

**The Knee Society**  
and the  
**American Association of Hip and Knee Surgeons**



**Combined Specialty Day Meeting**  
**Saturday, February 16, 2002**

Hyatt Regency Dallas Hotel  
Reunion Ballroom A-D  
Dallas, TX

**Scientific Program**

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## **Future Combined Specialty Day Meetings:**

New Orleans, Louisiana	February 8, 2003
San Francisco, California	March 13, 2004
Washington, DC	February, 2005

**Abstract Application forms for the 2002 Knee Society Interim Meeting and the 2003 Combined Specialty Day Meeting are available for download on the Knee Society Website (<http://www.kneesociety.org>). Deadline for receipt of Abstracts is April 1, 2002.**

# The Knee Society/AAHKS Combined Specialty Day Meeting Saturday, February 16, 2002

- 8:00 AM           **Welcome**  
Clifford Colwell, MD, Knee Society President  
Aaron Hofmann, MD, Knee Society Program Chair  
John Callaghan, MD, AAHKS President  
Richard White, MD, AAHKS Educational Committee Chair
- 8:06-9:15 AM   **Symposium I: Long -Term Follow Up after TKA**                   Moderator: Merrill A. Ritter, MD  
8:06 AM           Nonmodular                   E. Michael Keating, MD\*  
8:16 AM           Mobile bearing               Frederick F.Buechel, MD\*  
8:26 AM           Cementless                   Leo A. Whiteside, MD\*  
8:36 AM           Fixed bearing P.S.           Michael Kelly, MD\*  
8:46 AM           Fixed bearing P.R.           Robert Trousdale, MD
- 9:56-9:15 AM   Discussion
- 9:15-10:20 AM  **Symposia II: Polyethylene Wear**                                   Moderator: Gerard A. Engh, MD  
9:15 AM           New Polys for Old?         A. Seth Greenwald, DPhil  
9:25 AM           Backside Wear               Giles Scuderi, MD\*  
9:35 AM           Post Wear                   John J. Callaghan, MD\*  
9:45 AM           Cross-linked Poly          Orhun Muratoglu, PhD\*  
9:55 AM           Wear is not an Issue       Lawrence Dorr, MD\*
- 10:05-10:20 AM Discussion
- 10:20–10:35 AM **AMBREAK**
- 10:35-11:40 AM **Symposia III: Osteoarthritis in the Young Patient**                   Moderator: Richard S. Laskin, MD  
10:35 AM           Cement                       Thomas S. Thornhill, MD\*  
10:45 AM           Cementless                  Aaron A. Hofmann, MD\*  
10:55 AM           Mobile bearing              Robert Bourne, MD\*  
11:05 AM           HTO                          Richard Santore, MD  
11:15 AM           Uni                          Richard D. Scott, MD\*
- 11:25-11:40 AM Discussion
- 11:40 AM - 12:40 PM   **LUNCH** (*Knee Society Business Meeting – Members Only*)
- 12:40-1:27 PM   **THE KNEE SOCIETY AWARD PRESENTATIONS**
- 12:40-12:45 PM **JOHN INSALL AWARD**                                   Introduction: Norman Scott, MD  
12:45-12:52 PM **Why are Knee Replacements Failing Today?**  
Peter F Sharkey MD, *Philadelphia, PA*, Shani Shastri, MD, Gina Bissett, BA, William J Hozack, MD,  
Richard H Rothman, MD
- 12:52-12:55 PM Discussion

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

- 12:56-1:01 PM **MARK COVENTRY AWARD** Introduction: Robert Trousdale, MD
- 1:01-1:08 PM **Backsided Tibial Polyethylene Wear and Osteolysis in Modular Tibial Components**  
 Joshua J Jacobs, MD,\* *Chicago, IL*; Michele F Surace, MD; Aivars Berzins, MD; Robert M Urban;  
 Richard A Berger, MD, Raghu N Natarajan, PhD, Thomas P Andriacchi, PhD, Jorge O Galante, MD, DSc
- 1:08-1:11 PM Discussion
- 1:12-1:17 PM **CHITRANJAN RANAWAT AWARD** Introduction: Lawrence Dorr, MD
- 1:17-1:24 PM **The Effect of Selective Lateral Ligament Release on Knee Joint Stability in TKA**  
 Takeshi Kanamiya, MD, *St. Louis, MO*, Leo Whiteside, MD, Takashi Nakamura, MD, Kazuhiko Saeki, MD,  
 Masatoshi Naito, MD
- 1:24-1:27 PM Discussion
- 1:28-2:45 PM **SCIENTIFIC PAPER PRESENTATIONS** Moderator: Richard White, MD
- 1:28-1:34 PM **Castastrophic Polyethylene Failure of Unicdylar Implants with a Long Shelf Life Following**  
 Paper #1 **Gamma Irradiation in Air**  
 Thomas F McGovern, MD, *Alexandria, VA*, Deborah J Ammeen, BS, Gerard A Engh, MD
- 1:34-1:37 PM Discussion
- 1:38-1:44 PM **Which Functional Activities are Important to Patients After Total Knee Replacement?**  
 Paper #2 Jennifer M Weiss MD, *Houston, TX*, PC Noble, PhD, S Roberts, BS, MA Conditt, PhD, DR Lionberger, MD
- 1:44-1:47 PM Discussion
- 1:48-1:54 PM **Mobile Bearing Vs. Fixed Bearing TKA: Postoperative Pain, Function and ROM**  
 Paper #3 Carlos J Lavernia MD,\* *Miami, FL*, Ruben Hernandez, MD, Rafael Sierra, MD
- 1:54-1:57 PM Discussion
- 1:58-2:04 PM **Surgical Procedure for Correction of Flexion Contracture and Recurvatum in TKR**  
 Paper #4 Leo A Whiteside MD,\* *St. Louis, MO*
- 2:04-2:07 PM Discussion
- 2:08-2:14 PM **A Comparison of Stemmed Vs. Unstemmed Insall- Burstein-CCK Components in Revision TKA**  
 Paper #5 David G Nazarian MD, *Philadelphia, PA*, Robert E Booth, Jr., MD
- 2:14-2:17 PM Discussion
- 2:18-2:24 PM **Preoperative Hip to Ankle Radiographs in TKA: A Prospective, Randomized Study**  
 Paper #6 Mark W Pagnano, MD, *Rochester, MN*, James E McGrory, MD, Robert Trousdale, MD, Michael Nigbur, PA
- 2:24-2:27 PM Discussion
- 2:28-2:45 PM **BREAK**

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2:45-3:50 PM	<b>Symposium IV: Salvage of the Infected Knee</b>		Moderator: Cecil Rorabeck, MD
2:45 PM	Resistant Organisms	Doug Kilgus, MD	
2:55 PM	Single Stage	Thomas Schmalzried, MD	
3:05 PM	2 Stage with Block	Russell E. Windsor, MD*	
3:15 PM	2 Stage with Articulating Spacer	Roger H. Emerson Jr., MD	
3:25 PM	Fusion: The Last Option	Jerome Wiedel, MD	
3:35-3:50 PM	Discussion		
3:50-4:55 PM	<b>Symposium V: Revision Knee</b>		Moderator: Lawrence Dorr, MD
3:50 PM	Bone Loss	Paul A. Lotke, MD*	
4:00 PM	Balance	Kenneth A. Krackow, MD*	
4:10 PM	Fixation	Cecil H. Rorabeck, MD*	
4:20 PM	Joint Line Restoration	Richard Laskin, MD	
4:30 PM	Instability	Robert Trousdale, MD	
4:40-4:55 PM	Discussion		
5:00 PM	<b>Adjourn</b>		

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



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# Scientific Presentation Abstracts

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## Symposium I: Long -Term Follow Up after TKA

### Nonmodular

E. Michael Keating, MD, *Mooreville, IN*

We report the results of a non-modular metal-backed tibial tray total knee replacement at long term follow-up of 17 years. Between September of 1983 and December of 1996 we implanted 4,913 AGC primary total knee replacements at our institution. The surgeries were performed by 4 different surgeons using similar techniques. Demographic data was collected as to age, gender, indications for surgery, complications, clinical, and radiographic failures. The exclusion criteria for this study included infections and revisions. Sixty-two knees were excluded because of infection for a rate of 1.3%. 210 knees were lost to follow-up, 4.2%. This left 4,583 knees in 3,054 patients. There were 407 deaths, 8.9% during this follow-up period. The femoral and tibial components have been unchanged since 1983.

The femoral component is a flat on flat design. The tibial component is a non-modular, molded one-piece metal backed tibial tray. The diagnosis was osteoarthritis in 87% of the patients, the average age of the total knee replacements was 70.4 years. 60% of patients were women and all patients had femoral, tibial and patellar components inserted. There were 296 metal backed patella components and 4,287 all polyethylene patella components implanted. Kaplan-Meier analysis were performed with the endpoint being defined as radiographic loosening, revision, or both. There were 6, (0.18%) femoral revisions and 21, (0.46%) tibial revisions. All radiographically loose femoral components and 90% of the radiographically loose tibial components were revised. The clinical survival rate with revision of one or more components as the endpoint was 98.86% at 15 years.

Despite having nearly flat on flat geometry, and retaining the posterior cruciate, this total knee replacement has proved to have minimal wear and excellent longevity with time. Not a single component in this series was revised for polyethylene wear or osteolysis. The direct compression molded tibial articulation is a slightly different resin than is generally available in total knee replacements.

The authors feel that this is the reason that this non-modular configuration has had such excellent survival and success in the long-term 15-year follow-up of this component.

## **Symposium I: Long -Term Follow Up after TKA**

### **Mobile Bearing**

Frederick F.Buechel, MD, FACS, *South Orange, NJ*

Clinical, radiographic and survivorship analysis was performed on the initial cementless series of 309 primary and multiply-operated PCR meniscal bearing and rotating platform New Jersey LCS<sup>®</sup> total knee replacements followed for 10 years to a maximum of 20 years, mean 12.4 years.

Clinical results in patients surviving at least 10 years using a strict knee scoring scale were similar for PCL retaining and PCL sacrificing designs. Good to excellent results were seen in 97.9% of primary PCR meniscal bearing knees and in 97.9% of primary rotating-platform knees.

Radiographic analysis on minimum 10 year follow-up x-rays demonstrated stable fixation of all components, no gross migration but significant osteolysis requiring bearing exchange and bone grating in 3 multiply operated cementless rotating platform knees (1.8%) at an average of 10.2 years from their index surgery.

Survivorship of the primary cementless PCR meniscal bearing group with an endpoint of revision for any mechanical reason demonstrated 97.4% at 10 years and 83% at 16 years; using an endpoint of a poor clinical knee score the survivorship was 98.9% at 10 and 16 years, respectively. Survivorship of the primary cementless rotating platform group with endpoints of revision for any mechanical reason or a poor clinical knee score demonstrated 98.3% survivorship at 10 and 18 years, respectively.

No cementless rotating-bearing patella loosened, fractured or dissociated in this study, although one cementless rotating patella bearing (0.6%) in a multiply-operated patient wore through the inferior marker wire after 10.8 years causing metallosis, requiring revision.

## **Symposium I: Long -Term Follow Up after TKA**

### **Cementless**

Leo A. Whiteside, MD, *St. Louis, MO*

Between June 1981 and January 1984, 265 Ortholoc-I femoral and tibial components were implanted using bone-ingrowth technique in 202 patients. Five knees (five patients) were lost to followup and 66 knees were excluded because the patients died, leaving 184 knees (165 patients) with 15 to 18 years followup. One knee loosened during the 15 to 18 year followup period and was revised, and five knees were revised for infection. Survival rate at 18 years considering loosening was 98.6%. At 15 years after surgery, 79.9% of patients did not have pain, 10.1% had mild pain, 8% had moderate pain, and 2% had severe pain. At 18 years after surgery, 77.6% did not have pain, 7.2% had mild pain, 5.2% had moderate pain, and 1% had severe pain. Knee flexion was 110° preoperatively and increased to a mean of 115° at 2 years postoperative, then remained unchanged for the rest of the followup.

Intramedullary alignment proved to be highly effective, and has become the standard for total knee arthroplasty instrumentation systems. Total knee replacement with bone-ingrowth technique was a reliable and effective means of treating the end-stage arthritic knee. In patients who required revision surgery, excellent bone stock remained and revision with bone-ingrowth technique was accomplished easily.

## **Symposium I: Long -Term Follow Up after TKA**

### **Long Term Results with Fixed Bearing PCL Substituting Designs**

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

The original posterior stabilized knee prosthesis designed by Drs. Insall and Burstein was introduced in 1978 as a further modification of the original condylar prosthesis. This prosthesis built a PCL substituting mechanism into the device and was intended to improve stair climbing, improve range of motion and prevent posterior tibial subluxation. The posterior cruciate ligament substituting mechanism did not provide any medial-lateral prosthetic constraint.

The original Insall-Burstein Posterior Stabilized Knee utilized an all polyethylene tibial component. The initial cohort of 289 knees was evaluated between 9 and 12 years. Utilizing the HSS scoring system, the clinical results were: excellent 61%, good 26%, fair 6% and poor 7%. The average range of motion was 110°. Fourteen knees required revision: 5 for septic failure and 9 for aseptic loosening: 3 femoral and 6 tibial components. In 1980, metal backing of the tibial component was added to the design. The Insall group reported on the original cohort of non-modular posterior stabilized knees utilizing metal-backed tibial components at a mean follow-up of 10 years. One-hundred and one knees were available for analysis with: excellent 73%, good 23%, fair 0% and poor 4%. No tibial component loosening was reported. Additionally, an attempt was made to detect possible polyethylene wear or osteolysis in this group of patients. No significant polyethylene wear, nor osteolysis in this conforming design was noted. Excellent survivorship analysis of both groups of patients was reported. Survivorship of the all polyethylene tibial component PS design was 94% at 12 years and for the non-modular metal-backed tibial design was 96% at 11 years.

Clinical results utilizing this cemented posterior cruciate ligament design have been reported in an active cohort of patients less than 55 years at the time of implantation. One hundred and eight knees were analyzed with a minimum follow-up of 8 years (3-18 years). There were 103 unrevised knees and all of these scored good or excellent using the HSS scoring system. Additionally, all but two patients improved their Tegner activity scores.

Later modifications of the design, IBII and Nexgen Legacy, incorporated several design changes including the introduction of modularity in the tibial components. Additionally, patellofemoral problems seen in the original design were addressed with an anatomic femoral component with a raised lateral phalange and deeper trachlear groove to further optimize patellofemoral problems seen in the original design were addressed with an anatomic femoral component with a raised lateral phalange and deeper trachlear groove to further optimize patellofemoral kinematics. Clinical results of the IBII prosthesis were comparable to IBI at 10 years with an increased incidence of clinically insignificant radiolucencies noted with IBII. Although polyethylene wear is of greater concern in these modular implants, none was noted in this report.

Cemented posterior cruciate ligament substitution in total knee arthroplasty has proven to be versatile and durable utilizing the mentioned designs with strict adherence to the surgical principles of posterior cruciate ligament sacrifice and careful soft-tissue balance.

## **Symposium I: Long -Term Follow Up after TKA**

### **Fixed bearing P.R.**

Robert T. Trousdale, MD, *Rochester, MN*

The controversy over retention or substitution of the posterior cruciate ligament when performing a total knee arthroplasty continues. Excellent long-term results have been obtained with cemented condylar implants of cruciate-sacrificing, cruciate-substituting and cruciate-retaining designs.

An analysis of the Mayo Clinic Total Joint Registry was performed of all primary total knee arthroplasties performed between 1978 and 2000 (Rand, et al, AAOS 2001). There were 11,606 (86%) primary total knee arthroplasties. The prosthesis was PCL retaining in 8,052 (69%), PCL stabilizing in 2,994 (26%), PCL sacrificing in 412 (4%), and other (1%).

Survivorship in primary knee arthroplasties was 96% (CI 96-97) at 5 years, 91% (CI 90-92) at 10 years, 84% (CI 82-86) at 15 years, and 78% (CI 73-81) at 20 years. Using multivariate Cox modeling the estimated survival of our ideal knee patient, a female over the age of 70 with inflammatory arthritic using a nonmodular metal-backed component with cement fixation, an all polyethylene patella and a PCL retaining prosthesis is 99% (CI 99-100) at 5 years and 98% (CI 97-99) at 10 years.

## **Symposia II: Polyethylene Wear**

### **New Polys for Old: Contribution or Caveat?**

A. Seth Greenwald, D.Phil.(Oxon), *Cleveland, OH*

The enduring success of the low friction arthroplasty first advanced by Sir John Charnley as a solution for severe hip arthritic problems may be appreciated from the fact that in 2000 over 600,000 hip and knee arthroplasties were performed in the United States.

Nevertheless, aseptic loosening attributed to polyethylene debris-induced osteolysis is of contemporary concern, particularly as the indications for total joint replacement expand to younger patients and life expectancy increases. It is now known that irradiation in an environment where oxygen is present encourages UHMWPE component oxidation resulting in embrittlement and a decrease in wear performance. This process continues when components are shelf-stored in air or in permeable packaging for prolonged periods before use.

Sterilization in oxygen-free environments with barrier packaging and shelf dating reduce the prospect of material compromise. The use of ethylene oxide and gas plasma as alternative sterilization methods avoid oxidative degradation, but do not realize the potential benefits with respect to polymer wear reduction derived from cross-linking.

Recently, a number of “improved” polymers have emerged whose common benefit resides in increased cross-linking concurrent with minimizing oxidation. These processes, however, change the chemical structure of the polymer affecting both static mechanical properties and fatigue characteristics. A number of these polyethylenes have received FDA clearance and are commercially available in the absence of clinical reports. Corporate responsibility to assess short-term performance via evidence-based studies is requisite and should be a consideration in surgeon selection of highly cross-linked polymer components.

## **Symposia II: Polyethylene Wear**

### **Backside Wear of Modular Tibial Components in TKA**

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

Polyethylene wear debris in total knee arthroplasty has been recognized as a cause of osteolysis, which has become more evident with the introduction of modular tibial components. While the articular surface appears to be a source of polyethylene debris, the undersurface of fixed bearing modular tibial components has been reported to be another source. Though numerous locking mechanisms exist with fixed bearing designs, all have demonstrated motion between the tibial base plate and the polyethylene insert. Depending upon the implant design, quality of the polyethylene, forces applied and the time in vivo, the amount of polyethylene debris generated is variable. Controlling this motion with improved locking mechanisms, polished tibial baseplates or one-piece metal backed tibial components may be future solutions to the problems of polyethylene wear and the resultant osteolysis.

## **Symposia II: Polyethylene Wear**

### **Post Impingement**

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

Posterior cruciate substituting total knee replacements have performed well over the last two decades especially when all polyethylene and monolithic metal backed tibial components were utilized. Bearing surface wear and osteolysis were rarely reported.

With the use of modular metal backed tibial components more osteolysis and wear have been noted with posterior cruciate substituting designs. Cam-post impingement with transmission of forces to the modular tray connection and the bone cement interface have been reported. Design issues in avoiding cam-post impingement include tibial posts that allow rotation and post cam mechanisms that are not constraining and that allow hyperextension.

Technical considerations include avoidance of flexion of the femoral component, avoidance of posterior tibial slope and avoidance of excessive extension gap. If the implants are properly designed and these technical considerations are followed cam-post impingement should be minimized.

## **Symposia II: Polyethylene Wear**

### **Markedly Improved Adhesive Wear and Delamination Resistance with a Highly Crosslinked UHMWPE for Use in TKA**

Orhun K. Muratoglu, PhD, *Boston, MA*

The primary wear mechanisms in polyethylene tibial knee inserts have been identified as pitting, delamination, and adhesive/abrasive wear. Crosslinking of polyethylene has been shown to substantially improve the wear characteristics of acetabular components. However, the effect of crosslinking on the wear behavior of tibial knee inserts has yet to be determined. The purpose of this study was to assess the benefits of crosslinking in tibial knee inserts.

The highly crosslinked UHMWPE was prepared by irradiation at 125°C to a total dose level of 95 kilogray and melt-annealing at 150°C for two hours. Sulzer Natural Knee II tibial inserts were machined from the highly crosslinked UHMWPE and sterilized with ethylene oxide gas. These were tested on the AMTI knee simulator along with control components of the same design, which were sterilized with gamma irradiation (25-40 kilogray) in nitrogen. Prior to the knee simulator studies, the inserts were preconditioned in an air convection oven at 80°C for 35 days. The level of oxidation was then determined as a function of depth away from the articulating surfaces.

The control inserts showed a wear rate of  $8 \pm 2$  mg per million cycles, while the wear in the highly crosslinked inserts was not detectable. All three preconditioned, control inserts showed subsurface cracks and delamination following five million cycles of simulated gait. In contrast, highly crosslinked inserts did not show any indication of subsurface cracks or delaminations during the test.

This study strongly supports the use of highly crosslinked UHMWPEs in the manufacture of tibial knee inserts.

## **Symposia II: Polyethylene Wear**

### **Wear is not an Issue**

Lawrence D. Dorr, MD, *Inglewood, CA*

Wear as a cause of failure for total knee replacement is not an issue if the surgeon makes the correct choices in performance of the operation. The operation must be performed with a cobalt chromium femoral component, an articulation surface that protects against excessive wear (the design type should have a track record of 15-20 years of doing so).

The importance of the quality of the polyethylene for the articulation surface has been established by the AGC knee. If the surgeon chooses to resurface the patella it should be a cemented all polyethylene patella. Finally, it is the responsibility of the surgeon to perform the operation correctly so that the femoral and tibial components are mated so that they are not mal-aligned and that soft tissue balance provides correct stability.

## **Symposia III: Osteoarthritis in the Young Patient**

### **Use of Cemented Total Knee Arthroplasty**

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

Gonarthrosis encompasses a continuum of pathological changes of the knee in patients with variable demand and functional activity. There are indications for non-operative treatment, arthroscopy, osteotomy, uni compartmental knee replacement and total knee replacement. This section advocates the use of cement when choosing total knee replacement in the young osteoarthritic patient.

Evidence based data using cruciate sparing and cruciate substituting design supports the use of cement not only in elderly patients but in more active younger patients as well. While early data on cementless designs were problematic, there are recent studies reviewing the 18-year survivorship of cementless components as well as of hybrid fixation that would support the use of cementless designs in younger patients.

The advantage of cementless designs includes the ability to avoid cement fracture and cement particle formation as well as to load the bone in a potentially more physiologic fashion. There are many design features of cementless knees that have raised concern even at short term follow up. These include the use of metal-backed patella and un-stemmed tibial component fixed with screws.

In recent years there has been an increased interest in cementless hip fixation. It is misleading to confer these data in considering fixation of knee implants. Loading of the acetabulum is substantially different than in loading the knee. Femoral fixation in the hip requires pressurization of a blood filled canal with a large endosteal surface. In the knee, cement acts as a grout not only to fill voids between the implant and the bone but also to provide a uniform surface stabilizing the trabecular bone and eliminating marked disparities in the bony strength. Moreover, cement in the knee acts as a barrier to particle induced osteolysis that has a predisposition to attack the prosthesis bone interface. Finally, bone cement has a modulus of elasticity similar to both cortical and cancellous bone and can provide an interface suitable for the much stiffer implant.

With our current materials technology cement remains the best method for fixation of total knee implants. With newer materials, growth factors and cytokines capable of providing predictable bone ingrowth, uncemented fixation may be the ultimate method to achieve fixation in total knee arthroplasty.

## **Symposia III: Osteoarthritis in the Young Patient**

### **Cementless TKA in Patients under 50 Years of Age**

Aaron A. Hofmann, MD, *Salt Lake City, UT*

Total knee arthroplasty has been shown to be a reliable method of treating degenerative joint disease of the knee. It is now being used in younger patients for posttraumatic and rheumatoid arthritis. Advances in technology and design have allowed for more predictable results and longer lasting materials. There has been continued interest in cementless techniques, especially for these younger patients.

Between 1986 and 1998, 85 total knee replacements in 74 patients 50 years of age or younger were performed. All surgeries were performed by a single surgeon (AAH). There were 38 left knees and 49 right knees. The average age of the patients was 43 (range 31-50). Follow up averaged 111 months. Pre-operative range of motion (ROM) was 6-106 and post-operative ROM was 2-113. Knee scores were 67 pre-op and 97 post-op.

The majority of the diagnosis was posttraumatic arthritis or osteoarthritis (56%), indicating a young, active group of patients. There were 2 infections, 1 revision for a periprosthetic fracture and 14 polyethylene exchanges. There were no revisions for loosening or implant failure. There was a correlation between prior knee surgeries and the need for a manipulation. Radiographically there were no loose implants at latest follow up.

Cementless total knee arthroplasty in the young, high demand patient is a reliable procedure with excellent survivorship.

## **Symposia III: Osteoarthritis in the Young Patient**

### **Mobile Bearing TKR**

Robert B. Bourne, MD, FRCSC, *London, ON, Canada*

Polyethylene wear is an issue in total knee replacement (TKR) particularly in younger, more active patients. Mobile bearing TKRs (MBKs) have been suggested as a viable option for this patient group, perhaps combined with better bearing surfaces and polyethylene.

Mobile bearing TKRs offer the advantages of lower polyethylene contact stresses, self-alignment and improved kinematics. Areas of controversy with MBKs include gait versus total congruence, the femoral J curve and the importance of translation. Surprisingly, wear simulator studies have demonstrated increased gravimetric wear for mobile bearing TKRs compared to fixed bearing implants. Gravimetric wear was also increased in MBKs which were totally congruous (up to 90° flexion) compared to gait congruous (up to 20° flexion) or which feature rotation and translation compared to rotate only MBKs.

Long-term comparative, clinical studies are obviously needed to clearly define the role of mobile bearing TKRs in younger, more active patients.

*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: Sulzer SAL TKR, Smith & Nephew Genesis II & Profix MBK*

## **Symposia III: Osteoarthritis in the Young Patient**

### **Osteotomy in Unicompartmental Arthritis of the Knee**

Richard F. Santore, MD, *San Diego, CA*

For over 40 years, osteotomy has been performed to realign the leg in one or multiple planes in cases of symptomatic angular deformities of the knee. Results have been mixed. Orthopaedic scholars have challenged the rationale for valgus osteotomy for varus deformities.

Arthroscopy prior to valgus HTO has not been shown to significantly alter the outcome of the procedure. Preoperative gait study demonstrating varus thrust (high adduction moment) has correlated with a 50 percent failure rate within three years of the procedure. It is not possible to attribute all of the results, good or bad, from osteotomy about the knee to changes in static alignment or factors of single limb stance biomechanics.

For developmental deformities, valgus producing osteotomy of the knee is best done in the upper tibial area and varus producing osteotomies in the distal femur for reasons that pertain to the frontal plane slope of the joint line. Post-traumatic deformities are usually best done at the site of deformity. An alignment of 8-10 degrees of valgus is appropriate for valgus HTO. This is clinically effective and permits safe conversion to total knee replacement, if necessary.

Varus supracondylar osteotomies for valgus deformities are effective. Over correction should be avoided because of the potent loading of the medial compartment by varus alignment.

Osteotomy has an enduring role for pain relief and improved function in biologic joint preservation surgery of the knee. Patient selection, planning, technique, rigid internal fixation and rehabilitation all play a role in the ultimate outcome.

## **Symposia III: Osteoarthritis in the Young Patient**

### **Unicompartmental Knee Arthroplasty in the Young Arthritic Patient**

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

Unicompartmental knee arthroplasty (UKA) has remained a controversial operation for three decades. Many surgeons in the 80's and 90's found little or no indication for the procedure. Others remained enthusiastic for its use in selected osteoarthritic patients with unicompartmental disease.

Initially, UKA was thought to be appropriate for the elderly sedentary patient. With the advent of "minimally invasive" techniques, indications have expanded to include its use in younger patients (especially females) as an alternative to osteotomy or tricompartmental knee arthroplasty. Advantages over osteotomy include higher initial success, greater longevity and fewer early complications. If performed conservatively, salvage is not difficult. The extent of safe post-operative activity levels has yet to be established. Failure rates appear to be higher in heavy, active males.

A metallic interposition hemiarthroplasty in the form of a McKeever or MacIntosh prosthesis has been available for 40 years as a unicompartmental arthroplasty, but with limited use. It may still have a role in selected patients as a conservative temporizing procedure.

# **The Knee Society Award Presentations**

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## **JOHN INSALL AWARD**

### **Why are Knee Replacements Failing Today?**

**Peter F Sharkey MD, Philadelphia, PA, William J Hozack, MD, Richard H Rothman, MD, Shani Shastri, MD, Sidney M Jacoby, BA**

It is generally accepted that total knee arthroplasty is a safe, effective and durable procedure. Yet, over 35,000 knee revisions are performed worldwide annually. The cost and morbidity associated with revision surgery is substantial. The mechanisms by which total knee arthroplasties fail are documented, however, the reports on this subject have been historical and have reviewed revisions performed over extended periods of time.

The purpose of our study was to determine current mechanisms of failure of TKA in order to allow clinicians and researchers to focus their efforts on improving these outcomes. A retrospective review was done of all patients who underwent total knee revision over a three-year period (9/23/97 – 10/4/00) at one institution. The preoperative evaluation in conjunction with radiographs, laboratory data and intraoperative findings was used to determine causes of failure.

212 surgeries were performed on 203 patients (9 bilateral), 133 females and 79 males. The cases reviewed included knees revised between 9 days and 28 years (average 3.7 years) after the previous surgery. Reasons for revision were polyethylene wear 25.0%, aseptic loosening 24.1%, instability 21.2%, infection 17.5%, arthrofibrosis 14.6%, malalignment/malposition 11.8%, deficient extensor mechanism 6.6%, avascular necrosis of the patella 4.2%, periprosthetic fracture 2.8% and isolated patellar resurfacing 0.9%. More than one cause of failure was noted in 32% of patients. Polyethylene wear was the primary reason for late revision surgery, while infection was the most common cause for early failure (failure less than 2 years after previous operation).

More than 50% of knee revisions in our series were performed to correct instability, malalignment/malposition, and failure of fixation. Most of the revisions in our series were performed < 2 years after the primary replacement. Improvements in surgical techniques may diminish the incidence of knee revisions significantly.

## **MARK COVENTRY AWARD**

### **Backsided Tibial Polyethylene Wear and Osteolysis in Modular Tibial Components**

**Joshua J. Jacobs, MD**, *Chicago, IL*; Michele F. Surace, MD; Aivars Berzins, MD; Robert M. Urban; Richard A. Berger, MD, Raghu N. Natarajan, PhD, Thomas P. Andriacchi, PhD, Jorge O. Galante, MD, DSc

Wear and deformation were characterized at the backsurface of 25 posterior cruciate-retaining TKA polyethylene inserts from one manufacturer, retrieved postmortem from 20 subjects. The mean implantation time was 64.1 months (range, 4-156 months). The backsurface of the inserts was inspected using a stereomicroscope and a semiquantitative wear score was assigned. Extrusions of polyethylene into the screw holes and anteroposterior profiles of the backsurface were measured with a digital optical system. Coronal histologic sections of 13 proximal tibiae were inspected for the extent of penetration of granuloma.

In general, the damage to the back surface of these components was limited. Polishing was recorded on 21 (84 %) and abrasive wear on five (20 %) inserts. Pitting was present in 21 (84 %) components, but involved less than 1 % of the area in 20 (80 %) components. Delamination and cracking were not observed. Extrusions resulting from cold flow were seen in 10 (40 %) of the components.

A correlation was found between the depth of penetration of the granuloma along the posteromedial screw and the height of the corresponding extrusion. The height of both posterior extrusions was correlated to the penetration of granuloma at the bone-implant interface at the periphery of the tray.

The anteroposterior profiles showed a concave deformation of the back surface in 24 (96 %) of the cases. The concave deformation of tibial inserts may facilitate accumulation and transportation of wear debris to the tibial bone-implant interface through the screw holes in implants designed for cementless fixation.

## CHITRANJAN RANAWAT AWARD

### **The Effect of Selective Lateral Ligament Release on Knee Joint Stability in TKA**

**Takeshi Kanamiya, MD, St. Louis, MO, Leo A. Whiteside, MD, Takashi Nakamura, MD, Jerry Steiger, Masatoshi Naito, MD**

This study evaluated changes in stability of the knee after selective, sequential lateral ligament release. Seventeen cadaveric knees were tested in a knee kinematics testing device at 0°, 30°, 60°, and 90° flexion under 10Nm varus-valgus torque and 10Nm torque in internal-external rotation. In eight knees, stability was tested after each release: iliotibial band (ITB), lateral collateral ligament (LCL), popliteus tendon (PT), posterolateral corner capsule (PLC), and posterior capsule (PC).

To evaluate the ITB, PT, and PLC, nine additional knees were divided into three groups, and stability was compared after different combinations of soft tissue releases: all except the ITB, all except the PT, and all except the PLC. At full extension, varus laxity increased after release of the ITB alone (mean,  $4.1^{\circ} \pm 1.7^{\circ}$ ), a 37.7% increase as compared with that after total knee arthroplasty; and increased significantly compared with that after release of every other ligament ( $p < 0.05$ ).

After PT release, varus laxity increased at all flexion angles compared with that after release of the ITB alone. Varus laxity increased significantly after PT release at all flexion angles compared with that before PT release ( $p < 0.05$ ). Varus laxity increased significantly after release of the LCL at all flexion angles compared with that after total knee arthroplasty from 0° to 90° flexion ( $p < 0.05$ ).

After release of the PLC, varus laxity increased at all flexion angles, and was statistically significant from 0° to 30° flexion ( $p < 0.05$ ). Varus laxity appeared to increase more when the PC was released at full extension ( $p < 0.05$ ), but the difference was not statistically significant at 60° and 90° flexion.

## Paper #1

### **Catastrophic Polyethylene Failure of Unicondylar Implants with A Long Shelf Life Following Gamma Irradiation in Air**

**Thomas F. McGovern, MD, Alexandria, VA** , Deborah J. Ammeen, BS, Gerard A. Engh, MD

**Introduction:** Ultra high molecular weight polyethylene used for knee arthroplasty was routinely sterilized with gamma irradiation in air for more than a decade. Many of these implants are either still *in situ* with an unknown shelf life or remain available for implantation in the inventories of the manufacturer, company representatives, or hospitals. We describe the catastrophic wear necessitating early revision surgery of a unicondylar implant with a prolonged shelf life prior to implantation.

**Methods:** Between December 1997 and January 2000, a single surgeon implanted seventy-five consecutive Duracon (Howmedica, Rutherford, NJ) unicondylar arthroplasties in 62 patients. The all-polyethylene tibial components were gamma irradiated in air. Unbeknownst to the surgeon, 73 implants had a shelf life greater than 4 years. This was discovered by an investigation of product lot and code numbers following revision arthroplasty of two implants for catastrophic wear within 18 months of surgery.

**Results:** 37 knees (51%) have been or currently are scheduled for revision arthroplasty. These patients presented with a joint effusion and onset of pain within the first 2 years after surgery. Radiographs confirmed the presence of unexpected wear without component loosening. All retrieved tibial components demonstrated severe fatigue wear with polyethylene delamination and often embrittlement and fracture of the components. Fourier Transform Infrared Radiation analysis documented polyethylene oxidation of the magnitude of GUR-415/412 with a shelf life of 6 to 9 years.

**Discussion and Conclusions:** Although wear in knee arthroplasty is unavoidable, this catastrophic event has heightened our awareness of the potential for premature failure of highly oxidized polyethylene components. Surgeons must carefully monitor implants sterilized with gamma irradiation in air and obtain information relative to shelf life if premature wear is encountered. Manufacturers must specify the date and method of sterilization on the packaging of all components. No implant sterilized in this fashion should be implanted unless the shelf life is known.

## Paper #2

### Which Functional Activities are Important to Patients After TKR?

Jennifer M. Weiss, MD, *Houston, TX*, Philip C. Noble, MD, PhD, S. Roberts, BS, M.A. Conditt, PhD, D.R. Lionberger, MD

**Introduction:** Previous attempts to quantify patient function after total joint procedures have focused on gait and stairclimbing without consideration of activities of importance to each individual patient. This study was undertaken using a newly developed functional outcome questionnaire to identify activities that are important to total knee patients and the extent to which their knee replacement limits participation in these activities.

**Materials and Methods:** A self-administered, mail-back “Total Knee Function Questionnaire” (TKFQ) was developed, pilot tested, and mailed to 504 primary TKR patients at least one year post knee replacement. This instrument addressed participation in a broad range of physical, vocational and recreational activities. Patients were asked about their frequency of participation in, the personal importance of, and the perceived limitation in participation in these activities imposed by the TKR. The relationships among prevalence, perceived importance, and limitations were then evaluated using linear regression.

**Results:** Of the 243 patients who returned the questionnaire, 202 were primary TKRs (82%), 40% men and 60% women. The average age was 71 years (women: 70 years, men: 71 years). Reported prevalence of regular participation in physical activities ranged from 0.4% (cross-country skiing) to 72% (stretching). After stretching, the 3 next most prevalent activities were leg strengthening exercises (65%), gardening (47%) and dancing (21%). The percentage of patients who reported that the activities were important to them ranged from 0% (downhill skiing) to 68% (leg strengthening). The next 3 most important activities were stretching (65%), kneeling (58%), and sexual activity (45%).

Percentage of patients who reported that their TKR bothered them while participating in the various activities ranged from 24% (swimming) to 83% (squatting). Kneeling (78%) and gardening (60%) were also quite limited by the operated knee. There was a statistically significant relationship between prevalence of participation and the importance of each activity to the patient ( $R^2=.75$ ,  $p<.01$ ). Gardening and kneeling demonstrate a disparity between prevalence and limitation. The same two activities demonstrate a disparity between importance and limitation. While over half of the patients gardened and kneeled regularly and over two-thirds of the patients reported that these activities were important to them, over half of the patients reported significant limitations imposed by their TKR on these activities.

**Conclusions:** Although the high correlation between importance and prevalence suggests that TKR patients are indeed capable of participating in many activities which they consider important, several activities, including gardening and kneeling are both important to the patients and limited by their knee replacement. These results suggest that conventional questionnaires and scoring systems may be missing important information.

Moreover, comprehensive examination of the functional activities of TKR patients indicates that the response to any questionnaire is highly dependent on the specific activities assessed. This suggests that function after TKR may not be as satisfactory to the patient as previous studies have suggested.

## Paper #3

### **Mobile Bearing Vs. Fixed Bearing TKA: Postoperative Pain, Function and ROM**

Carlos J Lavernia MD, *Miami, FL*, Ruben Hernandez, MD, Rafael Sierra, MD

**Introduction:** Mobile bearing knees have been reported to improve motion and function in TKA. The objective of this study was to compare the postoperative pain, function and ROM in patients undergoing TKA.

**Methods:** 146 consecutive TKAs were studied. 82 AMK's and 64 LCS's. Patients were classified according to insurance type, ASA score, Charnley classification and Charlson Comorbidity index. Medical charts were reviewed and length of hospital stay, number of in-hospital consults, type of anesthesia, disposition upon discharge, and in-hospital as well as post-discharge complications were noted for each patient. ANOVA and ANCOVA statistically analyses were performed and a  $p < 0.05$  was considered significant.

**Results:** The average preoperative range of motion for mobile bearing and fixed bearing designs ranged from  $3.6^\circ$  to  $106^\circ$  and  $3.2$  to  $105^\circ$ , respectively. At follow-up, range of motion ranged from  $1.06$  to  $100.60^\circ$ .and  $83^\circ$  to  $99^\circ$ , respectively. After adjusting for preoperative scores and multiple covariates, there was no statistically significant difference in postoperative pain, function KS, HSS scores or ROM between the two groups.

**Discussion and Conclusion:** Our study showed no statistical difference in ROM and postoperative orthopedic scores with respect to TKA bearing design. Although preliminary statistical analyses demonstrated better outcome in patients who received a mobile bearing TKA, adjustments for sex, medical and orthopedic severity of illness and insurance nullified the difference. Our data showed no difference in the short-term outcome between mobile and fixed bearing designs. Medical and orthopedic severity of illness had a statistically significant effect on the postoperative evaluation.

## Paper #4

### **Surgical Procedure for Flexion Contracture and Recurvatum in TKA**

Leo A Whiteside MD, *St. Louis, MO*, William M. Mihalko, MD, PhD

A protocol was developed to correct flexion contracture and recurvatum deformities of the knee with choice of implant size and with placement of the distal femoral resection surface.

For flexion contracture:

- 1) Femoral component size was slightly oversized to tighten preferentially in flexion. The tibia was slightly over-resected to accommodate the femoral oversize and help correct the deformity.
- 2) The ligaments were balanced.
- 3) Posterior capsular release was done if residual flexion contracture remained.
- 4) Over-resection of the distal femur was done last to correct any remaining flexion contracture.
- 5) Release of the posterior cruciate ligament loosens the knee in flexion, not in extension, and is contraindicated in knees with flexion contracture.

For knees with recurvatum:

- 1) The femoral component was undersized to preferentially loosen the knee in flexion. The tibial surface was slightly under-resected to correct laxity in flexion and extension.
- 2) The distal femoral surface was under-resected to tighten the knee preferentially in extension.

530 patients (552 knees) had flexion contracture (542 knees) or recurvatum (10 knees) of 10 degrees before surgery. Ligament release and correction of varus or valgus contracture corrected flexion contracture to less than 3° in 515 knees (95%). Sixteen knees (3%) had release of the posterior capsule to correct residual flexion contracture, and 11 knees (2%) required over-resection of the distal femoral surface to achieve correction of flexion contracture. Mean flexion contracture at one month after surgery was  $7\pm 3^\circ$ . By one year the flexion contracture had decreased to  $2\pm 1^\circ$ .

In the knees with preoperative recurvatum, none had residual recurvatum at the conclusion of surgery, and none developed recurrent deformity.

## Paper #5

### **A Comparison of Stemmed Vs. Unstemmed Insall-Burstein-CCK Components in Revision TKA**

**David G. Nazarian MD**, Philadelphia, PA, Robert E. Booth, Jr., MD

**Introduction:** The use of a semi-constrained knee component helps provide greater stability to knees with deficient collateral ligaments. Controversy exists whether this constraint will lead to earlier prosthetic loosening when using this type of implant. Thus, some authors have advocated the use of intramedullary stems to augment component fixation. The purpose of this study was to compare retrospectively the results of the IB-CCK implant used with and without intramedullary stems.

**Methods:** One surgeon performed two hundred seven revisional knee arthroplasties with the IB-CCK. One hundred sixty-one knees had either one or two stems placed. One hundred eight femoral stems and 86 tibial stems were placed. Sixty-five knees had no femoral or tibial stem. The decision to utilize a stem was based on bone quality and component fixation at surgery. All components were cemented while the stems were tightly press fit without cement. Patients were followed clinically and radiographically with a Knee Society rating scale.

**Results:** The average knee scores went from 52 preoperatively to 86 postoperatively. The average range of motion postoperatively was 4° (range 0-10°) to 106° (94-118°) in this group. The average postoperative knee score was 86 in the unstemmed group and 85 in the stemmed group with no difference in average range of motion. There were 4 (3%) cases of tibial loosening and 2 (2%) cases of femoral loosening in the unstemmed group. There were 2 (2%) cases of tibial loosening and 2 (2%) cases of femoral loosening at an average follow up of 4.2 years (2-6.2). There were 2 supracondylar fractures and one infection in the unstemmed group and 2 infections in the stemmed group.

**Discussion and Conclusion:** Despite the higher constraint inherently designed in an IB-CCK component, this report did not show a significantly higher loosening without stems compared to implants used with stems. Thus, the use of a semiconstrained component does not alone constitute a requirement for the use of an intramedullary stem. The authors recommend that bone quality and component fixation at the time of surgery should be used as determinants for the additional use of a stemmed implant.

## Paper #6

### **Preoperative Hip to Ankle Radiographs in TKA: A Prospective, Randomized Study**

Mark W. Pagnano, MD, Rochester, MN, James E. McGrory, MD, Robert Trousdale, MD, Michael Nigbur, P.A.-C.

**Introduction:** Establishing a normal mechanical axis following total knee arthroplasty has been shown correlated with improved prosthetic survival. Whether a preoperative long leg standing radiograph helps the surgeon reproduce a normal mechanical axis after total knee arthroplasty is unknown. The purpose of this study was to evaluate whether a preoperative long leg radiograph helps to restore normal limb alignment after total knee arthroplasty.

**Methods:** One hundred nine consecutive primary total knee arthroplasties were randomized to either receive or not receive a preoperative long leg standing radiograph. All long leg radiographs were taken in a standardized fashion. Patients with previous hip or ankle surgery, femoral or tibial fracture, deformity greater than or equal to fifteen degrees, or who were obese (body weight index greater than forty kilograms per meter<sup>2</sup>) were excluded. All arthroplasties were performed by a single surgeon. The long leg radiographs were used to determine the angle of distal femoral resection and the location of the entry hole for the femoral intramedullary guide. The angle of distal femoral resection varied between five degrees and eight degrees (mean 6.1 degrees) among patients with long leg radiographs. In patients without long leg radiographs the distal femur was cut at five degrees. Long leg radiographs were obtained postoperatively in all patients and the mechanical axis was assessed, first by whether the mechanical axis fell within the central third of the knee, and second by the distance in millimeters that the mechanical axis fell from the knee center.

**Results:** No significant difference ( $p < 0.05$ ) in the postoperative mechanical axis was detected between the two groups. Eighty-seven per cent of the knees with long leg preoperative radiographs and 89 per cent of the knees without long leg preoperative radiographs had their mechanical axis pass through the central one-third of the knee ( $p > 0.05$ ). The mean distance in millimeters of the mechanical axis from the knee center was 1.2 millimeters (varus) in the long leg radiograph group and 2.5 millimeters (varus) in those without a long leg radiograph ( $p > 0.05$ ).

**Conclusions:** Preoperative hip to ankle long leg standing radiographs did not significantly help to obtain a neutral mechanical axis during routine total knee arthroplasty. Therefore in patients who have not had prior hip or ankle surgery, femoral or tibial fracture, and who are not obese, preoperative long leg radiographs need not be obtained.

## Symposium IV: Salvage of the Infected Knee

### Infection with Resistant Organisms

Douglas J. Kilgus, MD, *Winston-Salem, NC*

Antimicrobial resistance has increased in hospitals throughout the US over the past decade. Published reports of the results of the treatment of periprosthetic infections of the hip and knee involving these resistant organisms have been limited. Seventy patients with deep periprosthetic hip or knee infections were treated at Wake Forest University Baptist Medical Center between May, 1997 and March, 2001. Thirty-five patients had deep periprosthetic infections of their total hip arthroplasties and 35 had deep periprosthetic infections of their total knee arthroplasties. The infecting bacterial organism (or organisms) were identified in 69 of the 70 patients (one patient had a deep fungal infection with *Rhodotorula rubra*.)

The infections were divided into several sub-groups. Total hip arthroplasties were analyzed separately and together with total knee arthroplasties. The patients were also grouped by their infecting organisms. More specifically, the patients were subdivided into sub-groups: those who were infected with Staphylococcal bacterial strains that were sensitive to methicillin and those patients who were infected with bacteria that were resistant to methicillin (e.g., methicillin resistant *Staphylococcus aureus* and methicillin-resistant *Staphylococcus epidermidis*). The patients were then further subdivided into three groups based on the final success of their respective treatments.

Treatment was considered successful if, at the time of last follow-up, the patient was able to retain his or her hip or knee prosthesis either as a result of irrigation and debridement procedures alone or following excision of the infected total hip or knee prosthesis followed by successful reimplantation. Treatment was considered a failure if the patient eventually required arthrodesis, amputation, or was left as a permanent excision arthroplasty. Hips that were infected with antibiotic sensitive bacteria were treated successfully in 81 percent of cases. In contrast, hips infected with resistant organisms were treated successfully in only 48 percent of cases (nine of 19). Similarly, knees infected with sensitive organisms had a success rate of 89 percent, compared to only 18 percent of the total knee replacements (three of 16) that were infected with resistant bacterial strains.

Our ability to successfully treat deep periprosthetic total hip and knee infections that were infected with resistant Staphylococcal organisms were less successful and required a greater number of surgical procedures than periprosthetic hip and knee infections that were infected with more sensitive organisms. Infection by resistant Staphylococcal organisms led to significantly worse outcomes in terms of retention of components or the ability to have a successful reimplantation of hip or knee components ( $p \leq 0.00$ ).

## **Symposium IV: Salvage of the Infected Knee**

### **Treatment of the Infected TKA: Results of Debridement or Direct Exchange**

Thomas P Schmalzried, MD, *Los Angeles, CA*

In this literature review, 30 reports provided outcome data on 530 open debridements, 23 arthroscopic debridements, and 37 one-stage exchange arthroplasties. The average follow-up was 3.95 years, but the range was broad (0.02-14 years).

Infection was controlled in only 173 of the 530 infected TKR's (32.6%) treated by open debridement and retention of the prosthetic components, in 12 of the 23 cases (52.2%) managed by arthroscopic debridement, and in 33 of the 37 cases (89.2%) treated by one-stage exchange. There was wide variability in associated antibiotic therapy. Factors associated with success included debridements performed <4 months after the index procedure, <4 weeks duration of symptoms, antibiotic sensitive gram-positive organisms, well-fixed components with no radiological evidence of osteitis, and young healthy patients.

Factors associated with the failed debridements included post-operative drainage for more than two weeks, sinus tracts present at the time of the debridement, a hinged prosthesis, and immunocompromised host. Factors associated with successful one-stage exchange included infections by gram-positive organisms, absence of sinus formation, aggressive debridement, use of antibiotic-impregnated bone cement for the new prosthesis, and 12 weeks of antibiotic therapy. One-stage exchange arthroplasty failed in 4 of 37 cases; 2 were in patients with rheumatoid arthritis on corticosteroids.

Surprisingly little data is available on this topic. Debridement can be successful in early post-operative infections. One-stage exchange can be successful with a sensitive organism in a healthy host with prolonged antibiotic therapy.

## **Symposium IV: Salvage of the Infected Knee**

### **Two-Stage with Block**

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

The treatment options for the infected total knee replacement are: antibiotic suppression, debridement with retention of components and suppression, multiple debridements with component retention, single-stage reimplantation and two-stage reimplantation.

Two-stage reimplantation for infection has substantial literature support for being the procedure of choice for this complication. However, in acute infections, the other options may be considered. The two-stage procedure with a six-week interval of antibiotic therapy with a serum bactericidal concentration of 1:8 has yielded 90 - 98% success and thus represents the definitive treatment for this difficult problem. Plastic surgical support may be indicated along with an infectious disease consultation.

After component removal and meticulous debridement of cement, necrotic tissue and synovectomy, antibiotic spacers may be utilized. Single block spacers limit motion but keep the joint tensed. However, bone erosions may develop during the six-week course of antibiotic treatment. Articulated spacer blocks have become more popular because they allow limited motion of the joint and maintenance of the joint space.

Further bone loss is generally not encountered and spacer blocks allow the patient to do more aggressive range of motion exercises. Some experience is available with spacer blocks utilizing the original, but cleaned and sterilized implants that permit better motion. Essentially similar to a single-stage reimplantation, the spacer block option has gained some support. Rarely, spacer blocks should not be utilized, such as in yeast infections where proper antibiotic treatment is unavailable for use within the acrylic.

After a six-week or longer course of antibiotic treatment is concluded, the spacer blocks are removed and the wound is examined with frozen section and immediate gram staining performed intraoperatively. Long-term suppressive antibiotic treatment after successful reimplantation of a new prosthesis is not recommended, but the implants should be inserted with antibiotic-impregnated cement.

## **Symposium IV: Salvage of the Infected Knee**

### **Comparison of a Mobile Bearing to a Fixed Bearing Unicompartmental Implant**

Roger H. Emerson Jr., MD, *Plano, TX*

Mobile bearing prostheses have diminished contact stresses in the polyethylene. Does this fact lead to better survivorship of the prosthesis? This hypothesis was investigated in a series of uni-compartmental implants.

Fifty-eight sequential mobile bearing Oxford implants were compared to 51 fixed bearing implants with a metal-backed tibial tray. The surgery was performed from 1988 to 1994 by two surgeons. The 2 groups were well matched, and the average follow-up was 6.6 yrs for the mobile bearing group and 8.5 years for the fixed bearing group. Radiographic and clinical parameters were followed, with all data maintained prospectively.

The survivorship was 90.0% for the mobile bearing group at 10 years compared to 85.4% for the fixed bearing group. Five failures were noted in the mobile bearing group. Three were due to progressive lateral compartment disease. There was only 1 femoral loosening and 1 bearing replacement for mal-tracking in the mobile group. No visible polyethylene wear or wear related problems such as osteolysis were found in the mobile group. The bearing movement was measured on flexion and extension radiographs with no consistent pattern of movement noted. The fixed bearing group had 7 failures; 4 aseptic loosening and 3 complete polyethylene wear-throughs.

Mobile bearing uni-compartmental knee implants have excellent survivorship at 10 years. The theoretical benefits of the design translate to low rates of polyethylene wear. Tibial component appears to be more prevalent in fixed bearing designs. There was only one mechanical problem from the mobile mechanism.

## **Symposium IV: Salvage of the Infected Knee**

### **Fusion: The Last Option**

Jerome D. Wiedel, MD, *Aurora, CO*

The most common indication for an arthrodesis of the knee today is a failed infected total knee prosthesis. Other causes of a failed total knee replacement that might necessitate a knee fusion include aseptic loosening, deficient extensor mechanism, poor soft tissues and Charcot joint.

Techniques available for achieving a knee fusion are external fixation and internal fixation methods. The external fixation compression devices have been the most widely used for knee fusion and have been quite successful until the indications for fusion changed to mostly failed prosthetic knee replacement. With failed total knee replacement, the problem of severe bone loss became an issue and the external fixation compression devices even including the biplane external fixators have been the least successful method reported for gaining fusion. The Ilizarov technique has been shown to achieve rigid fixation in spite of this bone loss, and review of reports are showing high fusion rates using this method.

Internal fixation methods including plate fixation and intermedullary nails have had the best success in gaining fusion in the face of this bone loss and have replaced external fixation methods as the technique of choice for knee fusion when severe bone loss is present. A review of the literature and a discussion of different fusion techniques will be presented including a discussion of the advantages, disadvantages, risks and complications.

## **Symposium V: Revision Knee**

### **Large Bone Defects and Revision TKA: Impaction Bone Grafting**

Paul A. Lotke, MD, *Philadelphia, PA*

Revision total knee arthroplasties are associated with some degree of bone loss. Most of the loss can be compensated with the use of wedges, augments, or modest cement fill. However, large defects do not allow adequate prosthetic support and we then depend on other techniques such as bulk allografts, articulated devices, or impaction bone grafting. This report focuses on the use of impacted bone graft into large bone defects, with or without the use of wire mesh to contain the defect.

Twenty-four patients with massive bone defects are included in this series. The average age of revision surgery is 69 years, and the average preop Knee Society score was 46, and preop function score was 47. After surgery these scores increased to 92 points and 52 points respectively. The average range of motion was 1-105° (0-5° and 90-120°). Results show that there have been no mechanical failures. There have been two complications: The first, a periprosthetic fracture from a fall one year after surgery, which was treated successfully with internal fixation. The second, a patient had a staph epidermidis infection four weeks after surgery, which was treated successfully with open debridement, irrigation and IV antibiotics.

We conclude that impaction bone grafting with cemented stems is a valuable adjunct in revision total knee surgery, especially when there are large irregular defects. Containment with mesh is a useful technique to obtain solid impaction. Results to date have been very satisfactory.

## Symposium V: Revision Knee

### Ligament Balancing in Revision TKR

Kenneth A. Krackow, MD, *Buffalo, NY*

Ligament balancing can be thought of in terms of balancing the gaps—flexion and extension in all cases, and balancing the collateral structures in cases of fixed varus and valgus deformities. In primary TKR these are largely, though not entirely separate considerations. In revision TKR they can be more closely related.

While providing correct alignment is viewed as an important feature for preventing premature failure, and one might consider residual and acquired deformities to be a major feature of TKR revision, it seems in experience that there are many other aspects which take precedence. In particular, bone loss and fixation stability seem to be examples.

In simple revision situations with poly wear and minor bone loss in association with loosening and deformity, the principles of ligament balancing will be essentially identical to those in primary TKR. We will be releasing the tight, concave side of the deformity in attempt to achieve a balanced soft tissue sleeve—meaning that with tension stress across the joint the medial and lateral remaining soft tissues are taut while also the tibial femoral alignment is proper—a zero mechanical axis alignment.

In many other revision situations there may be some element of concave side release, however, it seems that one needs not focus so much on this. Perhaps we are naturally led to the release during the generally more difficult and extensive exposure with its requirement for adequate mobilization to remove components.

Beyond these situations, we frequently have the important question of increasing the level of prosthetic constraint. Also, this question is one that relates to when to use a CIP\* (constrained intercondylar prosthesis), rather than a PS prosthesis. In rare cases we may be asking whether a CIP will be sufficient or if it is necessary to use a hinge or even bail out to a fusion.

This author's own published cadaver studies on the GAP effects of ligament and other soft tissue release essentially define the limits of the CIP prostheses and therefore the indications for using hinges or moving to non-arthroplasty options. The basic issue here is "control" of the flexion space. When one does not have adequate collateral function, and especially with loss of posterior capsular function, to keep the tibia from falling far away during flexion, the CIP\* prosthesis is likely to fail. Failure will be due to instability, even frank dislocation in flexion. Also the caution is raised to be alert to the possibility that this behavior is not initially apparent. During trial or final reduction and with the extensor mechanism relocated, the tightness of that mechanism may function to hold the tibia *up* against the posterior femur and tighten the flexion space. However, if that patient achieves good flexion ROM, this motion occurs with stretching of the quad mechanism, and such stretching may thwart control of the flexion space. Flexion instability and even prosthesis dislocation can result.

\*CIP: constrained intercondylar prosthesis—e.g. CCK, TC-III, TS, etc.

## **Symposium V: Revision Knee**

### **Fixation—Its Use in Revision TKR**

Cecil H. Rorabeck, MD, FRCSC, *London, ON, Canada*

The choices of fixation in revision TKR are to use cement alone, cementless fixation or "hybrid." Factors which affect choice are bone quality, bone defects, stem length, etc. Fixation of most revision TKR's is accomplished in a "hybrid" manner, namely cementing the implant in the metaphyseal area and using a canal filling stem distally or proximally. Occasionally, stems are cemented but only in the very elderly and in patients with very poor bone stock and limited stem length.

Data from this centre using "hybrid" fixation for revision TKR includes 95 patients with a minimum five-year follow up where the revision was performed for aseptic failure. All infected cases were excluded. A detailed analysis of the method of fixation of the femoral and tibial stems (cemented or cementless), the degree of canal fit and fill and the method of stabilization (posterior stabilized or varus/valgus constraint) were carefully analyzed. The effect of increasing constraint on bone remodeling and component loosening were the main variables analyzed. The results of these 95 patients at a minimum five-year follow up demonstrates that five patients were revised.

While it was not statistically significant, there was a tendency for the incidence of stem loosening to increase with increasing constraint (VVC). The data has demonstrated that the technique of "hybrid" fixation of implants and stems in revision TKR is both effective and durable.

## **Symposium V: Revision Knee**

### **Joint Line Position During Revision TKR**

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

Maintenance of the proper joint line level during a total knee replacement is crucial. Abnormal elevation of the prosthetic joint line can lead to a decreased potential for flexion, *patella baja*, and impingement of the patellar component on the tibial component. Abnormal depression of the prosthetic joint line can lead to mid flexion instability.

During a primary knee replacement, maintenance of the joint line can be easily obtained by removing a section of distal femur equal in thickness to that of the distal thickness of the femoral component being used. In the revision situation, however, many landmarks are often gone or obscured. In revision surgeries the following techniques and landmarks may be used either individually or in combination

- 1). The distance from the adductor tubercle to the joint line on the contralateral knee can be measured on pre-op X Rays, corrected to magnification, and reproduced on the affected knee
- 2). The distance from under the insertion of the MCL onto the medial epicondyle is normally 28mm +/- 3mm
- 3). The normal joint line is usually approximately 15mm proximal to the tip of the fibula
- 4). The normal joint line is usually approximately 10mm distal to the inferior pole of the patella

Restoration of the joint space level in a revision knee most often requires the use of distal and posterior femoral augments and/or bone grafts. The worst-case scenario is the one with a large flexion space that the surgeon erroneously attempts to fill by just increasing the thickness of the tibial polyethylene. This leads to a large joint line elevation with its attendant problems.

## **Symposium V: Revision Knee**

### **Instability**

Robert T. Trousdale, MD, *Rochester, MN*

Ligament imbalance or incompetence may result in clinical symptoms of functional instability after a total knee arthroplasty (TKA). TKA is a balance between conformity and constraint, conformity related to the shape of the corresponding articular surfaces and constraint implying a restriction of rotation-translation.

In general one should use the least amount of constraint required to obtain a stable knee in order to minimize the stresses placed on the implant host interface. Nonlinked, posterior stabilized and constrained implants which provide increased varus/valgus as well as anterior/posterior stability, as well as linked hinges which provide the ultimate in implant stability all have a role in the treatment of the failed TKA.

Indications, theoretical and practical advantages and disadvantages, and outcome of the various constrained implants will be discussed in this presentation.

## **CME Accreditation Statement**

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

The American Academy of Orthopaedic Surgeons designates this educational activity for maximum of 8.0 hours in category 1 credit toward the AMA Physician's Recognition Award. Each physician should claim only those hours of credit that he/she actually spent in the activity.

## **Goals and Objectives**

The Knee Society/AAHKS Specialty Day Meeting is designed to provide practicing orthopaedic surgeons with state-of-the-art information about the surgical applications and treatment protocols for the diagnosis and management of total knee replacement, and to enhance the care of patients with arthritis and degenerative diseases of the knee joint. The program is designed to meet the seven essentials of the Accreditation Council for Continuing Medical Education, and as a result, program participants will receive the highest quality education and become eligible for up to eight hours of Category 1 CME credit.

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.

## **Disclaimer**

The material presented at this continuing medical education activity has been made available by the Knee Society/AAHKS for educational purposes only. This material is not intended to represent the only, nor necessarily best, methods or procedures appropriate for the medical situations discussed, but rather is intended to present an approach, view, statement of opinion of the faculty, which may be helpful to others who face similar situations.

The Knee Society/AAHKS disclaims any and all liability for injury or other damages resulting to any individuals attending a session, and for all claims which may arise out of the use of the techniques demonstrated therein by such individuals, whether these claims shall be asserted by a physician or any other party.

## **FDA Statement**

Some drugs or medical devices demonstrated at the Specialty Day Meeting have not been cleared by the U.S. Food and Drug Administration (FDA) or have been cleared by the FDA for specific purposes only. The FDA has stated that it is the responsibility of the physician to determine the FDA status of each drug or medical device he or she wishes to use in clinical practice.

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To obtain information regarding the clearance status of a device or pharmaceutical refer to the product labeling or call the FDA 1-800-638-2041 or visit the FDA internet site at <http://www.fda.gov/cdrh/510khome.html>

## **Financial Disclosure**

Each participant in the Specialty Day Meeting has been asked to disclose if he or she has received something of value (any item, payment, or service valued in excess of \$500) from a commercial company or institution which relates directly or indirectly to the subject of their presentation.

The options are as follows:

- a. Research or institutional support has been received
- b. Miscellaneous non-income support (e.g., equipment or services), commercially derived honoraria, or other non-research related funding (e.g., paid travel)
- c. Royalties
- d. Stock or stock options; or
- e. Consultant or employee

If a participant has received something of value from a commercial company or institution, as asterisk (\*) will appear next to their name in the Program outline. The Knee Society/AAHKS does not view the existence of these interests or commitments as necessarily implying bias or decreasing the value of the author's participation in the Specialty Day Meeting.

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