The Knee Society

and the

American Association of Hip and Knee Surgeons

Combined Specialty Day Meeting

Saturday, March 25, 2006

McCormick Place South Grand Ballroom B-C
Chicago, IL

Scientific Program

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Future Combined Specialty Day Meetings

San Diego, CA	February 17, 2007
San Francisco, CA	March 8, 2008
Las Vegas, NV	February 21, 2009
New Orleans, LA	February 27, 2010
San Diego, CA	February 26, 2011
San Francisco, CA	February 11, 2012
Washington, DC	February 23, 2013
New Orleans, LA	March 15, 2014

Abstracts for the 2006 Knee Society Interim Meeting, the 2007 Specialty Day Meeting Award consideration and the 2006 AAHKS Annual Meeting (papers and posters) can be submitted on the Knee Society Website (www.kneesociety.org) or the AAHKS website (www.aahks.org). The deadline for receipt of Abstracts is April 15, 2006.

2006 Combined Specialty Day Scientific Program

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and
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Saturday, March 25, 2006
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Chicago, IL

ACCREDITATION

This activity has been planned and implemented in accordance with the Essential Areas and policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint sponsorship of the American Academy of Orthopaedic Surgeons and The Knee Society. The American Academy of Orthopaedic Surgeons is accredited by the ACCME to provide continuing medical education for physicians.

CREDIT HOURS

The American Academy of Orthopaedic Surgeons designates this educational activity for maximum of 8 category 1 credits toward the AMA Physician's Recognition Award. Each physician should claim only those hours of credit that he/she actually spent in the activity.

OBJECTIVES

The Knee Society/AAHKS Specialty Day program is designed to provide practicing orthopaedic surgeons with current information regarding surgical techniques, emerging technology and symposia discussions on managing total knee arthroplasty, and to enhance the care of patients with arthritis and degenerative diseases of the knee joint.

Please complete and return your Evaluation Form to the Knee Society table at the conclusion of the Meeting. Thank you!

Please turn off cell phone ringers while inside the Scientific Session rooms. Thank you.

The Knee Society/AAHKS
Combined Specialty Day Scientific Program
Saturday, March 25, 2006

8:00 AM	**WELCOME** Russell E. Windsor, MD, Knee Society President John J. Callaghan, MD, Knee Society Education Committee Chair Joseph C. McCarthy, MD, AAHKS President Arlen D. Hanssen, MD, AAHKS Education Committee Chair
	SYMPOSIUM I: IMPROVING ON THE BASICS IN TKR: DIFFICULT DEFORMITES Moderator: Merrill A. Ritter,* MD, Mooresville, IN
8:05-8:12 AM	**Severe Valgus and Varus Deformities** Daniel J. Berry,* MD, Rochester, MN
8:13-8:20 AM	**Recurvatum** E. Michael Keating,* MD, Mooresville, IN
8:21-8:28 AM	**Flexion Contracture** Johan Bellemans,* MD, Leuven, Belgium
8:29-8:36 AM	**Extraarticular Deformity** Russell E. Windsor,* MD, New York, NY
8:36-8:51 AM	**DISCUSSION**
	SYMPOSIUM II: OPTIMIZING FLEXION IN TOTAL KNEE REPLACEMENT Moderator: Cecil H. Rorabeck, MD, London, ON, Canada
8:52-8:59 AM	***In Vitro* Studies on High Flexion** Harry H. Rubash,* MD, Boston, MA
9:00-9:07 AM	**Performance Characteristics of High Flexion Knee Designs** A. Seth Greenwald, DPhil (Oxon), Cleveland, OH
9:08-9:15 AM	**How to Optimize Flexion Using Standard Prostheses and Techniques** Richard D. Scott,* MD, Boston, MA
9:16-9:23 AM	**Use of High Flexion Fixed Bearing Knees** Michael A. Kelly,* MD, New York, NY
9:24–9:31 AM	**Use of High Flexion Mobile Bearing Knees** Chitranjan S. Ranawat,* MD, New York, NY

9:32-9:39 AM **Rehabilitation and Pain Management Protocols to Obtain High Flexion**
Adolph V. Lombardi, Jr.,* MD, Columbus, OH

9:39-9:54 AM **DISCUSSION**

9:55-10:10 AM **BREAK**

SYMPOSIUM III: DVT PROPHYLAXIS IN TOTAL KNEE REPLACEMENT: THE ONGOING DEBATE
Moderators: Daniel J. Berry,* MD, Rochester, MN and John J. Callaghan, MD, Iowa City, IA

10:10-10:14 AM **American College of Chest Physicians (ACCP) Guidelines: Rationale for Recommendations**
John J. Callaghan, MD, Iowa City, IA

10:15-10:22 AM **Aspirin is Enough**
Paul A. Lotke,* MD, Philadelphia, PA

10:23-10:29 AM **Rationale for Use of Low-Molecular Weight Heparin**
Clifford W. Colwell,* Jr., MD, La Jolla, CA

10:30-10:36 AM **Rational for Use of Warfarin**
Vincent D. Pellegrini, Jr., MD, Baltimore, MD

10:36-10:50 AM **DISCUSSION**

The Knee Society Award Presentations

10:50-10:53 AM **Mark Coventry Award**
Introduction: James A Rand, MD, Paradise Valley, AZ

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10:54-11:04 AM ***Mark Coventry Award Paper***
Venous Thromboembolic Disease after Total Knee Arthroplasty: Prevention of Readmission by Extended Prophylaxis
Vincent D. Pellegrini, Jr., MD, Baltimore, MD

11:05-11:10 AM **DISCUSSION**

11:11-11:14 AM ***Chitranjan Ranawat Award***
Introduction: Thomas P. Sculco, MD, New York, NY

11:15-11:25 AM ***Chitranjan Ranawat Award Paper***
Long Term Survivorship and Failure Modes of 1000 Cemented Condylar Total Knee Arthroplasties
Michael B. Vessely,* MD, Lake Oswego, OR

11:26-11:31 AM **DISCUSSION**

11:32-11:35 AM ***John Insall Award***
Introduction: Russell E. Windsor, MD, New York, NY

11:36-11:46 AM ***John Insall Award Paper***
Factors Affecting Patient Satisfaction with Total Knee Arthroplasty
Philip C. Noble, PhD, Houston, TX

11:47-11:52 AM **DISCUSSION**

11:53 AM-12:03 PM **JOHN INSALL TRAVELING FELLOWSHIP REPORT**
Presenter: W. Norman Scott, MD, New York, NY

12:04-12:55 PM **LUNCH BREAK**
(Knee Society Business Meeting - Members Only)

SYMPOSIUM IV:
COMPUTER ASSISTED AND MINIMALLY INVASIVE TOTAL KNEE REPLACEMENT
Moderator: Lawrence D. Dorr,* MD, Inglewood, CA

12:55-1:02 PM **Computerized Navigation in Total Knee Replacement**
Past, Present and Future
Richard S. Laskin,* MD, New York, NY

1:03-1:10 PM **Use of the Computer as a Teaching Tool in Knee Replacement Surgery**
S. David Stulberg,* MD, Chicago, IL

1:11-1:18 PM **Use of Computer Assisted Surgery in Difficult Total Knee Reconstruction**
Kenneth A. Krackow,* MD, Buffalo, NY

Approaches to MIS Knee Replacement:
1:19-1:25 PM **Why I Use the Mini-Quadriceps Split**
Giles R. Scuderi,* MD, New York, NY

1:26-1:32 PM **Why I Use the Mid-Vastus Approach**
Steven B. Haas,* MD, MPH, New York, NY

1:33-1:39 PM **Why I Use the Sub-Vastus Approach**
Mark W. Pagnano,* MD, Rochester, MN

1:40-1:55 PM **DISCUSSION**

1:55- 2:10 PM **BREAK**

SYMPOSIUM V:
WEAR IN TOTAL KNEE REPLACEMENT
Moderator: Leo A. Whiteside,* MD, St. Louis, MO

2:10–2:17 PM **Kinematics Related to Wear Following Total Knee Replacement**
Timothy M. Wright,* PhD, New York, NY

2:18-2:25 PM **Information from Autopsy and Revision Retrievals**
Gerard A. Engh,* MD, Alexandria, VA

2:25-2:32 PM **The Unicompartmental Knee:**
Design and Technical Considerations in Minimizing Wear
Jean-Noël A. Argenson MD, Marseille, France

2:33-2:40 PM **The Cruciate Retaining Knee:**
Design and Technical Considerations in Minimizing Wear
Thomas S. Thornhill,* MD, Boston, MA

2:41-2:48 PM **The Cruciate Substituting Knee:**
Design and Technical Considerations in Minimizing Wear
Robert E. Booth, Jr.,* MD, Philadelphia, PA

2:49-2:56 PM **The Mobile Bearing Knee:**
Design and Technical Considerations in Minimizing Wear
Douglas A. Dennis,* MD, Denver, CO

2:56-3:10 PM **DISCUSSION**

SYMPOSIUM VI:
BURNING ISSUES IN REVISION KNEE SURGERY
Moderator: Steven J. MacDonald, MD, London, ON, Canada

3:10-3:17 PM **Use of Cemented Versus Cementless Stems**
Robert T. Trousdale,* MD, Rochester, MN

3:18-3:25 PM **Patella Reconstruction Options**
Arlen D. Hanssen,* MD, Rochester, MN

3:26-3:33 PM **How Much Constraint is Necessary?**
Thomas P. Sculco, MD, New York, NY

3:34-3:41 PM **Options for Reconstructing Bony Defects**
Thomas P. Vail,* MD, Durham, NC

3:42-3:49 PM **When is a Hinge an Option?**
William J. Maloney, III,* MD, Stanford, CA

3:49-4:04 PM **DISCUSSION**

SYMPOSIUM VII:
PEARLS ON AVOIDANCE AND TREATMENT OF INTRAOPERATIVE AND POSTOPERATIVE COMPLICATIONS
Moderator: David G. Lewallen, MD, Rochester, MN

4:04-4:10 PM **Medial Collateral Ligament Tears**
Aaron G. Rosenberg,* MD, Chicago, IL

4:11-4:17 PM	**Exposure of the Stiff Knee** W. Norman Scott,* MD, New York, NY
4:18-4:24 PM	**Dealing with Preoperative Hardware** J. Bohannon Mason*, MD presenting for Thomas K. Fehring,* MD, Charlotte, NC
4:25-4:31 PM	**Patella Tendon Avulsion** Robert L. Barrack, MD, St. Louis, MO
4:32-4:38 PM	**Patella Maltracking** Paul F. Lachiewicz,* MD, Chapel Hill, NC
4:39-4:45 PM	**Wound Complications** Kelly G. Vince,* MD, Hermosa Beach, CA
4:45-5:00 PM	**DISCUSSION**
5:00 PM	**Adjourn**

(*) indicates something of value received from a commercial company or institution

Scientific Presentation Abstracts

Symposium I: Improving on the Basics in TKR: Difficult Deformities

Severe Valgus and Varus Deformities

Daniel J. Berry, MD *Rochester, MN*

Optimal knee stability and function are achieved by gaining optimal limb alignment and ligament balance during total knee arthroplasty.

Varus Knee

In the varus knee the medial structures typically are contracted. After making cuts to optimize limb alignment, the following measures may be used to provide knee balance:

1. Removal of residual medial femoral and tibial osteophytes—this prevents "tenting" of the medial structures by excessive bone.
2. Release of the medial joint capsule from the proximal tibia.
3. Selective release of the superficial MCL subperiosteally from the medial tibia. Release of posterior MCL fibers loosens the knee more in extension, increase of anterior MCL fibers loosens the knee more in flexion.
4. Other methods for severe cases: (a) medial femoral epicondylar osteotomy, (b) resection of the medial tibial bone with downsizing of tibial component.
5. Cautions: Avoid over release of superficial MCL especially in women.

Valgus Knee

In the valgus knee lateral structures typically are contracted and the lateral femoral condyle is hypoplastic. After optimal bone cuts (attention to get proper femoral rotation) the following measures may be used to gain optimal knee balance:

1. Remove lateral osteophytes.
2. Release lateral joint capsule from tibia.
3. Pie crust lateral structures: start with IT band, include LCL as needed. Preserve the popliteus which helps maintain stability in flexion.
4. Release of arcuate complex from lateral condyle, either as soft tissue sleeve or as epicondylar osteotomy. Reserve this method for cases in which pie crust method insufficient.
5. Cautions: Avoid over release of lateral structures from epicondyle which can lead to excessive lateral laxity in flexion (and posterior stabilized knee dislocation in figure-4 position).

References:

1. Insall JN, Easley ME: Surgical techniques and instrumentation in total knee arthroplasty. P. 1553. In Insall JN, Scott WN, (eds): *Surgery of the knee*. Churchill Livingstone, Philadelphia, 2001.

2. Kanamiya T, Whiteside LA, Nakamura T, Mihalko WM, Steiger J, Naito M: Effect of selective lateral ligament release on stability in knee arthroplasty. *Clin Orthop Rel Res* 404:24-31, Nov. 2002.

3. Whiteside LA, Saeki K, Mihalko WM: Functional medical ligament balancing in total knee arthroplasty. *Clin Orthop Rel Res* 380:45-57, Nov. 2000.

Financial Disclosure: a,c – DePuy; a – Zimmer, Stryker

Symposium I: Improving on the Basics in TKR: Difficult Deformities

Preoperative Recurvatum

E. Michael Keating, MD, *Mooresville, IN,* John Meding, MD

Recurvatum is a deformity seen in preoperative total knee replacement patients with an incidence of less than 1% of all primary knees. Because of the unusual occurrence, many surgeons have little experience in dealing with this deformity. Many surgeons have concerns regarding the recurrence of the deformity and the potential for other instabilities in the knee developing post operatively, especially now, with the realization of increased post wear in posterior stabilized implants with hyperextension or when hyper extended.

Preoperative recurvatum can be associated with severe osseous deformities, including genu valgus and ligamentous laxities, as well as neuro muscular disease. The presence of nuero muscular disease does not preclude total knee replacement. However a thorough evaluation of the quadriceps, hamstrings, and foot and ankle complex should be done. In a previous review, from the Mayo Clinic, patients with poliomyelitis, and extremely weak quadriceps and severe muscular dysfunction had an increased chance of recurrence of hyperextension, which is similar to our experience in poliomyelitis. However, the absence of the quadriceps by itself does not cause the hyperextension deformity, nor does it cause it to recur. Our experience in the treatment of recurvatum in patients with neuro muscular disease is that if the ankle is able to dorsiflex to neutral or past neutral, then the deformity is unlikely to recur. However, if the ankle is unable to dorsiflex to neutral, then the deformity recurrence is mandatory in order for the patient to be able to walk. This is a very important observation that should be made preoperatively in patients with nuero muscular disease. In patients with no neuro muscular disease, the deformity is often due to genu valgus and, or anterior tibial erosion. In patients with normal neuro muscular function hyperextension deformities do not recur and there is no need to try to over stuff the extension gap. A paper published by us several years ago showed that recreating the joint line prevented recurrence of deformity. It is important to avoid even mild degrees of residual instability in the coronal plane because this will cause an increased recurrence of the hyperextension deformity especially in rheumatoid arthritis.

Conclusion: In patients with normal neuro muscular function, recurvatum tends not to recur after total knee replacement. However, care should still be taken to avoid any ligamentous instability and hyperextension at the time of surgery. Doing this, the deformity tends not to recur. In 57 knees previously reported on from our institution only two knees developed 10 degrees of hyperextension post operatively. Both of which had some residual medial instability at the time of surgery. No other knee had a recurrence of deformity and the tibia femoral joint line post operatively was within .6mm of the original joint line.

References:

Giori NJ, Lewallen DG: Total knee arthroplasty in limbs affected by poliomyelitis. *J Bone Joint Surg.* 84A: 1157-1161, 2002.

Meding, JB, Keating EM, Ritter, MA, Faris PM, Berend ME: Total knee replacement in patients with genu recurvatum. *Clin Orthop* 393: 244-249, 2001.

Meding, JB, Keating EM, Ritter MA, Faris PM, Berend ME: Genu Recurvatum in total knee replacement. *Clin Orthop* 416: 64-67, 2003.

Financial Disclosure: a – Biomet

Symposium I: Improving on the Basics in TKR: Difficult Deformities

Surgical Algorithm for Treating Flexion Contracture during Total Knee Arthroplasty

Johan Bellemans, MD, *Leuven, Belgium,* H. Vandenneucker, J. Victor, J. Van Lauwe

A specific surgical algorithm for dealing with flexion contracture in total knee arthroplasty at our institution was retrospectively evaluated using a prospectively collected database of 2898 patients.

Our algorithm consisted of 4 sequential steps that were executed until full passive extension was achieved. In step 1 mediolateral ligament balancing was performed together with meticulous resection of all osteophytes. In step 2 a progressive posterior capsular release and gastrocnemius release was performed. Step 3 included additional overresection of the distal femur up to a maximum of 4 mm, and in step 4 a tenotomy of the hamstrings was performed.

The results from our study demonstrate that 98.6% of the cases with flexion contracture less than 30 degrees (N=889) could be corrected with step 1 and 2. Even in flexion contractures greater than 30 degrees (N=35), additional proximalisation of the distal femur and hamstring tenotomy was only necessary in 28.6% and 22.8% of cases respectively.

Financial Disclosure: a,b,c,e – Smith and Nephew

Symposium I: Improving on the Basics in TKR: Difficult Deformities

Correcting Extra-Articular Deformity in Primary TKA

Russell E. Windsor, MD, *New York, NY*

Most knee deformities can be corrected by standard medial or lateral ligamentous release during routine total knee replacement. Extra-articular deformity, caused by fracture malunion/non-union, dysplasia, or osteootomy, may cause a significant impact on obtaining proper alignment of the knee during this procedure. Long standing x-rays should be obtained to assess the anticipated distal femoral and proximal tibial resection needed to restore the correct mechanical axis.

There are three surgical options: (1) Standard total knee replacement with appropriate ligament release; (2) 2-Stage delayed corrective osteotomy and total knee replacement; (3) 1-Stage corrective osteotomy and total knee replacement utilizing intramedullary rod extensions or supplemental plate fixation. Extra-articular deformity may either add to the overall deformity or subtract from it. As a general rule, if the proposed line of resection of the distal femur or proximal tibia does not violate the collateral ligament insertions, a standard total knee replacement can be performed. Extra-articular deformities >20 degrees located in the mid-diaphysis are best treated by two-stage corrective osteotomy and total knee replacement. Deformities >20 degrees between the mid-diaphysis and metaphysis can be treated by single-stage osteotomy and total knee replacement utilizing intramedullary stem fixation and supplemental screws or plates to control rotation.

Another general rule (Hungerford) states that, the farther the deformity is away from the knee, the less impact it has on the mechanical axis at the knee joint itself. However, for most cases, once carefully assessed can be done utilizing standard total knee replacement with appropriate ligamentous releases.

References:

Wang JN, Wang CN. TKA with extra-articular deformity. *J Bone Joint Surg* 84-A:1769-74, 2002

Wolff A, Hungerford DS, Pepe CL: The effect of extra-articular varus and valgus deformity on total knee arthroplasty. *Clin Orthop* 271:35-45, 1991

Lonner JH, Siliski JM, Lotke PA: Simultaneous femoral osteotomy and total knee arthroplasty for treatment of osteoarthritis associated with severe extra-articular deformity. *J Bone Joint Surg* 82-A:342-8, 2000

Financial Disclosure: c, e - Zimmer

Symposium II: Optimizing Flexion in Total Knee Replacement

Achieving Flexion after TKA: In Vitro Robotic Studies

Harry H. Rubash, MD, *Boston, MA,* Ephrat Most, PhD, Guoan Li, PhD

Total knee arthroplasty is a highly successful and reproducible procedure yielding outstanding results for patients with a variety of disorders. Most contemporary knee designs are associated with a range of motion between 110° – 120° of knee flexion. However, several patient activities are associated with knee flexion greater than 120°. New total knee arthroplasties have been designed to accommodate higher degrees of flexion. We applied in vitro robotic experimental protocols to quantify the kinematic and biomechanical aspects of knee flexion in the native knee and after fixed and mobile bearing standard and high flex TKA designs.

Cadaveric human knee specimens were tested using the robotic testing system. The native knee kinematics was evaluated under combined quadriceps (400N) and hamstring (200N) muscle load and measured at 0°, 30°, 60°, 90°, 120°, 135° and 150° of flexion. A TKA was then inserted using: a NexGen CR component, NexGen CR-Flex component, NexGen LPS component, NexGen LPS-Flex fixed bearing component and NexGen-Flex mobile bearing component (Zimmer, Inc., Warsaw, IN). The reconstructed knee was tested using the same protocol as described for the intact knee. The capability of standard and high flexion TKAs to restore knee kinematics, specifically posterior femoral translation and axial tibial rotation up to 150° was evaluated by comparing the data to that of the intact normal knee. In addition femoral-tibial contact was compared.

The in vitro robotic system has given us new insights into the kinematics and biomechanics of the native knee and the knee after TKA. The native knee achieves flexion by combining a highly mobile lateral meniscus with posterior femoral rollback and internal tibial rotation. The native knee in high flexion is very stable due to the geometrical interlocking of the femur, tibia, and the posterior soft tissues. The Anterior Cruciate Ligament and the Posterior Cruciate Ligament do not appear to play a significant role in high degrees of flexion. After TKA, all total knee arthroplasties had associated kinematic paths that were very similar to that of the intact knee. However, standard designs were associated with limited femoral rollback after approximately 125° and posterior contact between the femoral component and the posterior edge of the tibial polyethylene. High flexion designs were found to permit more normal knee kinematics and to accommodate increased femoral rollback with improved loading of the tibial polyethylene articular surface. High flexion designs had the capacity of allowing a more natural kinematic path and biomechanical contact when compared to standard designs.

The in vitro robotic testing system has provided important information concerning the kinematics and biomechanical aspects of the native knee and the knee after TKA. This information is extremely important and will aid in the development of improved surgical techniques and prosthetic designs for total knee arthroplasty.

Financial Disclosure: a,c - Zimmer

Symposium II: Optimizing Flexion in Total Knee Replacement

Performance Characteristics of High Flexion Knee Designs

A. Seth Greenwald, DPhil (Oxon), *Cleveland, OH*

Introduction: The success of total knee arthroplasty has contributed to its worldwide expansion to Middle Eastern and Asian patient populations, where the attainment of high knee joint flexion is often a cultural requirement. This study investigates the tibial plateau stresses that occur during high flexion activities in four contemporary total knee designs.

Methods: A three-dimensional, finite element model was created for each design studied from physical measurements of sterile, implantable quality production parts. Loading conditions for the more demanding high flexion activities of stair descent (60°), stair climb (90°) and deep knee bends (135°) were simulated. Contact areas and stresses on the tibial insert were calculated and their magnitudes and locations imaged photorealistically allowing visual comparisons of the different designs for each loading condition.

Results: Each design handled the demands of high flexion activities in a different manner. Total contact areas varied between 277mm^2 and 831mm^2 with peak contact stress varying between 8.0MPa and 34.2MPa. Femoral cam engagement in the posterior stabilized designs promoted load sharing between the central post and the posterior medial and lateral compartments of the tibial plateau.

Discussion and Conclusions: The results of this study demonstrate that high flexion activities are very demanding and cause large stresses to develop in the posterior tibial plateau regions. This increases the likelihood of early polymer damage and suggests that design conformities which avoid line contact at these increased flexion angles are needed to ensure component longevity.

The FDA has NOT cleared the following medical devices for the use described in this presentation. The following medical devices are being discussed for an off-label use. (Finsbury Dual Bearing Knee, Aesculap emotion)

Symposium II: Optimizing Flexion in Total Knee Replacement

How to Optimize Flexion Using Standard Prostheses and Techniques

Richard D. Scott, MD, *Boston, MA*

It is important to be aware that high knee flexion (greater than 130 degrees) is not necessary for most activities of daily living. Seventy degrees of knee flexion is necessary for a normal gait on level ground. Ninety degrees is needed to ascend most stairs. One hundred degrees is necessary to descend these stairs and clear the trailing leg. One hundred and five degrees is needed to arise from a normal chair. One hundred and twenty degrees is enough to arise from a low sofa or standard toilet seat.

Certain patients are more likely than others to have difficulty achieving adequate flexion after TKA including those with specific diagnoses (JRA, RA, post-traumatic, post-multiple surgeries) and patients with poor pre-operative motion. Intra-operative factors affecting motion include certain aspects of surgical technique and specific prosthetic geometry. The best predictor of ultimate knee flexion for individual patients is their flexion against gravity with the capsule closed at the end of the procedure. Post-operative factors influencing flexion include wound healing, the rehabilitation program, patient pain threshold and their motivation.

In summary, the causes of stiffness after TKA are multi-factorial. The potential for a problem can usually be anticipated pre-operatively and minimized by taking certain intra-operative and post-operative measures regarding surgical technique, prosthetic design and rehabilitation.

References:

1. Scott, R.D., and Siliski, J.M.: The Use of a Modified V—Y Quadricepsplasty during Total Knee Replacement; to Gain Exposure and Improve Flexion in the Ankylosed Knee. *Orthopedics*, 986;8:45-48.
2. Lee, D.C., Kim, D.H., Scott, R.D., and Suthers, K: Intraoperative Flexion Against Gravity as an Indication of Ultimate Range of Motion in Individual Cases After Total Knee Arthroplasty. *J. Arthroplasty*, 1998,13:500—503.
3. Scott, R.D.: "Total Knee Arthroplasty". Elsevier, Philadelphia, Pa. 2006.

Financial Disclosure: c – DePuy Ortho

Symposium II: Optimizing Flexion in Total Knee Replacement

Use of High Flexion Fixed Bearing Knees

Michael A. Kelly, MD, *New York, NY*

Patients in many parts of the world, particularly the Middle and Far East, utilize deep flexion of their knees in many activities of daily living. As the long term clinical TKA successes in younger patients have emerged, these more active patients often wish to utilize increased ROM as well.

Current posterior cruciate ligament substituting TKA designs are only intended for safe ROM of 120-125. With this in mind, the design of fixed bearing high flexion TKA has begun to emerge. Typically, these designs utilize extended posterior femoral condyles to improve the tibio-femoral contact area in deep flexion, avoiding edge loading of the femoral component.

To reduce extensor mechanism impingement in deep flexion, the tibial component is recessed anteriorly. Early designs utilized a posterior cruciate ligament substitution with improved spine-cam kinematics, but PCL retaining designs have begun to emerge. Early biomechanical evaluation by Rubash *et al* has demonstrated excellent kinematics of a single high flexion PS design. Early clinical results with these designs have demonstrated excellent ROM with improved posterior offset and likely better contact.

It should be remembered that high flexion following TKA is a multi-factorial issue involving more than prosthetic design alone.

References:

Lig, Most E. Sultan P, Schule S, Zayaontz S. Park SE, and Rubash HE: Knee Kinematics with a High-Flexion Posterior Stabilized Total Knee Prosthesis. An In-Vitro Robotic Experimental Investigation. *JBJS* 86A: 1721-1729 2004

Argenson JN, Scuderi GR, Komistek RD. Scott WN, Kelly MA, and Aubaniac JM: In vivo kinematic evaluation and design consideration related to high flexion in total knee Arthroplasty. *J Biomech* 38(2):277-84 2005

Kim YH, Sohn KS, Kim JS: Range of Motion of Standard and High Flexion Posterior stabilized Total Knee Prosthesis. *JBJS* 87: 1470-1475 2005.

Financial Disclosure: c,e - Zimmer

Symposium II: Optimizing Flexion in Total Knee Replacement

Design Specific Increase in Range Of Motion with the PFC Sigma RP-F TKR: A Matched-Pair Study

Chitranjan S. Ranawat, MD, *New York, NY,* A.S. Ranawat, MD, S. K. Gupta, B. Zikria, J. Zikria

Introduction: The new PFC Sigma RP-F knee has been designed to permit 155º of flexion after TKR without compromising wear, polyethylene contact stresses, patello-femoral tracking, or stability by utilizing a third articulating condyle in the post-cam mechanism. This study explores the question of whether component design can influence post-operative ROM after TKR independent of pre-operative ROM.

Materials and Methods: From July 2004 to March 2005, 50 posterior-stabilized PFC RP-F knees were performed in 45 patients who were matched to 50 RP knees in 45 patients for age, sex, BMI, pre-operative diagnosis, duration of follow-up and pre-operative ROM as shown in Table 1. Clinical and radiographic analysis was done according to criteria defined by The Knee Society.

	P.F.C. Sigma RP-F	**P.F.C. Sigma PS RP**	***p* value**
Number of TKA	50	50	
Follow-up (months)	6.6 (range 3-12)	8 (range 3-12)	
Age (years)	67 (range 48-84)	68.5 (range 48-89)	0.5
BMI	28 (range 20.9-36.8)	28.7 (range 22.1-41)	0.5
Sex M:F	10:35	10:35	
Pre-op diagnosis	Osteoarthritis 50	Osteoarthritis 50	
Mean Pre-op ROM	110º (60º-130º)	110º (70º-130º)	0.4
Mean Post-op ROM	122º (range 90º-150º)	116º (90º-130º)	.04
Increase in ROM if pre-op ROM < 120º	15º	7º	.04

Discussion: This study is the first to suggest that patients with less motion have more to gain from the RP-F design. This was most apparent in patients with less than 120º of motion. With the new PFC SigmaRP-F design, greater knee ROM after TKR can be achieved independent of the patient's pre-operative ROM. Future primary TKRs may need to incorporate the design features of the RP-F knee to maximize potential ROM.

Financial Disclosure: e – DePuy Ortho

Symposium II: Optimizing Flexion in Total Knee Replacement

Rehabilitation and Pain Management to Obtain High Flexion in Total Knee Arthroplasty

Adolph V. Lombardi, Jr., MD, FACS, *Columbus, OH,* Alejandro J. Viacava, MD; Keith Berend, MD

While the primary goal of total knee arthroplasty is to relieve pain and discomfort, functional restoration has emerged as an important goal. Clinical pathways continually evolve and focus on rapid recovery and improvement in functional restoration.

The entire perioperative process for the patient and family, including both office and hospital procedures, has been refined to establish a culture of healing in which patients are advised from the initial evaluation that they will be able to rapidly return to activities of daily living. Currently, patients are out of bed within hours of surgical intervention, commencing range of motion and discharged directly to home within 24 to 48 hours. Various groups of patients undergoing primary TKA are retrospectively reviewed to examine the independent effects of the perioperative protocols and less invasive approach on early outcomes.

Refined perioperative protocols in combination with a less invasive; mini-arthrotomy approach using specialized instrumentation has resulted in a dramatic improvement in early postoperative. In addition, flexion requirements for functional restoration, factors influencing range of motion, techniques for enhancing range of motion are reviewed.

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Financial Disclosure: c,d,e – Biomet, Inc

Symposium III: DVT Prophylaxis in Total Knee Replacement: The Ongoing Debate

American College of Chest Physicians (ACCP) Guidelines: Rationale for Recommendations

John J. Callaghan, MD, *Iowa City, IA*

The following are the recommended guidelines for prevention of venous thrombosis reported in *CHEST* 2004: 126 (suppl. 3). They are designed to provide guidance to health care providers and are not intended to replace or preclude clinical judgment. The strength of the benefits and risks are based upon randomized control trials. Definitions of the grades of recommendations are given below.

Grades of Recommendations	
Grade*	Supporting Evidence/Implications
1A	Randomized controlled trials have consistent results. It is very certain that benefits do, or do not, outweigh risks. This is the strongest recommendation.
1B	Randomized controlled trials have inconsistent results or major methodological weaknesses. Strong recommendation.
1C+	Generalization from randomized controlled trials was considered to be secure or the data from observational studies is overwhelmingly compelling. Can apply to most patients in most circumstances. Strong recommendation.
1C	Observational studies or data are generalized from randomized controlled trials in one group of patients to a somewhat similar but different group of patients. Intermediate strength recommendation. May change when stronger evidence is available.
2A	Randomized controlled trials have consistent results, but the balance between risk and benefit is unclear. Intermediate-strength recommendation.
2C+	Strong results from randomized controlled trials can be extrapolated to a similar patient population or there is overwhelming evidence from observational studies. Best action depends on patient circumstance. Weak recommendation.
2B	Randomized trials have inconsistent results or major methodological weaknesses. Risk versus benefit is unclear. Weak recommendation.
2C	Observational studies or generalized from randomized trials in one group of patients to a different group. Risk versus benefit is unclear. Very weak recommendation.

*Grade 1 recommendations are assigned if it is very certain that benefits do, or do not, outweigh the risk, burdens and costs. Grade 2 recommendations are assigned if it is less certain of the magnitude of the benefits and the risk, burdens, and costs and thus the relative impact.

(continued on next page)

(continued)
American College of Chest Physicians (ACCP) Guidelines: Rationale for Recommendations

Table 7. Prophylaxis for Major Orthopaedic Surgery Patients		
Procedure	**Recommended Prophylaxis**	Grade
Elective total hip replacement	• Enoxaparin: 40 mg SQ daily* **-OR-** • Warfarin: started preoperatively or the evening after surgery; target INR range: 2 to 3 • Duration: at least 20 days; ideally 28 to 35 days *Adjuvant prophylaxis with IPC device and/or GCS may improve efficacy.* *Sole therapy with aspirin, IPC device, GCS, venous foot pumps, or SQ heparin is not recommended.*	1A 1A 1A 2C 1A
Elective total knee replacement	• Enoxaparin: 30 mg SQ q12h* **-OR-** • Warfarin: started preoperatively or immediately postoperatively; target INR range: 2 to 3 • Alternative: optimal use of IPC device • Duration: at least 10 days *Aspirin or SQ heparin should not be used alone.* *Venous foot pumps should not be used alone.*	1A 1A 1B 1A 1A 1B
Hip-fracture surgery	• Enoxaparin: 40 mg SQ daily* **-OR-** • Warfarin: started preoperatively or immediately postoperatively; target INR range: 2 or 3 **-OR-** • Heparin: 5000 units SQ TID **-OR-** • Duration: at least 10 days; ideally 28 to 35 days *Initiate prophylaxis if surgery will be delayed.* *Mechanical prophylaxis if anticoagulation prophylaxis is contraindicated.* *Sole use of aspirin is not recommended.*	1C+ 2B 1B 1A 1C+ 1C+ 1A

GCS=graduated compression stockings; IPC=intermittent pneumatic compression
*Initiate therapy 12 to 24 hours after surgery

References:

CHEST 2004: 126 (suppl. 3) http://www.chestjournal.org/content/vol126/3_suppl/

National Guideline Clearinghouse: *Antithrombotic therapy for venous thromboembolic disease: the Seventh ACCP Conference on Antithrombotic and Thrombolytic Therapy*
http://www.ngc.gov/summary/summary.aspx?doc_id=5893&nbr=3879

Symposium III: DVT Prophylaxis in Total Knee Replacement: The Ongoing Debate

Aspirin Prophylaxis for Thromboembolic Disease after Total Knee Surgery

Paul A. Lotke, MD, *Philadelphia, PA,* Jess H. Lonner, MD

Aspirin is an effective anti-platelet agent and has been used for decades by orthopaedic surgeons for prophylaxis against thrombolembolic disease. It permanently inactivates the cyclooxygenase activity of prostaglandin H (cox 1) with dosage as low as 30 mg/day. Since the newer anticoagulants, like the low molecular weight heparins, reduce the incidence of DVT more efficiently, aspirin is perceived by some not to be as effective. However, its safety, clinical effectiveness and ease of extended dosing, make it very attractive and it continues to be used by many orthopaedic surgeons. This report reviews our experience with aspirin as the main chemoprophylactic agent after total knee surgery.

Methods: We have followed every one of 2817 consecutive total knee patients for a minimum of 6 weeks. Aspirin, 325 mg twice a day for six weeks, was the principle chemoprophylactic agent in all patients except 67 who received warfarin for preexisting medical reasons or were in clinical trials of investigational agents. Adjuvant intermittent compression foot pumps were used while patients were in the hospital.

Results: There were a total of 8 deaths (0.28%); 4 from myocardial disease (0.14%); 2 from fatal PE (0.07%), 1 each from a cerebral vascular event and a fat embolus. There were 5 symptomic nonfatal PE requiring readmission (0.18%). Bleeding complications occurred in 10 patients (0.4%); 2 on a clinical trial for an investigational drug, 2 on warfarin and 6 on aspirin.

Discussion: The risk of fatal pulmonary embolus has been dramatically reduced in the past decade and this risk appears to be the same for most anticoagulant regimens at this time. The combination of widespread utilization of regional anesthesia, improved surgical techniques, early mobilization, short hospital stays, improved analgesic strategies, compression devices, and use of a chemoprophylactic agent, all combined, appear to have reduced this risk. Our results with aspirin demonstrate an incidence of fatal PE of 0.07% and an incidence of major bleeding of less than 0.4%. This experience compares well with other chemoprophylactic agents and offers a significantly reduced risk of bleeding and subsequent improved clinical outcomes. Carefully balancing the risks vs. benefits, aspirin continues to be our chemoprophylactic agent of choice.

Financial Disclosure: e – J&J, Stryker

Symposium III: DVT Prophylaxis in Total Knee Replacement: The Ongoing Debate

Rationale for Use of Low-Molecular Weight Heparin

Clifford W. Colwell, Jr., MD, *La Jolla, CA*

Low-molecular-weight heparins (LMWH) have been studied extensively in total knee arthroplasty (TKA) and provide highly effective and safe DVT prophylaxis. LMWH received the highest rating, A1, in the ACCP recommendations in DVT prophylaxis after elective TKA.[3] Prevalence of DVT with LMWH prophylaxis was 33% in TKA data pooled from six randomized studies, with a proximal DVT rate of 7.1%.[3] A meta-analysis reported a 2.4% rate of major bleeding with LMWH.[2] LMWH, given by subcutaneous injection, can be started before surgery or after surgery. Also available is a synthetic pentasaccharide, fondaparinux, which received an A1 rating in the ACCP recommendations. A study with over 1,000 patients had an overall DVT rate was 12.5% with a proximal DVT rate of approximately 2.4%. No major bleeding was reported, but overall bleeding was 2.1%.[1] As with all interventions, the benefit has to be considered against the risk in use of these anticoagulants.

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Financial Disclosure: a – AstraZeneca, Pharmacia, Aventis, Sanofi, Boehringer

Symposium III: DVT Prophylaxis in Total Knee Replacement: The Ongoing Debate

Rationale for Use of Warfarin

Vincent D. Pellegrini, Jr., MD, *Baltimore, MD*

Venous thromboembolic disease (VTED) is the most common reason for readmission following total knee arthroplasty. While other agents have been shown to have superior efficacy in primary prevention of venographic DVT, extended outpatient warfarin prophylaxis after TKA is highly effective in preventing VTED related readmission as well as PE with negligible bleeding risk compared with newer agents.

Readmission for VTED occurred after only 0.6% of TKA (8/1321; 3 PE, 5 DVT) compared with 1.62% of THA (32/1972; 14 PE, 18 DVT; RR 0.37, p=0.009). Forty-eight hours of continuous epidural anesthesia resulted in no meaningful reduction in DVT after TKA. Among TKA patients discharged on warfarin for any reason the VTED readmission rate was 0.21% (1/484) compared with 1.05% (5/477; p=0.12) for those with negative venograms discharged without further anticoagulation. No patient experienced major bleeding complications while on warfarin after TKA.

While residual DVT was three times more common after TKA than THA, readmission for VTED was nearly three times more frequent after THA than TKA. Secondary prophylaxis with outpatient warfarin provided effective protection against VTED with comparable readmission rates of 0.27% and 0.21% for THA and TKA. Surveillance venography was a poor predictor of VTED readmission risk; we recommend extended VTED prophylaxis for all patients following total knee arthroplasty.

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The Knee Society Award Presentations

MARK COVENTRY AWARD
for Best Basic Science Paper

Venous Thromboembolic Disease after Total Knee Arthroplasty: Prevention of Readmission by Extended Prophylaxis

Vincent D. Pellegrini, Jr., MD, *Baltimore, MD,* Christopher T. Donaldson, MD, Daniel C. Farber, MD, Erik B.Lehman, MS, C. McCollister Evarts, MD

Introduction: Venous thromboembolic disease (VTED) is the most common reason for readmission following total knee arthroplasty.

Methods: Screening contrast venography was performed from 1984 - 2003 in 3,293 elective total joint arthroplasty patients (1,972 THA; 1,321 TKA). All patients with VTED received warfarin therapy. From 1984–1992, patients with no venogram were discharged without further anticoagulation; from 1993 – 2003, those without venography received 6 weeks warfarin therapy. Patients with negative venography received no further anticoagulation after hospital discharge. VTED readmissions were tracked for 6 months postoperatively.

Results: Venography was completed in 1,842 patients; deep vein thrombosis was evident after 42.3% TKA (343/810) compared with 16.9% THA (175/1,032). However, readmission for VTED occurred after only 0.6% of TKA (8/1321; 3 PE, 5 DVT) compared with 1.62% of THA (32/1972; 14 PE, 18 DVT; RR 0.37, p=0.009). Forty-eight hours of continuous epidural anesthesia resulted in no meaningful reduction in DVT after TKA. Among TKA patients discharged on *warfarin for any reason* the VTED readmission rate was 0.21% (1/484) compared with 1.05% (5/477; p=0.12) for those *with negative venograms* discharged without further anticoagulation.

Discussion: While residual DVT was three times more common after TKA than THA, *readmission for VTED* was nearly three times more frequent after THA than TKA. Secondary prophylaxis with outpatient warfarin provided effective protection against VTED with readmission rates of 0.27% and 0.21% for THA and TKA, respectively. Surveillance venography was a poor predictor of VTED readmission risk; we recommend extended VTED prophylaxis for all patients following total knee arthroplasty.

CHITRANJAN RANAWAT AWARD
for Best Work on a Surgical Technique

Long Term Survivorship and Failure Modes of 1000 Cemented Condylar Total Knee Arthroplasties

Michael B. Vessely, MD, *Lake Oswego, OR,* Andrew L. Whaley, MD, W. Scott Harmsen, MS, Cathy D. Schleck, BS, Daniel J. Berry, MD

The purpose of this study was to examine the factors affecting survivorship and to analyze the reasons for reoperation and revision of a cemented modular condylar total knee arthroplasty (TKA). One thousand and eight consecutive primary cemented cruciate retaining total knee arthroplasties performed at one institution from 1987-1989 were studied. At the time of this study 411 patients (562 knees) had died, 43 patients (45 knees) had their knee components revised or removed, and 47 patients (62 knees) were lost to followup.

Two hundred and forty-four patients (331 knees) were alive and had not had their TKA components removed or revised at the time of latest follow-up. Mean follow-up of living patients with components in situ was 15.7 years (range, 14.5 to 17.9 years). Survivorship at fifteen years for component removal for any reason, revision for any reason, revision for mechanical failure, and revision for aseptic loosening were 93.7%, 95.9%, 97.0%, 98.8%, respectively. Survivorship for the first three endpoints was significantly poorer among patients aged less than 60.

Forty-five knees had components removed or revised: approximately one third were removed for infection (16 of 45), one third for aseptic loosening or tibial polyethylene wear (16 of 45), and one third for other causes. Twenty knees had reoperations that did not involve component removal or revision (mostly periprosthetic fracture or infection).

Mechanical implant failures accounted for less than half of the reoperations and revisions in the first 15 years after arthroplasty; while infection and periprosthetic fractures accounted for a substantial portion of revisions and reoperations. As mechanical arthroplasty failures have become less common other modes of complications related to the arthroplasty have become proportionately more frequent.

Financial Disclosure: a – DePuy

JOHN INSALL AWARD
for Best Work on a Clinical Subject or Outcomes Report

Factors Affecting Patient Satisfaction with Total Knee Arthroplasty

Philip C. Noble, PhD, *Houston, TX*, Michael A Conditt, PhD, Karon Cook, PhD, and Kenneth B. Mathis, MD

Introduction: In previous studies, 15-20% of patients have reported that they are dissatisfied with their knee function after TKR. In this study we examine the contribution of potential factors as predictors of patient satisfaction following TKR.

Methods: 253 patients with unilateral primary TKR were enrolled at a minimum of 1 year post-surgery. Each patient completed a self-administered, validated "Knee Function Questionnaire", consisting of 55 scaled multiple choice questions regarding respondents' participation, limitations, and the perceived importance of a broad range of physical, vocational, and recreational activities. The questionnaire also explored each patient's level of satisfaction with TKR and their expectations with respect to post-operative function and outcome. The association between function, expectation and satisfaction was examined using univariate and multivariate logistic regression.

Results: Thirty-nine (14%) patients reported dissatisfaction with the functional outcome of their TKR. Of these, 17 (44%) had a significant symptoms, including frequent swelling (36% (dissatisfied) vs 18% (satisfied), $p=0.04$) and stiffness (23% vs 5%; $p<0.0001$). Dissatisfied patients without significant symptoms (56%) could not be distinguished from satisfied patients on the basis of age, gender, or activity level. However, 50% of dissatisfied patients reported they were not as active as they expected pre-operatively vs. 14% of satisfied patients ($p<0.0001$). Dissatisfied patients also experienced significantly more difficulty in performing those functional activities of greatest personal importance ($p=0.008$).

Discussion and Conclusions: Surgeons should recognize that residual symptoms after TKR are a significant source of patient dissatisfaction. In those without symptoms, patient satisfaction is most strongly influenced by patients' expectations of how their knee should function rather than the patient's ability to perform functional tasks.

Symposium IV:
Computer Assisted and Minimally Invasive Total Knee Replacement

Computerized Navigation in Total Knee Replacement Past, Present and Future

Richard S. Laskin MD, *New York, NY*

The initial computer assisted navigation systems relied upon pre-operative CT scans or intraoperative use of image intensifier images to help guide placement of the cutting jigs. Although the accuracy of using these types of systems was excellent, the logistical problems attendant to their use has led to a more frequent use of intraoperative "morphing software" for navigation systems.

These systems are not without their logistical difficulties, however. Most rely upon line of sight infrared cameras which may be blocked by the OR personnel. Furthermore the use of large trackers that are stabilized in their respective bones by means of transcortical pins have the risk of associated stress fracture.

Traditionally, the major indication for computerized navigation was to reduce the chance of malposition of the implants. Regardless of the type of system used, accurate registration of intraoperative landmarks is imperative. Rotatory plane accuracy is especially difficult since localization of the medial femoral epicondyle is difficult without some type of intra-operative image.

Malposition in the coronal plane can lead to early loosening and implant wear (Lotke and Ecker: Clin Orthop 1977, Jeffrey: JBJS Orthop 1991, Ritter and Farris: Clin Orthop 1994).Several randomized prospective studies (Victor: Clin Orthop 2004, Bolognesi and Hofmann: Clin Orthop 2005, Chin: J. Arthroplasty 2005, Decking: J. Arth 2005, Chauhan: JBJS 2004) have shown the specific efficacy of computerized navigation in the coronal plane using variety of systems, with accuracy to within 1°. Since the accuracy using standard instrumentation is usually within 2° to 3° this is a statistical improvement. Although it is difficult to argue against an increase in accuracy, there is no evidence at this point that the extra degree of accuracy using the computerized systems will have a clinical benefit.

One of the major potential benefits of computerized navigation is in the assessment of soft tissue balance. A study by Van Damme, Belemans, and Victor (JBJS 2005) has provided "normal values" to guide in soft tissue balance. Since one of the major causes of revision knee replacement is instability from soft tissue imbalance, this benefit of computerized navigation may in the future outweigh that of more accurate bony resections.

Electromagnetic induction systems are now in early clinical use in attempt to avoid the problems with line of sight infra-red systems. There is likewise the potential for the use of smaller trackers, and possibly trackers which may be permanently implanted allowing for follow-up of patients after surgery.

Financial Disclosure: c,e – Smith and Nephew

Symposium IV:
Computer Assisted and Minimally Invasive Total Knee Replacement

Use Of the Computer as a Teaching Tool in Knee Replacement Surgery

S. David Stulberg, MD, *Chicago, IL*

Computer assisted orthopaedic surgery (CAOS) for total knee arthroplasty was developed to increase the accuracy and reliability with which the procedure was performed. The developers of this technology were particularly hopeful that surgeons who were less experienced or who performed relatively few TKA would benefit from the use of CAOS-TKA. In fact, the surgeons who have found the current forms of CAOS-TKA most helpful are those with substantial experience in TKA surgery. Current CAOS-TKA systems introduce issues that increase, not diminish, the complexity of TKA for the inexperienced surgeon.

Current CAOS-TKA systems were not developed to be tools to teach surgeons how to perform, or improve their skills in performing, TKA. However, the most important contribution of this technology may prove to be its impact on the education of knee surgeons. There are a number of ways in which the computer can become a teaching tool for knee replacement surgery. These include:

1. Interactive instructional programs
2. Laboratory assessment of procedure comprehension and surgical skills
3. Surgical simulators
4. Pre-operative planning tools
5. Intra-operative feedback and measurement tools
6. Post-operative assessment of pre-operative plan and intra-operative performance

Many of these teaching applications are potentially available with current computer technology. However, these applications must be developed separately from current CAOS-TKA systems to be truly effective as tools for teaching inexperienced or less experienced surgeons TKA surgery.

Financial Disclosure: e - Aesculap

Symposium IV:
Computer Assisted and Minimally Invasive Total Knee Replacement

Use of Computer Assisted Surgery in Difficult Total Knee Reconstruction

Kenneth A. Krackow, MD, *Buffalo NY*

Computer navigation systems provide fast, simultaneous, accurate information at total knee arthroplasty, some of which is not available with mechanical instrumentation. Other data that may be available may only be known in sequence rather than simultaneously and may require much more complicated or time consuming mechanical alignment guides and measuring devices.

Measurements of all positions and angles with computer instrumentation are relatively faster, more accurate, and produce output of multiple data points or features simultaneously.

Difficult TKR reconstructions would typically be those involving significant deformity, loss or deformity of bone stock, poor range of motion, and/or obesity.

With regard to deformity, navigation may be the only way to get an accurate assessment of that deformity which the surgeon must manage. First, any flexion contracture or recurvatum information is accurately and very early available as the patient's knee and bones are registered in the system. Never before have we had nearly so accurate assessment of full extension and recurvatum before the introduction of computer systems.

In terms of varus/valgus deformity, the amount of correction or adjustment is not given during ordinary physical exam or by measuring even long standing x-rays. Bone wear or defects and ligamentous laxity make these unpredictable indicators. The amount of soft tissue sleeve adjustment that is necessary is instead provided by the tibio-femoral angle, which is assumed during a tension stress examination. By this is meant a distraction of the tibia away from the femur. In this manner at or near full extension the respective medial and lateral aspects of the capsular ligamentous sleeve are approximately equally taut. If the mechanical axis deviation of the tibia, so positioned below the femur is zero, the femoral head being in line with the knee and ankle, then there is no sleeve deformity, and cuts perpendicular to the respective bony mechanical axes plus proper prosthesis size, thickness, and level, will provide a well aligned, balanced knee.

If the mechanical axis is a certain degree of varus or valgus different from zero degrees neutral, then that is the angular deformity which has to be balanced, typically by soft tissue release. As the thickness of tibiae and femora at the level of the knee are approximately 70-90 mm, every degree of sleeve deformity corresponds to approximately 1.3 to 1.4 mm of ligament release to provide elongation to match the convex side of the deformity. Across an 80 mm knee 10 degrees of sleeve deformity or asymmetry will require 80 x 1.3 to1.4 degrees or about 10-11mm of soft tissue elongation. This information gives one the idea of how difficult or practical it will be to achieve proper balance.

Obese patients may be particularly difficult for placing, aligning, and assessing mechanical instrumentation used for alignment and jig placement. Tracking pins and computer registration are much simpler and more accurate in this setting.

Similarly, bone defects and abnormality of shaft curvature or other shapes may make ordinary mechanical instruments totally unusable. Again, registration to a computer system is not necessarily or usually affected and greater accuracy and confidence can be appreciated with knee navigation.

There are many more subtle ways in which the computer can be of assistance.

Financial Disclosure: a,c,e - Stryker

Symposium IV:
Computer Assisted and Minimally Invasive Total Knee Replacement

Approaches to MIS Knee Replacement:
Why I Use the Mini-Quadriceps Splitting Approach

Giles R. Scuderi, MD, *New York, NY*

Minimally invasive total knee arthroplasty has gained popularity over the last several years and the limited quadriceps splitting incision is part of the continuum of these modified approaches with limited access and visibility. The learning curve is short since the arthroplasty is performed with the same surgical technique using modified and smaller instruments that are more adaptable to the limited operative field. With a gradual shortening of the skin incision and medial parapatellar arthrotomy, a smaller and comfortable operative field will be obtained.

Optimizing patient selection and paying specific attention to the operative details will insure clinical success. Experience has demonstrated that there are certain patient characteristics that are better suited for minimally invasive TKA. A shorter, thinner female patient with a lower body mass index, a narrower femur and better pre-operative range of motion is better suited for minimally invasive surgery. Caution needs to be taken with patients who have rheumatoid arthritis or inflammatory arthritis, limited range of motion with severe fixed angular deformity or prior surgery.

The surgical procedure has not essentially changed from the standard techniques. The real difference is that the procedure is performed in an operative field with limited visibility. The addition of modified and smaller instruments has made it easier to access the joint with little or no damage to the extensor mechanism. Minimally invasive TKA can easily be converted to a more extensile approach if there is any difficulty with exposure, positioning the instrumentation or the implants during the arthroplasty. It is important to remember that TKA is historically a successful operation and the minimally invasive surgical technique should not compromise the outcome.

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Financial Disclosure: a,c,d,e - Zimmer

Symposium IV:
Computer Assisted and Minimally Invasive Total Knee Replacement

Approaches to MIS Knee Replacement: Why I Use the Mid-Vastus Approach

Steven B. Haas, MD, MPH, *New York, NY*

We previously described the mini mid vastus (MMV) approach and reported on our first year experience. This controlled study showed improved range of motion and function at 6 weeks, 3 months and 1 year post-op without an increased rate of complications or radiographic outliers. We are now reporting on a larger series of patients who underwent MIS TKA with MMV approach.

Between September 2001 and September 2004, 391 consecutive minimally invasive total knee arthroplasties were performed in 335 patients. There were 248 females and 87 males. The average preoperative motion was 109 degrees with a range of 75 to 150 degrees. A MMV approach was used in all patients. Epidural anesthesia and a Genesis II (Smith and Nephew, Memphis, TN) posterior stabilized knee were used in all cases.

Mean range of motion at six weeks post-operatively was 111 degrees. This improved to 121 degrees at 3 months and 125 degrees at both 1 year and 2 years post-operatively. Post-operative motion was related to pre-operative motion; however patients with less pre-operative motion saw the greatest improvements in motion at 6 weeks and 3 months. We did not observe an increased complication rate with this approach. There were no fractures, extensor mechanism or neurovascular complications. The infection rate was 0.5 %.

Minimally invasive total knee arthroplasty with a mini mid vastus approach is associated with rapid functional recovery and significant improvements in range of motion. This procedure can be performed safely and provides excellent clinical results.

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Financial Disclosure : a,c,e – Smith & Nephew

Symposium IV:
Computer Assisted and Minimally Invasive Total Knee Replacement

MIS TKA with a Modified Subvastus Approach

Mark W. Pagnano, MD, *Rochester, MN*

The MIS subvastus approach provides very good exposure through a small incision, preserves all four attachments of the quadriceps to the patella, does not require patella eversion, minimizes disruption in the suprapatellar pouch and allows rapid and reliable closure of the knee. The patella and entire distal portion of the extensor mechanism can be retracted into the lateral gutter of the knee where they remain out of the way and allow direct visualization of both femoral condyles. When coupled with instruments designed specifically for small incision surgery the modified subvastus approach is reliable, reproducible and safe. Using a simple set of retractors the surgeon can perform the surgery without making any blind cuts or free-hand cuts and that enhances surgical accuracy and patient safety.

The clinical usefulness of the traditional subvastus approach to the knee has been limited because it is difficult to evert the patella in muscular or obese patients.[1] Given that most total knee patients are overweight it is not surprising that most total knee surgeons have never adopted the traditional subvastus approach despite clear data that the subvastus approach leads to less postoperative pain and a stronger extensor mechanism than a traditional medial parapatellar approach.[2,3] Interestingly, when the subvastus approach is modified to avoid patellar eversion the exposure is enhanced particularly when compared to alternative approaches for minimally invasive surgery .[4]

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Financial Disclosure: c - Zimmer

Symposium V: Wear in Total Knee Replacement

Kinematics Related to Wear Following Total Knee Replacement

Timothy M. Wright, PhD, *New York, NY*

Wear has been the focal problem limiting the longevity of joint replacements and as such has received considerable attention over the past twenty years. The realization that oxidative degradation of polyethylene plays a critical role in knee wear, together with the availability of new forms of polyethylene aimed at improving wear resistance, may have delegated wear to a manageable problem. If so, the focus in knee design can shift from concerns about wear and fixation to providing more normally functioning knee replacements. Paramount to such an approach is an understanding of knee kinematics with the goal of replicating normal motions for a broad range of activities without creating situations in which polyethylene bearing geometries or constraint structures experience deleterious stresses and without overburdening ligamentous constraints.

Unfortunately, kinematics studies of knee replacement patients have revealed considerable variation between different activities and even within the same type of implant design. Results from knee simulator studies likewise demonstrate that kinematics and activity level significantly affect wear behavior. Empirical approaches have also been tried in linking inferred patient kinematics with the resulting damage observed on subsequently retrieved components, but with marginal success. New approaches, however, that integrate simulator experiments with implant retrieval studies and computational stress analyses show promise. Their success as design tools rests, however, on incorporating statistical techniques, robust material and failure criteria for polyethylene, and appropriate wear models.

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Symposium V: Wear in Total Knee Replacement

Information from Autopsy and Revision Retrievals

Gerard A. Engh, MD, *Alexandria, VA*

Retrieved tibial components provide a unique opportunity to evaluate polyethylene wear. We measured wear of 81 unicondylar and 89 cruciate-retaining total knee components implants that were implanted at our institution and retrieved at the time of revision or autopsy. All implants had been sterilized by gamma-irradiation-in-air, and each arthroplasty had been performed for medial compartment osteoarthritis. Wear was quantified as the change in bearing thickness, divided by years in vivo. Multiple linear regression analysis was used to evaluate the statistical association that wear had with patient age, weight, gender, polyethylene thickness, polyethylene shelf age, and postoperative mechanical axis.

Medial compartment wear in total knees (0.33+/-0.28mm/year) and medial compartment wear in unicondylar knees (0.48+/-0.39mm/year) were each significantly associated with the same three factors: patient age, polyethylene shelf age, and postoperative mechanical axis. Three-fifths of the variation in unicondylar or total knee wear could be explained by these three factors alone.

Operating on a patient that was ten years younger (versus any arbitrary age) increased both unicondylar and total knee wear by 0.14mm/year and 0.11mm/year, respectively. Shifting the postoperative mechanical axis 10mm medially increased unicondylar and total knee wear by 0.07mm/year. Implanting a bearing with a 1-year longer shelf age increased total knee wear by 0.12mm/year and unicondylar wear by 0.24mm/year.

When the differences in the three variables of patient age, mechanical axis alignment, and polyethylene shelf-age are adjusted for, the wear rates of unicondylar verses total knee implants are similar.

Wear of gamma-irradiated-in-air polyethylene tibial bearings implanted into the medial tibiofemoral compartment seems largely driven by one implant variable (shelf age), one patient variable (patient age), and one surgical technique variable (postoperative mechanical axis). The importance of these factors held whether the bearing was retrieved from a total or unicondylar arthroplasty.

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Symposium V: Wear in Total Knee Replacement

The Unicompartmental Knee: Design and Technical considerations in Minimizing Wear

Jean-Noël A. Argenson, MD, *Marseille, France,* Sebastien Parratte, MD

Unicompartmental knee arthroplasty can be an alternative to total knee replacement for patients with unicompartmental tibiofemoral noninflammatory disease. With careful patient selection and newer instrumentation the previously reported causes of failure (i.e., progression of arthrosis and tibial loosening) may be eliminated, leaving polyethylene wear emerging as the predominant failure mechanism in more contemporary designs. Increased wear will also increase load at the bone-implant interface and wear particles will generate osteolysis leading to component loosening and unreplaced compartment degeneration.

The design related factors able to minimize wear include polyethylene thickness greater than six millimeters, limited shelf age, and designs allowing large areas of contact mediolaterally and anteroposteriorly. Congruous mobile bearing may play a significant role when associated to a reduced dislocation rate and a reproducible surgical technique.

The technical factors include an accurate instrumentation avoiding component-to-component malposition and consequently edge loading, and a slight undercorrection of the preoperative deformity. The patient related factors include limited overweight, functional anterior cruciate ligament and correctable frontal deformity.

Continued research is mandatory to improve polyethylene strength including cross-linking and sterilization methods. Better understanding of kinematics and contact forces may provide long term survival and patient satisfaction following unicompartmental arthroplasty.

Symposium V: Wear in Total Knee Replacement

The Cruciate Retaining Knee: Design and Technical Considerations in Minimizing Wear

Thomas S. Thornhill, MD, *Boston, MA*

Wear in total knee arthroplasty is predominately a function of patient activity, material properties, the bearing surface and back sided wear issues in modular designs. Patient weight and activity are issues common to knees whether they are fixed bearing, mobile bearing, cruciate retaining or cruciate substituting.

In the past 20 years there were multiple designs that were associated with increased polyethylene wear and osteolysis in a variety of total knee systems. Some of these problems were seen when instrument systems first emphasized alignment but not soft tissue balance. Moreover, polyethylene was traditionally gamma irradiated in air which led to oxidation, locking mechanism fatigue, and then both polyethylene wear and damage. Terminal hot isostatic pressing of certain polyethylene facilitated delamination and other forms of polyethylene damage that led to failure.

In the early 80's, many cruciate retaining designs adopted a flat on flat articulation. The rational was that flat on flat was the best compromise of congruity vs. conformity. Two coated planes have maximum contact and minimal constraint. Unfortunately, lift off is a known phenomenon in knee replacement and flat on flat articulations become point loaded with lift off. Additionally, flat on flat articulations in cruciate retaining design mandate a precise balance of soft tissues. If there is not sufficient conformity to provide a "memory" during the initial "bedding" in process of polyethylene and healing of the soft tissues, paradoxical motion can occur. Multidirectional motion and sliding both increase wear of polyethylene.

Current cruciate retaining designs have increase conformity and hence increase contact while at the same time limit paradoxical motion and provide a memory for soft tissue healing. Cruciate retaining designs also avoid the problems of impingement both in hyperextension and rotation seen in many cruciate substituting designs. Lift off has, in fact, been shown to be less in cruciate retaining than in cruciate substituting designs.

Other features of cruciate retaining modular designs have been to improve locking mechanisms, reduce micro motion and to polish the tibial plate to reduce back sided wear.

Based upon the success of highly cross-linked polyethylene in the hip, there is now introduction of moderately cross-linked polyethylene in the knee. This will decrease wear and at the same time not compromise the locking mechanism that led to failure and increased back sided wear in early designs.

Financial Disclosure: *a,c - DePuy; a - Biomet, Smith & Nephew*

Symposium V: Wear in Total Knee Replacement

The Cruciate Substituting Knee: Design and Technical Considerations in Minimizing Wear

Robert E. Booth, Jr., MD, *Philadelphia, PA*

Minimizing wear in total knee arthroplasty is a study in interfaces and compromises. Since the primary reasons for premature/accelerated wear and failure relate to surgical errors, isolated technical and design modifications presume proper alignment, stability, and balance. Polyethylene wear was almost unknown in the early total condylar knees, and the quest for greater stability and motion created the posterior stabilized concept.

The original post-and-cam design has been improved to **increase** stability in flexion, just as high flexion prompted reinforcement of the posterior articulation. Motion and rollback are unsurpassed in PS designs – even beyond mobile bearings – with no increased cost or risk.

Despite high modularity, the best designs preserve almost total coronal conformity and minimize wear to levels well below non-conforming cruciate retaining designs. Predictable and reproducible motion is routine and largely the reason for the PS knee's far lower incidence of osteolysis.

While polyethylene remains the most cost effective and versatile interface, it is still the sacrificial element in most prosthetic joints; and "light" cross-linking appears to have enhanced its durability. Backside wear is reduced by polished surfaces and stiffer metals, but at the risk of passive stress shielding.

The compromise between prosthetically guided motion and anatomically induced motion gives the PS TKA the widest safety range, greatest reliability, lowest wear rates, greatest spectrum of applicability, and highest success rate of all total knee designs.

Financial Disclosure: c - Zimmer

Symposium V: Wear in Total Knee Replacement

Mobile Bearing Total Knee Arthroplasty: Design and Technical Considerations in Minimizing Wear

Douglas A. Dennis, MD, *Denver, CO*

Premature polyethylene wear is a major cause of failure of total knee arthroplasty and has been attributed to numerous factors including poor surgical technique, reduced polyethylene thickness, poor locking mechanisms of modular fixed bearing tibial components, gamma irradiation sterilization techniques in the presence of oxygen, and adoption of low conformity implant designs.

The use of mobile bearing implants potentially reduces polyethylene wear by providing increased implant conformity, reduced polyethylene contact stresses, and improved kinematic patterns in gait resulting in reduced shear stresses.

Self-alignment of the polyethylene bearing with the femoral component further lessens polyethylene surface stresses, improves patellofemoral kinematics, and minimizes posterior cruciate substituting post impingement, increasing the potential for enhanced polyethylene longevity.

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Financial Disclosure: a,c – *DePuy; a - Zimmer*

Symposium VI: Burning Issues in Revision Knee Surgery

Cemented and Cementless Stem Augmentation in Revision Total Knee Arthroplasty

Jason R. Hull, MD, Daniel J. Berry, MD, Miguel E. Cabanela, MD**, Robert T. Trousdale, MD**, *Rochester, MN*

Obtaining rigid component fixation can be challenging in revision total knee arthroplasty. Intramedullary stems provide a reliable adjunct to fixation by bypassing bone defects and transferring stresses away from damaged metaphyseal interfaces.

Despite success with both cemented and uncemented stem augmentation, controversy persists over the optimal method of fixation due to a lack of firm indications for each technique as well as little published outcome data. Currently, the primary advantages of cemented stems include more rigid initial fixation and the ability to introduce antibiotic loaded cement into the intramedullary canal.

Advantages of cementless stems include more predictable component alignment and ease of removal should re-revision be necessary. The mechanical failure rate of cementless stems is approximately 7-16% at mid-term follow-up, compared to 0-3% for cemented stems. More long-term data is needed to establish the durability of both methods of stem fixation.

Financial Disclosure: a,b,c - DePuy

Symposium VI: Burning Issues in Revision Knee Surgery

Patellar Reconstruction Options during Revision TKR

Arlen D. Hanssen, MD, *Rochester, MN*

In 30-50% of revision TKR, the existing patellar component is acceptable and is simply retained. Criteria for retention include a well-fixed, well positioned component with minimal or no wear and with a compatible geometry. In 40-50%, the component may be loose, malpositioned, or damaged with sufficient residual bone >10 mm. Treatment includes a traditional onlay or bi-convex inset patellar design. In less than 10% of cases, there may be severe patellar bone loss leaving only a patellar shell or remnant.

Treatment options for severe patellar bone loss include a patellar resection arthroplasty, “Gull-Wing” osteotomy, patellar bone grafting, or use of a specialized revision patellar implant. Patellectomy should be avoided. Resection arthroplasty is straightforward however anterior knee pain, lateral subluxation and fragmentation are common and clinical results often deteriorate. Bone-grafting is a simple technique of impaction grafting the bony shell with containment interpositional tissue flap. This approach imparts the potential for restoring patellar bone stock and facilitates patellar tracking. A relatively new approach is the use of a porous metal baseplate for bony ingrowth with a polyethylene component cemented onto the baseplate.

The outcome of patellar intervention is dependent upon proper femoral and tibial rotation. Isolated patellar revision has a high incidence of associated perioperative complications. Associated femoral and/or tibial malrotation should be assessed at every patellar revision as an integral part of the solution to patellar failure is to address any malrotation of these other components.

Financial Disclosure: a,c – Zimmer Corp

Symposium VI: Burning Issues in Revision Knee Surgery

How Much Constraint is Necessary?

Thomas P. Sculco, MD, *New York, NY*

One of the keys to long term success in total knee replacement is knee joint stability. In most deformities soft tissue asymmetry is present and can be corrected by soft tissue balancing techniques which allow the implant to "block open" the joint in flexion and extension symmetrically with resultant knee joint stability. Once this stability has been established standard implants (PCL retaining or Posterior Stabilized types) may be used.

If persistent laxity occurs despite soft tissue balancing, implants with greater constraint must be used. The constrained condylar types will improve stability and are useful particularly in the severe valgus knee with marked medial laxity or in revision procedures. If femoral bone is well preserved constrained condylar knees may be used without stems. In a recent series of 140 knees treated with a constrained condylar prosthesis without stems the failure rate was 2.5% at follow up of 2-7 years.

When there is marked bone loss and absent ligament support a rotating type hinge knee may be needed to restore bone deficits through augmentation and stabilization of the knee by the fixed axis nature of these designs.

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Symposium VI: Burning Issues in Revision Knee Surgery

Options for Reconstructing Bony Defects

Thomas Parker Vail, MD, *Durham, NC,* Jeffrey L. Bush, MD

The number of revision total knee arthroplasties performed each year in the United States is increasing. From 1990 to 2002, the rate of primary total knee arthroplasty per 100,000 people in the United States nearly tripled. *Even considering the advances in technology that might be on the horizon, the combination of more primary knee arthroplasty in a younger and more active group means articular surface wear, particle generation, osteolysis, implant loosening and bone loss.*

There are multiple well known methods for dealing with deficient bone stock during total knee revision. However, traditional methods have not always been sufficient to deal with the array of bone defects that extends from peri-articular, into the metaphysis, and finally into diaphyseal bone. Smaller contained defects have been managed by filling the defect with cement or bone graft. Larger defects have been treated with modular augments, impaction grafting, or bulk structural allograft. Modular augments have commonly been cemented, and associated with the use of bone cemented and cementless stems.

Hinged, rotating platform prostheses and larger custom implants are reserved for massive bone loss with ligamentous instability where periarticular bone replacement is indicated. More recently, the use of metaphyseal filling implants that fill the gap between the common revision and the megaprosthesis have provided an alternative solution for metaphyseal bone deficiencies

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Financial Disclosure: a,c,e – Wright Medical, Zimmer; a – J&J, Smith Nephew

Symposium VI: Burning Issues in Revision Knee Surgery

When is a Hinge an Option?

William Maloney, III, MD, *Stanford, CA*

One of the basic principles in revision TKR is to use the least constrained implant that provides satisfactory stability. Inability to achieve ligament balance in complex revision knee replacement is primary indication for a hinged knee implant. In general, this is a relatively uncommon and occurs in approximately 1 % of knee revisions. Excluding tumorous conditions, significant compromise to the ligamentous structures of the knee occur primarily in three situations: 1. massive bone loss associated with aseptic loosening and osteolysis, 2. periprosthetic femur fracture, and 3. bone loss associated with a chronic septic TKR (sepsis, implant removal, debridement and spacer implantation).

Historically, hinged knee prosthesis had relatively poor outcomes. Loosening rates were high and salvage was difficult. Mechanical failure of the implant was common. However, modern implant design has addressed two important issues that have made hinged knee implants a more viable option for complex knee revision surgery. First generation hinged knee implants were primarily fixed bearing designs. As a result high loads were transmitted to the implant bone interface contributing to aseptic loosening. Modern designs incorporate a rotating platform. This helps to dissipate some force compared to a fixed bearing hinge and in addition may provide some forgiveness as it relates to femoral component rotational alignment. In the past, hinged knee prosthesis were designed for reconstruction after excision of tumors about the knee and not for failed knee replacement. On the femoral side, the amount of bone removal required to accommodate the femoral component often exceeded the amount of bone loss that was present. Newer designs have included lower profile femoral components to minimize further bone resection. Additionally, modularity permits “off the shelf” customization making them more user friendly.

Long term outcome studies with modern hinged prostheses do not exist. However, short to intermediate term reports show promising results in this difficult group of patients. Although complication rates are still relatively high, pain and function improved significantly. These studies have demonstrated restoration of walking capacity and knee stability without early mechanical failure. In what is typically a low demand group of patients, a rotating hinged knee prostheses is a reasonable option for these difficult cases.

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Financial Disclosure: c - Wtight Medical Technology

Symposium VII: Pearls on Avoidance and Treatment of Intraoperative and Postoperative Complications

Disruption of the MCL during Primary TKA

Aaron G. Rosenberg MD, *Chicago, IL,* Richard A. Berger MD, Seth S. Leopold, MD, Joshua J. Jacobs, MD

Disruption of the MCL during primary total knee arthroplasty is a serious complication. In patients with MCL insufficiency noted pre-operatively or as the result of iatrogenic injury, most reports advocate using constrained-condylar or hinged type implants. Some investigators describe MCL advancements or reconstructions, which may be used with minimally-constrained or unconstrained implants, but these all have been used and reported in patients with valgus deformity and incompetence of the MCL demonstrated pre-operatively rather than as an intra-operative ligament injury.

Since medial-side soft-tissue reconstructions have shown promise in arthroplasty of the valgus knee while a number of clinical studies in the non-arthroplasty literature suggest that the MCL has considerable capacity to heal following injury we have been performing primary MCL repair or re-attachment in cases where the MCL is inadvertently injured during TKA. A consistent regimen of bracing, implantation of unconstrained (or minimally-constrained) prostheses, and physical therapy has been employed. We were able to identify 16 patients who suffered this complication and were so treated. At 2 year minimum evaluation and no loss to follow-up, primary repair or re-attachment of the MCL and post-operative bracing without the use of a constrained prosthesis was successful. No patient required bracing beyond the initial six-week period, had subjective or objective coronal plane instability, or revisions for any reason. The average HSS knee score was 93 at a mean follow-up of nearly 4 years. Location of the MCL injury (femoral origin, midsubstance disruption, or tibial insertion) did not appear to correlate with outcome, as all patients appeared to maintain coronal plane stability following repair or re-attachment and bracing.

Four knees in this series received a PCL-substituting implant because of severe flexion contractures or varus-flexion deformities. Despite the absence of the PCL as a secondary restraint to valgus stress in those four knees, there was no distinguishable difference in coronoal plane stability seen in the knees with PCL-substituting implants compared with the 12 that retained the PCL.

This series excluded patients with pre-operative valgus deformities. Those patients may have pre-existing injury to or attenuation of the MCL. Simple primary repair or re-attachment of the MCL in those patients may be less reliable, as valgus deformity may persist or recur following arthroplasty, and may result in increased stresses on the medial repair. Other investigators have described a variety of medial-side reconstructions for such cases and should be considered along with use of a more constrained implant in the valgus knee with MCL injury or incompetence or in cases where abnormal valgus loading forces persist after surgery.

Financial Disclosure: a – Zimmer, Inc.

Symposium VII: Pearls on Avoidance and Treatment of Intraoperative and Postoperative Complications

Exposure of the Stiff Knee

W. Norman Scott, MD, *New York, NY*

A stiff total knee replacement is disturbing to the patient, as well as the surgeon, because it can be painful and lead to decreased use and disability.

Factors related to a lower post-operative range of motion in a group of patients with varus alignment were female gender, an extreme varus alignment pre-operatively and young age. While in a valgus group of patients, factors related to limited flexion included young age and limited intra-operative extension. (Ritter JBJS 85A). However, the principal predictive factor of the post-operative range of motion was the pre-operative range of motion. Patients with post-traumatic arthritis are susceptible to post-operative stiffness (J Arthoplasty 18:805 2003; Lonner; Andereson) Further factors influencing post-operative range of motion are patient compliance with the rehabilitation program and their tolerance to pain. A patient who does not actively participate in their physiotherapy will develop arthrofibrosis and limited motion.

There are several technical factors that influence post-operative range of motion including overstuffing of the patellofemoral joint; mismatch of the flexion and extension gaps; inaccurate ligament balancing; component malposition; oversized components; joint line elevation; and excessive tightening of the extensor mechanism at the time of closure.

Surgical options include arthroscopic arthrolysis, open arthrolysis, and component revision. Arthroscopic arthrolysis, and PCL resection in a tight cruciate retaining knee with a manipulation provides variable results. While Bocell , CORR reported an improvement of motion in only 43% of knees with this technique; Williams CORR reported an average 30.6° of improvement in knee motion. Open arthrthrolysis involves a radical debridement, release of a tight PCL if present, lateral retinacular release and quadricepsplasty. Dennis favors a pie-crust quadricepsplasty followed by a gradual manipulation (Orthop). A quadriceps snip at the time of exposure will also have the same benefit (Garvin CORR).

Financial Disclosure: c - Zimmer

Symposium VII: Pearls on Avoidance and Treatment of Intraoperative and Postoperative Complications

Dealing with Preoperative Hardware

J. Bohannon Mason, MD presenting for Thomas K. Fehring, MD, *Charlotte, NC*

The presence of periarticular hardware is not uncommon in primary total knee replacement. Careful planning is essential to deal with the variety of devices encountered. Medially based hardware can usually be removed at the time of arthrotomy. Laterally based hardware is more problematic and can be addressed during a separate surgical procedure or by removal at the time of primary surgery. Partial removal can also be effective through the percutaneous removal of isolated screws or the judicious use of metal cutting burrs. Computer assisted surgery can facilitate proper alignment when intramedullary hardware prevents the use of intramedullary guides.

Retained periarticular hardware is usually accompanied by complicated skin incisions. In these situations, the cutaneous blood supply of the anterior aspect of the knee must be carefully considered prior to total knee replacement. Usually the most lateral incision is used and a subfascial flap is raised to remove the hardware and perform the replacement.

While most hardware can be dealt with at the time of knee replacement, a staged approach should be used if there is a history of wound healing problems or elevated serologic markers. One must also be cognizant of the creation of stress risers following periarticular hardware removal. If full removal is necessary, a short period of restricted weight-bearing is recommended. Long stems bypassing isolated screw holes are usually unnecessary.

Financial Disclosure: a,c,e – Depuy; a,c,e – J&J

Symposium VII: Pearls on Avoidance and Treatment of Intraoperative and Postoperative Complications

Preventing and Treating Extensor Mechanism Disruption Related to TKA

Robert L. Barrack, MD, *St. Louis MO,* R.S. Burnett

A consecutive series of 19 patients with chronic extensor mechanism disruption after total knee arthroplasty (TKA) were treated with allograft reconstruction. Preoperatively, all patients had full passive extension and a complete extensor lag.

Two methods of reconstruction were used: an Achilles tendon allograft with calcaneal bone block (10 patients) or a quadriceps tendon-patella-patellar tendon-tibial tubercle composite allograft (9). At a mean follow up of 55 months all patients were community ambulators. The KSCRS improved from a preoperative score of 27 points to a postoperative value of 76 points ($p<.01$). The mean postoperative extensor lag was 14 degrees (range, 0-90), and 15 patients (79%) had a lag of less than 10 degrees. All patients thought that their functional status had been improved.

Important factors that are useful for the surgeon to identify and prevent this complication are discussed. An accurate preoperative clinical and radiographic examination, patient comorbidities, surgical exposure and technique, implant design, and intraoperative instrumentation may be factors that the surgeon can identify to reduce complications involving the extensor mechanism in TKA.

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Symposium VII: Pearls on Avoidance and Treatment of Intraoperative and Postoperative Complications

Patella Maltracking

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Maltracking of the patella component of total knee arthroplasty usually leads to the complications: subluxation – dislocation, fracture, excessive wear or implant failure. Patella maltracking is usually a sign of some technical problems in the arthroplasty. These include incorrect rotation or alignment of the femoral or tibial components and incorrect resection or position of the patella component. The author recommends posterior –stabilized components, with the femoral component aligned with "Whitesides' lines" (epicondylar axis), tibial component rotation determined by anatomic landmarks and an asymmetric patella resection. A trial reduction to test patella tracking is performed using a towel clip. A lateral retinacular release may be required for knees with excessive preoperative valgus alignment, severe patellofemoral arthritis, a preoperatively subluxed patella, or a very stiff knee. An Insall-type proximal realignment is reserved for those knees with a dislocated patella preoperatively, a history of recurrent patella dislocation or revision for maltracking-dislocation if the orientation of the components is correct.

The author performed 255 consecutive primary posterior-stabilized knees using an anatomic femur and 3-peg offset-dome patella. Component alignment was performed using Whiteside's lines for the femoral component, medial border of the tubercle for the tibial component and previously reported (Larson et al Clin Orthop 2001) techniques for the patella. The prevalence of lateral release was 6.6% and most knees requiring this had excessive preoperative valgus (mean 15°). At follow-up of 2 to 7 years (mean 3.5), there had been 3 patella fractures (1.2%) and no reoperations for the patellofemoral joint. Two patella components have radiographic loosening but the patients are asymptomatic.

Patella maltracking is an avoidable problem in total knee arthroplasty. When treating a patient with obvious patella maltracking, it is necessary to evaluate the entire knee arthroplasty for alignment, component rotation and stability. At reoperation for maltracking, the surgeon must be prepared to revise all components. A proximal realignment will usually be successful if component position is satisfactory.

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Symposium VII: Pearls on Avoidance and Treatment of Intraoperative and Postoperative Complications

Wound Problems in Total Knee Arthroplasty

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Wound problems can often be prevented with careful planning. Years before a knee arthroplasty is required, transverse incisions for patellar surgery and high tibial osteotomy are fine. A standard knee arthroplasty incision will always be appreciated at a later date. When lateral incisions are necessary (following previous lateral tibial plateau fracture) they should be re-used for the arthroplasty, perhaps with a tibial tubercle osteotomy. The arthroplasty surgeon confronted with multiple previous incisions should choose either the one that has healed most recently or the most lateral. When too many incisions are present, when skin and scar are adherent to underlying tissue or when wound healing appears questionable, soft tissue reconstruction with expanders or gastrocnemius flap is preferred.

Deep infection must be ruled out by aspiration, and if present, mandates an entirely different course of action including irrigation, debridement and polyethylene exchange if acute, and resection arthroplasty in the chronic situation.

Poor wound healing in the face of total knee arthroplasty is a potentially devastating complication that may result in multiple reconstructive procedures and even loss of limb. Early recognition followed by expeditious debridement and soft-tissue reconstruction is the mainstay of management of wound complications in total knee arthroplasty.

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Goals and Objectives
The Knee Society/AAHKS Specialty Day program is designed to provide practicing orthopaedic surgeons with current information regarding surgical techniques, emerging technology and symposia discussions on managing total knee arthroplasty, and to enhance the care of patients with arthritis and degenerative diseases of the knee joint.

Upon completion of this activity, participants will be able to:

- Critique presentations of surgical techniques and demonstrations of treatment options.
- Discuss management of patients who present with musculoskeletal injuries and conditions related to the knee joint.
- Determine indications and complications in TKA and other surgical interventions.
- Update basic knowledge and skills through clinical research findings and biomechanical studies.

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