed no vascular lesions.

All the peri-operative electromyographs showed electrical anomalies from tourniquet inflation onwards but these disorders worsened all the osteotomy and fixation stage. They disappeared a few minutes after loosening of the tourniquet.

These results suggest that ischaemia of the anterior tibial nerve rather than a genuine compartment syndrome are responsible for impaired dorsiflexion of the ankle and foot in cases of valgus osteotomy.

The authors therefore recommend various changes to surgical procedure relating to approach, automatic ancillary correction and fixation material and they discuss the use of the inflatable tourniquet.

## HIGH TIBIAL OSTEOTOMY VERSUS UNICOMPARTMENTAL JOINT REPLACEMENT IN DEGENERATIVE KNEE JOINT DISEASE

*Carl J. Wirth, M.D., Djordje Lazovic, M.D., and Thilo Busche, M.D.*

If conservative treatment of degenerative arthrosis with varus malalignment is no longer successful, two surgical options are available: valgization by corrective high tibial osteotomy, and unicompartmental joint surface replacement.

**MATERIALS AND METHODS:** Since 1988 we have made a prospective randomized study in Hannover, Germany of the results of high tibial osteotomy (HTO) versus unicompartmental joint replacement in 64 knees of 64 patients with medial compartment osteoarthritis. Each patient was evaluated clinically and radiologically each year post-operatively. The follow-up time now ranges from a three year minimum to six years.

**RESULTS:** So far total joint replacement was required in six patients, three with aseptic loosening of a unicompartmental joint replacement and three with progressive degenerative arthrosis following HTO. This was clearly reflected by the survival rate of both techniques. With HTO a preoperative varus alignment of 8.5° was slightly overcorrected to a postoperative axis of 9.9° valgus. With unicompartmental joint replacement, a preoperative varus axis of 6.1° was corrected to a physiologic valgus axis of 6.0°. The Knee Society Score evaluation showed a more pronounced decrease in the surviving knees with unicompartmental joint replacement compared to HTO.

**CONCLUSION:** The overall results of unicompartmental joint replacement and of HTO were almost even in our prospective randomized study in patients with varus gonarthrosis.



## ANATOMY OF THE HUMAN RETROPATELLAR ARTICULAR CARTILAGE SURFACE: A STUDY OF CURVATURE PROPERTIES

G.A. Ateshian, Ph.D., S.D. Kwak, M.Phil., W.W. Colman, M.D.,  
V.C. Mow, Ph.D., J.H. Henry, M.D., and R.P. Grelsamer, M.D.

The topography of the patello-femoral articulating surfaces may play a major role in the tracking of the patella and in determining joint contact stresses. This study quantitatively describes the topography of the retropatellar articular surface by precisely characterizing its ridges and facets. This information should be useful in prosthetic design and in accurate mapping of cartilage lesions.

**METHODS:** The three-dimensional topography of the articular surfaces of 22 unpaired fresh frozen human patellofemoral joints were determined using stereophotogrammetry (Ateshian *et al*, *J Biomech*, 1991). The data were surface-fitted and smoothed, and curvature characteristics of the surface were calculated. Maps of the maximum principal curvature and directions of minimum principal curvature were displayed for all specimens. These maps showed the location, orientation, and "sharpness" of ridges on the surface.

**RESULTS:** All the patellae except one exhibited (a) a median ridge on the proximal aspect, and (b) a transverse ridge on the lateral aspect of the retropatellar surface. Six patellae exhibited a transverse ridge that crossed entirely from the lateral aspect to the medial aspect. In 16 of 22 specimens, the proximal median ridge and the lateral transverse ridge merged to form a single ridge, extending disto-medially and dividing the patella into superior lateral, medial, and inferior lateral facets. This topography has not been reported previously and is detected by our surface curvature calculations. Finally, a secondary ridge and odd facet were found in most (17 of 22) specimens, in agreement with the current literature.

## PATELLAR RESURFACING VERSUS RETENTION IN TOTAL KNEE ARTHROPLASTY

Julian Feller, FRACS, John Bartlett, FRACS, and Derek Lang, FRCS

Patellar resurfacing in total knee arthroplasty (TKA) remains controversial. Despite numerous articles addressing the problem, there are relatively few published reports of controlled series. Of those that have been published, the majority deal either with a specific situation such as the rheumatoid knee or advanced patellofemoral disease or include mixed groups in terms of diagnosis, surgeon or prosthesis. It is difficult to decide whether the potential benefits of patellar resurfacing outweigh the potential complications in the typical osteoarthritic knee undergoing a replacement arthroplasty. The purpose of this prospective and randomized study was to evaluate the role of routine patellar resurfacing in a so-called "routine" TKA for osteoarthritis.

**PATIENTS AND METHOD:** Forty patients undergoing primary TKA for osteoarthritis by one surgeon using one prosthesis type (uncemented femoral and tibial components) and in whom the patella was not severely deformed were included in the study. They were randomized to either patellar retention or patellar resurfacing (cemented, all polyethylene component) regardless of the state of the patellar articular cartilage. Although patients were not randomized according to the state of the patellar articular cartilage, the distribution of the severity of changes was similar in both groups. Apart from removal of osteophytes, no surgery was undertaken on the retained patellas. No patient in either group required a lateral release to achieve satisfactory patellar tracking. All surviving patients (19 in each group) were evaluated at 3 years using the HSS knee score and a new, specifically designed Patellar score (maximum of 30 points for a combination of anterior knee pain, quadriceps strength, ability to get out of a chair, and stair climbing ability). The observer was unaware of the group to which each patient had been allocated.

**RESULTS:** No TKA was revised, although two patients in the resurfacing group had a further procedure (one for suprapatellar pouch adhesions, one for undiagnosed posterolateral pain). The mean HSS and Patellar scores at follow-up were 89 and 28 in the patellar retention group and 83 and 26 in the patellar resurfacing group. The differences were not significant at the 0.05 level. Statistically significant lower follow-up HSS and Patellar scores were recorded in females and in heavier patients.

**DISCUSSION:** We specifically excluded knees in which the patella was severely deformed as their inclusion may skew the results of such a study. There were no complications related to patellar resurfacing. In the medium term, we did not find any significant benefit to be conferred by resurfacing the patella during TKA for osteoarthritis if the patella is not severely deformed.

PATELLAR PROSTHESIS POSITIONING WITH REFERENCE  
TO THE PROSTHETIC TROCHLEA IN TKR—  
A ROENTGENOGRAPHIC STUDY

*P. Beaufils, M.D., M. Hossenbaccus, M.D., J.P. Levai, M.D.,  
J.P. Bouraly, and DIOMED Group*

Tilting and gliding of the patella may be a cause of poor results after TKR, resulting from patellar instability, and/or incorrect positioning of the implant. The "ideal" position may be defined by two criteria: parallelism of the patellar implant to the plane of the trochlea and centring on the centre of the trochlea and not the centre of the bony patella. The aim of the study was to evaluate radiologically the precision of a patellar cutting system taking its landmarks not from the anterior surface of the patella but directly from the prosthetic trochlea, in order to fulfil these requirements.

**MATERIALS AND METHOD:** In a prospective multicentric study, the patellar gliding and tilting, the position of the implant in relation to the bony patella, the cranio caudal cutting plane, the height and the thickness were radiologically evaluated in 134 primary identical TKR, using this cutting system. Results were correlated with pre-operative position of the patella, divided into 4 groups: perfect centring (103), tilting (18), subluxation (12), dislocation (1).

**RESULTS:**

- No gliding
- Tilting: The mean tilt angle was 0.81°. It was <3° in 87.3%, and <6° in 97.01%. Surgical approach, and pre-op position had no influence. Retinacular release (20 cases) had no influence on external tilt, but led to an internal tilt greater than 4° in 4 cases.
- Centring in relation to the bony patella: The implant was centred in 69.4%, medial in 29.8%, and lateral in 0.8%.
- Cranio caudal cutting plane was vertical in 85.8% (parallel to the anterior surface of the patella)
- Patellar height and thickness were not modified.

**DISCUSSION:** The use of a cutting patellar system fixed to the prosthetic trochlea provides a good precision when positioning the patellar component: no gliding, low tilting rate, vertical cut plane, thickness maintained. Centring of the patellar implant on the trochlea rather than on the bony patella leads to medialisation of the implant in 1/3 of cases.

A FINITE ELEMENT MODEL FOR THE ASSESSMENT OF  
JOINT STRESSES IN TWO TYPICAL TKR DESIGNS

*M. Simondi, F. Lavaste, P. Beaufils, and J.P. Bouraly*

**PURPOSE:** The design of the tibio-femoral joint geometry in TKR may contribute to wear of the polyethylene tibial component. The aim of our study was to develop a three dimensional finite element model to evaluate stresses in the tibio-femoral joint, and to compare two typical designs of TKR. In order to assess stresses in the bone/implant interface, the torque necessary to keep a loaded rotation in place was also studied.

**MATERIAL:** The finite element method provided a useful tool for analysing the 3D mechanical behaviour of TKR prostheses. An original mesh generator providing geometrical parameter variation was developed to facilitate changes in the shape of the components. The mechanical model was used to analyse three parameters: contact areas, compressive stresses under a static loading, and torques under loading with axial rotation. The method was validated by comparing experimental results from a knee simulating device. Two theoretical designs, considered representative of typical TKR designs, were compared. The designs were identical in the sagittal plane. In the frontal plane, the cross-section of the contact surface was flat for one design, and the other curved (noncongruent because of the need for axial mobility). A global compressive load of 4000 N along the axis of the tibial component was applied for two rotations: 0° and 15°, at 60° of flexion. In order to maintain the 15° rotation, a torque about the tibial axis was applied; this torque defined the requirement for maintaining a loaded rotation.

**RESULTS:** No significant difference was found between contact areas measured on the experimental device (110 mm<sup>2</sup>±10) and with the numerical model (95 mm<sup>2</sup>±20).

At 0° rotation, the flat design contact area was found to be larger, and compressive stresses smaller (43 MPa for the flat design, 50 MPa for the curved one).

At 15° rotation, the torque required to maintain a loaded rotation was higher for the curved design compared to the straight one (15 Nm and 4 Nm respectively).

**DISCUSSION:** TKR prosthesis design requires a compromise between congruency and mobility. The flat frontal cross-section design was less stressed than the curved one. Although curvature improves the inherent stability of the implant, the bone/implant interface was more constrained, thus transmitting greater shear stress to the fixation component, which can lead to loosening.

## SURVIVAL ANALYSIS AND PREDICTORS FOR FAILURE IN UNICOMPARTMENTAL PCA KNEE REPLACEMENT

*Arsi Harilainen, M.D., Jerker Sandelin, M.D., Pekka Ylinen, M.D., and Veijo Vahvanen, M.D.*

109 unicompartmental PCA arthroplasties were evaluated after a mean 2.7-year follow-up (range, 0.25–5.9 years).

**RESULTS:** In ninety-one medial arthroplasties the mean pre-operative tibiofemoral angle  $1.3^\circ$  ( $\pm 4.2^\circ$ ) varus was corrected to  $6^\circ$  valgus ( $p < 0.001$ ). Correspondingly, in eighteen lateral arthroplasties,  $16.2^\circ$  ( $\pm 4.8^\circ$ ) valgus was realigned to  $7.7^\circ$  valgus post-operatively ( $p < 0.001$ ). There were indications for revision in twenty-seven out of 109 cases. Conversion to total arthroplasty has been performed in sixteen patients, and in four patients tibial and/or femoral components have been exchanged. The main reason for revision was polyethylene wear which had resulted in increasing varus or valgus deformity. According to statistical analysis clinical findings at follow-up (first step pain and contra-compartmental pain) and lateral knee replacement predicted the risk for revision. Estimated cumulative survival at 3.7 years was 77% for the medial, and 45% for the lateral replacements, respectively ( $p = 0.3159$ ).

**DISCUSSION:** Results and survival of a fairly new metal-back design of knee prosthesis were even worse than of their old-fashioned predecessors. Revision rate after PCA unicompartmental knee replacement is unacceptably high and this type of prosthesis cannot be recommended. New designs of endoprostheses should be carefully tested before their general use.

## ENDOPROSTHETIC RECONSTRUCTION OF THE DISTAL FEMUR AND KNEE AFTER RESECTION FOR BONE TUMOURS

*Hayden G. Morris, Rodolfo Capanna, Domenico Campanacci, and Mario Campanacci*

**PURPOSE:** To review our experience using the Kotz prosthesis for distal femur and knee reconstruction after resection for malignant bone tumours and to analyse the results and complications.

**SIGNIFICANCE:** This analysis allows for more accurate prediction of future management and has led to design modification.

**METHOD:** 93 distal femoral reconstructions after tumour resection have been reviewed. Average follow-up was 51 months. The prosthesis has been assessed with respect to long term radiological appearances, functional outcome and complications.

**RESULTS:** Complications requiring reoperation were numerous (55%). There was a 5% infection rate for primary cases. The polyethylene bushing of the knee hinge mechanism failed in 42% of cases, failure correlating with age, weight, and quadriceps excision. Stem breakage occurred in 6% of cases, always through the basal screw hole. Quadriceps excision was associated with infection, stem breakage, bushing failure and clinical results. Radiologically, at final follow-up, there were excellent or good results recorded in most cases. A correlation was found between the number of screws used for fixation of the diaphyseal stem and the diaphyseal bone remodeling grade. Clinically there were 75% excellent or good results. Failure was usually associated with a complication, especially infection. Suggestions concerning prevention of complications are made. Design modifications are discussed. The hinge mechanism and quadriceps excision are discussed in detail.

**CONCLUSION:** The endoprosthesis used in this anatomical location has a survivorship of 76.5% at 8 yrs.

**Albert Trillat**  
**Young Investigator's Award—Winner**

**"Effects of a Notchplasty on the Normal Knee"**

Robert F. LaPrade, M.D.

We assessed the possible association between intercondylar notchplasty and early arthritic and gait changes in the knee. Eighteen adult greyhounds were divided equally into three groups and followed for 6 months. Group I had a sham operation and served as controls. Group II had a 4 mm notchplasty of the lateral femoral condyle where it articulates with the tibial spine. Group III had a 7 to 8 mm notchplasty of the lateral femoral condyle (50% of the lateral femoral condyle).

Both Group II and Group III dogs had a decreased normalized peak vertical force by force plate gait analysis at 3 and 6 months compared to Group I controls ( $p < .05$ ). There was no significant difference between Groups II and III. The notch width index (NWI) remained the same throughout the study for Group I. In Groups II and III the NWI increased immediately after surgery, but at the end of 6 months, these returned to near preoperative measurements ( $p < .05$ ). Histopathologic studies (*hematoxylin-eosin* and *Safranin O* stains) revealed remodeling of the notchplasties with a thin layer of lamellar bone covered by fibrous connective tissue. Both Group II and Group III dogs demonstrated loss of surface proteoglycans in the articular surfaces outside the notchplasty sites ( $p < .05$ ).

We found that intercondylar notchplasty in the anterior cruciate ligament-intact knee caused early arthritic histopathologic changes and abnormal gait studies at 6 months. In addition, we found that a significant refilling of an apparently nonimpinged notchplasty occurred by six months after surgery.

**Albert Trillat**  
**Young Investigator's Award—Runner-Up**

**"Meniscus Regeneration With and Without Autogenous Tissue Scaffold: A Comparative Canine Study"**

Thomas Parker Vail, M.D.

The purpose of this project was to evaluate the use of autogenous tissues to reconstruct a surgically excised meniscus in a canine model. In order to test this hypothesis, a total of nineteen adult mongrel canines underwent complete medial meniscectomy of the stifle joint. These animals were divided into two groups and compared. The control group (seven animals) had meniscectomy without grafting. The grafted group (twelve animals) had meniscectomy followed by immediate replacement using an autogenous tissue graft. The anterior, posterior, and midsubstance height, as well as the exposed tibial surface area was recorded for the intact meniscus, the fresh implanted graft, and the regenerate at the time of harvest in both the grafted and non-grafted groups. In the grafted group, one specimen was harvested at ten days, two at twenty-eight days, two at three months, two at six months, two at nine months, and three at twelve months. In the control group two specimens were harvested at six and nine months, and three at twelve months. Photographs were taken, histologic sections of the regenerate and the articular cartilage were studied. Dimensional analysis was performed using a two-way analysis of variance to compare the regenerate to the intact for both groups, and to compare the grafted to nongrafted regenerate. All harvested specimens showed articular cartilage changes. Histologic analysis showed collagenous tissue with cellularity increasingly resembling normal meniscus over time in both groups. The graft served as a scaffold over which the synovium grew into the joint space, with both the graft and the associated regenerate tissue visible at twelve months after implantation. Analysis of variance revealed significantly more coverage of the exposed tibial surface in the mediolateral (ML) dimension in the grafted group relative to the non-grafted group ( $p=0.0061$ ). In the anteroposterior (AP) dimension there was more coverage of the tibial plateau in the grafted than in the non-grafted group, but the trend did not reach statistical significance ( $p=0.061$ ). Both the grafted and non-grafted groups had significantly more tibia exposed in both the AP and ML dimensions at harvest ( $p<0.05$ ) than in the intact state prior to meniscectomy. This work suggests that autogenous tissues can be used to increase tissue regeneration after meniscectomy in a canine model, with the graft serving as a scaffold over which regenerate tissue can grow into the joint.

## VIDEO THEATER ABSTRACT PRESENTATIONS

### Video Theater Hours of Operation

Saturday, May 27 9:00 a.m.-1:00 p.m.  
Sunday, May 28 9:00 a.m.-1:00 p.m.  
Monday, May 29 9:00 a.m.-1:00 p.m.  
Tuesday, May 30 9:00 a.m.-1:00 p.m.

\* Denotes Exhibitor

### Video #1

G. Agar, MD,\* N. Halperin, MD  
*Arthroscopically Assisted Reconstruction Of The Anterior Cruciate Ligament Using Semitendinosus And Gracilis Tendons*

### Video #2

Mario Berenstein, MD\*  
*Laser Instrumentation In Arthroscopy Surgeries*

### Video #3

Mario Berenstein, MD\*  
*Ankle Arthroscopy Surgery*

### Video #4

David N. Caborn, MD,\* Bill Adkisson, MD, Darren Johnson, MD,  
William Urban, MD, Mark McDonald, MD  
*Arthroscopic Repair Of A Bankart Lesion Using Tag Suture Anchors*

### Video #5

Philippe Delince MD,\* P.Y. Descamps, MD, T. Scheerlinck, MD, D. Hardy, MD  
*Etiological Hypotheses Of Cyclops Nodule And Its Prevention*

### Video #6

Peter J. Fowler, MD\*  
*Posterior Cruciate Ligament (PCL) Reconstruction: Arthroscopically Assisted Technique Using Hamstring Tendons*

### Video #7

Danilo Gervasoni, MD,\* G. Savori, MD, G. Grazioli, MD, A. Salvini, MD,  
C. Moreshesti, MD  
*A Personal Method And Instrumentation In ACL Arthroscopic Repair (In-Out Technique)*

### Video #8

Christopher D. Hamilton, MD,\* Ronald E. Glousman, MD, Neal S. El Attrache, MD,  
Frank W. Jobe, MD, Christopher Jobe, MD  
*International Impingement: Expanding The Concepts Of Impingement And Instability*

## VIDEO THEATER ABSTRACT PRESENTATIONS

### Video #9

Masao Ishimura, MD\*  
*Arthroscopic Meniscal Repair With Fibrin Glue*

### Video #10

Sung-Jae Kim, MD,\* Dong-Seung Lee, MD, Nam-Hong Choi, MD,  
Soo-Chan Lee, MD, Hyun-Chung Kim, MD  
*One-Incision Technique For Arthroscopic PCL Reconstruction*

### Video #11

Michael R. Krogsgaard, MD, PhD,\* Poul Dyhre-Poulsen, MD, PhD,  
Adam Hede, MD, PhD  
*Initiation And Demonstration Of The Cruciate Ligament Reflexes Of The Knee*

### Video #12

Yoshiomi Kuriwaka, MD,\* Yuuji Okada, MD, Kazumasa Inoue, MD  
*Development Of Drill Hole Preparation And Syndesmopexy Tool In ACL Reconstruction Surgery*

### Video #13

Jacques Philippe Laboureau, MD\*  
*A Two Bundle Reconstruction Of The PCL*

### Video #14

Franz Landsiedl, MD\*  
*Arthroscopic Intra And Extraarticular Capsulorrhaphy As Therapy Of Recurrent Dislocation Of The Shoulder*

### Video #15

Neil James Maki, MD\*  
*Posterior Shoulder Instability: Rationale For Arthroscopic Treatment*

### Video #16

Ichiro Yoshii, MD\*  
*Outside-In Approached Inside Meniscal Suture Technique*

## POSTER ABSTRACT EXHIBITS

Poster Exhibits will be on display during regular meeting hours and during all breaks. Poster Exhibits will be located in the Grand Foyer of the Hong Kong Convention and Exhibition Centre.

\* Denotes Poster Exhibitor

- # 1 G. Agar, MD,\* N. Halperin, MD, O. Haroe Peer, MD  
*Arthroscopically Assisted Reconstruction Of The Anterior Cruciate Ligament Using Semitendinosus And Gracilis Tendons*
- # 2 K. C. Ang, MD,\* P. Thiagarajan, MD, S. Das De, MD, K. Bose, MD  
*Knee Ligament Injuries Associated With Open Tibial Fractures*
- # 3 Noemi Balajti MD,\* Andrea Santha, MD  
*Endoscopic Carpal Tunnel Release*
- # 4 D. J. Beard, MSc\*  
*The Effect Of Reconstruction On Proprioception In The Anterior Cruciate Ligament Deficient Knee*
- # 5 J. Bono, MD,\* Pamela J. Sherman, MD, R. Windsor, MD, T. Sculco, MD, A. Fuchs, MD, M. Figgie, MD, A. Inglis, MD, R. Laskin, MD, R. Adelman, MD  
*Intramedullary Arthrodesis Following Failed TKA*
- # 6 Kamal Bose, MD,\* James Goh, MD, Peter Lee, MD  
*The Role Of Vastus Medialis Oblique On Patella Tracking During Knee Extension*
- # 7 Peter J. Brooks, MD,\* R. Robert Miller, PhD, Robert Gorab, MD, V. James Sammarco, MD  
*Viability Of Human Articular Cartilage Awaiting Fresh Transplantation*
- # 8 Paolo Bulgheroni, MD,\* Paola Guffanti, MD, Ornella Galli, MD, Stefano Cattaneo, MD, Luca Andrini, MD, Coretta Sapienza, MD  
*Walking In Anterior Cruciate Ligament Injuries*
- # 9 Francisco A. S. Cafalli, MD,\* Amancia Ramalho, MD, Serafirm Vincenzo Cricenti, MD, Rogerio Pedreschi Caldana, MD  
*Tridimensional Measurements Of Cruciate Ligaments*
- #10 S. C. N. Chan, MD,\* B. B. Seehdom, MD  
*The Effect Of Tibial Geometry On Prediction Of Tenions In The Cruciate Ligaments Of The Knee*
- #11 Dezso Csepai, MD\*  
*The Diagnostic Value Of Arthroscopy In Symptomatic Shoulder Instability In Young Overhead Athletes*
- #12 Ramon Cugat, MD,\* Montserrat Garcia, MD, Juan Carlos Monllau, MD, Xavier Cusco, MD, Jaume Vilaro, MD, Xavier Juan, MD, Angel Ruiz-Lotorro, MD  
*Anatomical Landmarks Of The ACL*
- #13 Delcogliano, MD,\* A. Branca, MD, A. Caporaso, MD, M. Maji, MD, Salvatore Franzese, MD  
*Cyclops Syndrome: A Vibrovascular Tumor?*

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- #14 Salvatore Franzese, MD,\* Antonio Delcogliano, MD, Antonio Caporaso, MD, Camilla Sagarriga Visconti, MD, Giulio Maccauro, MD, Giovanni Lorini, MD, Claudio Cappabianca, MD, Francesco Franceschi, MD  
*X-Ray Microfocus, SEM, Fluorescent And Light Microscopy To Evaluate Bone-Biomaterials Interactions*
- #15 Francesco Paolo Di Carlo, MD,\* F.P. DiCarlo, MD, G. Carchia, MD, F. Di Pietro, MD, V. Cariello, MD, A. Macchiarola, MD, D. Borestti, MD  
*Osteochondritis Dissecans Of Knee: Fragment Fixation By Histoacryl*
- #16 F. Franceschi, MD,\* Antonio Delcogliano, MD, Salvatore Franzese, MD, V. Denaro, MD, M. Valeriani, MD, S. Denaro, MD  
*Somatosensorial Central Abnormalities After Lesion Of Anterior Cruciate Ligament*
- #17 B. Fromm, MD,\* J. Graf, MD, H. P. Kaps, MD  
*Nerve Supply Of Anterior Cruciate Ligaments And ACL-Allografts*
- #18 Akihiro Fujimoto, MD,\* Yoshikatsu Kuroki, MD, Yujiro Mori, MD  
*The Long Term Natural History Of Anterior Knee Pain Syndrome In Adolescents*
- #19 T. Ted Funahashi, MD,\* Dale M. Daniel, MD, Kenton Kaufman, PhD  
*The Effects Of Gravity And Attachment Sites On The Isometry Of The PCL*
- #20 Levente Gaspar, MD,\* Kalman Szepesi, MD, Csaba Farkas, MD, Zoltan Jonas, MD  
*Changes Of Knee Stability In ACL Rupture And After The Reconstructive Surgery*
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*Early Pathological Change In Experimentally Produced Articular Cartilage Injury-Findings Of DDP Layer And Surface Injury*
- #24 Peter Hidas, MD,\* Geza Bartos, MD, Istvan Berkes, MD  
*Mensicus Replacement*
- #25 D. Hirtz, MD,\* G. Godolias, MD, D. Schellhoh, MD  
*Meniscus Rupture At Its Base After Sports Injuries-Meniscus Suture (Indication, Results, And Specific Problems)*
- #26 Sherwin S. W. Ho, MD,\* Marc N. Coel, MD, Richard D. Wasnich, MD  
*MRI Abnormalities In The Asymptomatic, Older Knee*
- #27 Rikito Hokama, MD,\* Masamitsu Tsuchiya, MD, Akio Kigawa, MD  
*Effect Of Increase In Quadriceps Muscle Power And Body Weight On Promotion In Rank Of Sumo Wrestlers*
- #28 Sadafumi Ichinohe, MD,\* Masaaki Yoshida, MD, Tatsuya Kikuchi, MD, Hanae Hakoishi, MD, Akira Izumi, MD, Yuu Aoki, MD, Masataka Abe, MD  
*Follow-Up Study Of ACL Reconstruction Using Leeds-Keio Ligament*

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*Length Change Of The Intra-Articular Graft In ACL Reconstruction Using Modified Over-The-Top Method With Bone Trough*
- #30 Marty Ivey, MD,\* William L. Buford, Jr., PhD, Rita M. Patterson, M. Eng.,  
Greg L. Peare, MD, Doane K. Nguyen, MD  
*Muscle Balance At The Knee-Moment Arms For The Normal Knee, ACL Minus Knee, PCL Sparing Prosthesis, And PCL Sacrificing Prosthesis*
- #31 Marko Kadija, MD,\* Milan Gusic, MD  
*Significance Of The Arthroscopic Management In The Treatment Of The War Injuries In The Region Of The Knee*
- #32 Hiroo Kanai, MD\*  
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- #33 Kyoseki Kanemitsu, MD,\* Shinro Takai, MD, Nobuyuki Yoshino, MD,  
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- #34 Akiyoshi Kawarabayashi, MD,\* Shinro Takai, MD, Nobuyoshi Watanabe, MD,  
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*MR Imaging In Osteochondritis Dissecans Of The Knee*
- #35 Sung-Jae Kim, MD,\* Hyun-Kon Kim, MD, Dong-Wook Kim, MD,  
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*New Method Of Reconstruction For Ligamentous Injuries Of Medial Compartment Of Knee*
- #36 Masashi Kimura, MD,\* Kennji Shirakura, MD, Yasukazu Kobayashi, MD,  
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- #37 Z. Knoll, MD,\* I. Berkes, MD, L. Jozsa, MD  
*Histological Follow-Up The Healing Of Patellar Tendon Used For The Replacement Of ACL*
- #38 Tatsuo Kobayashi, MD,\* Y. Yoshihara, MD, A. Samura, MD, M. Shimmei, MD  
*Chondrocalcin Is Useful Marker To Evaluate Cartilage Degeneration In ACL Insufficient Knee*
- #39 Holger E. Koepf, MD,\* A. Zschaebitz, MD, H. J. Gabius, PhD, F. E. Isemer, MD  
*The Healing Process In Ruptured Patellar Tendons—Modifications In The Expression Of Endogenous Lectins*
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- Lipscomb and Anderson presents  $\approx 27$  cases

- Paul Brief Anthropology 1981

- A. J. S. Med 1954 22 N<sup>o</sup> 1.

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- 1988 + D.S.S. Brit Med J

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