Session 20: The New Arthritic Patient and Arthroplasty Treatment Options

Learning Objectives
Upon completion of this activity, participants should be able to:

1. Describe the indications of unicompartmental femorotibial knee replacement.

2. Provide the key technical points during surgery for patellofemoral replacement.

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Medial Unicondylar Replacement

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Introduction: There is a renewed interest in unicompartmental knee arthroplasty (UKA); however, the presence of preoperative patellofemoral arthritis as a contraindication to unicompartmental arthroplasty is controversial. This study reports the 11- to 15-year results of UKA with an emphasis on failure mechanisms and progression of patellofemoral arthrosis.

Methods: In a prospective study of 513 consecutive potential knee replacement candidates, 59 patients (12%) underwent medial unicompartmental arthroplasty of the knee. All 59 patients had isolated unicompartmental disease without either clinical symptoms or radiographic evidence of patellofemoral arthritis; intraoperatively no patient had more than Outerbridge class 2 chondromalacia. No patient was lost to follow-up. The average follow-up was 13 years (range, 11-15 years).

Results: The preoperative Hospital for Special Surgery knee score of 55 points (range, 30-79 points) improved to a mean of 90 points (range, 60-100 points) at final follow-up. Patellofemoral symptoms were present in only 1.6% of patients at 10 years; this increased markedly to 10% of patients at 15 years. Radiographically, progressive patellofemoral joint space loss, present in 6% of patients at 10 years, increased to 26% at 15 years. Four patients (10%) had moderate or severe patellofemoral symptoms at final follow-up; 2 were revised to a primary total knee replacement at 7 and 11 years for progressive patellofemoral degeneration. No component was radiographically loose and no osteolysis
was seen. The Kaplan-Meier survival with loosening or revision for any reason was 98.0% ± 2.0% at 10 years and 95.7% ± 4.3% at 15 years.

**Conclusion:** At up to 15 years, UKA yielded good clinical results; however, progressive patellofemoral arthritis was the primary mode of failure. Progression of patellofemoral arthrosis occurred despite the lack of patellofemoral symptoms or radiographic evidence of patellofemoral arthritis preoperatively. Patients with preoperative clinical or radiographic evidence of patellofemoral arthritis should not be considered as acceptable candidates for unicompartmental replacement as progressive patellofemoral arthritis is the main mode of failure with increasing time of follow-up.

**Lateral Unicondylar Replacement**

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**Introduction:** Limited long-term follow-up data are available for unicompartmental knee arthroplasty (UKA) performed for lateral femorotibial osteoarthritis. Indeed, both the anatomical and the biomechanical characteristics are different in each of the knee femorotibial compartments, and similar surgical treatment may not give reproducible results when applied to a different compartment. The aim of this study was to report the average 10-year follow-up of a consecutive series of lateral UKA performed in the same institution.

**Methods:** Between 1984 and 2004, 40 isolated lateral UKAs were performed and followed in the institution while 703 isolated medial UKAs were performed and followed during the same period. The average age of the patients at surgery was 62 years (range, 34 to 76 years) and 22 of them were women. The average body mass index was 27 (range, 21 to 43). All patients were evaluated preoperatively and postoperatively using the Knee Society Score (KSS). The radiological indication was based on full loss of cartilage limited to the lateral femorotibial compartment evaluated on stress x-rays and full weight-bearing views of the limbs evaluating the mechanical axis. Patellofemoral arthritis with full loss of cartilage assessed of the patellofemoral views was considered as a contraindication of the procedure as well as ligamentous laxity. All components were cemented.

**Results:** The average follow-up was 10.8 years (range, 4 to 20 years). All patients had marked preoperative pain and the average preoperative mechanical axis (hip-knee-ankle) was 6° of valgus. The average KSS improved from 55 to 95 and from 58 to 92 for function. The average postoperative mechanical axis was 3° of valgus (range, 1° to 6°). Four knees were revised, 1 for tibial migration and 3 for progression of osteoarthritis (1 in the patellofemoral compartment treated with patellofemoral arthroplasty, 2 in the medial femorotibial compartment treated by medial UKA in one case and TKA in the other case). Implant survival at 20 years was 80% (0.62-0.99).
Discussion/Conclusion: Lateral UKA represents in our experience 5% of all UKA implantations. However, the long-term results of lateral UKA presented in this study compare at least equally with those reported for medial UKA. The surgical technique and the outcome described for medial UKA cannot be directly applied to the lateral compartment, since the kinematics of the knee are different in both compartments because of a different femoral and tibial anatomy. This difference in kinematics has also been found for subjects implanted with medial and lateral UKA showing an average of 0.8 mm of posterior femoral rollback during flexion for medial UKA and an average of 2.5 mm for lateral UKA.

The rule of undercorrection of the deformity should be strictly applied to lateral UKA, and the positioning of the femoral component should accommodate the femoral divergence of the lateral condyle when the knee is flexed to avoid impingement with the tibial spines when brought into extension. Additionally, internal rotation of the tibial component when performing lateral UKA accommodates well the typical “screw-home” mechanism occurring during knee flexion. Most of the cases in the present series of lateral UKA were performed through a medial arthrotomy as in the experience of Sah and Scott; however, since the introduction of minimally invasive surgery with dedicated cutting guides, the surgical approach is now realized through a lateral arthrotomy without subluxation of the patella, and the results reported in this study for the most recent cases look fairly reproducible. The specific anatomical and biomechanical characteristics of the lateral compartment need to be accommodated at the time of surgery when performing lateral UKA. Despite the limited number of indications because of the preponderance of medial osteoarthritis, lateral UKA may represent an equally valid alternative to total knee arthroplasty when a single femorotibial compartment of the knee is affected.

References
Mobile Bearing Unicondylar Replacement

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Over the past decade, the advantages of unicompartmental (UKA) over total knee arthroplasty (TKA) have become increasingly evident. Studies show that UKA provides better range of motion (ROM), a higher level of activity, and increased patient satisfaction compared with TKA. Despite being reported more than 15 years ago, many surgeons continue to follow the standard indications outlined by Kozinn and Scott.1

Classic Indications for UKA Advocated by Kozinn and Scott (1989)1:
- Exclude patients who weigh > 82 kg (180 lbs)
- Exclude age < 60 years
- Exclude patients who have more than minimal erosive changes in the patellofemoral articulation
- Exclude patients with anterior knee pain, thought to be a sign of significant patellofemoral involvement
- < 15° cumulative angular deformity
- NOT physically active or performing heavy labor
- ROM > 90°; flexion contracture < 5°
- Minimal rest pain
- Non-inflammatory
- Intact anterior cruciate ligament (ACL)
- Applying these conservative indications, the percentage of patients with osteoarthritic knees who may be candidates for UKA is reported to be between 2% and 15%.

More Liberal Indications Advocated by Nuffield Orthopaedic Care Centre (2007)2:
- Full thickness medial cartilage loss
- Anterior disease with preserved posterior bone
- Fully correctable, full thickness lateral cartilage
- Intact ACL
- Applying these more liberal indications, the percentage of patients with osteoarthritic knees who may be candidates for UKA is approximately 35%.

Clinical Experience: A mobile-bearing unicondylar device was approved in 2004. Availability and interest in UKA has led to a surge in use. Any new device requires review of early results to identify problems or highlight changes in indications and outcomes. This prospective study reviews our initial experience with a mobile-bearing UKA (MB-UKA). From July 2004 to October 2006, 294 patients (348 knees) underwent MB-UKA, making the study group available for minimum 2-year follow-up. All cases were performed via minimally invasive technique. Indications for medial MB-UKA were those advocated by the Nuffield Centre. No other indications or contraindications were
used, allowing investigation of demographics and location of preoperative pain as variables. Statistical analysis included Student’s \( t \)-test and log-rank analysis of survivorship variables.

One-hundred twenty-three patients (41.8%) were males and 171 (58.2%) were women. Age averaged 61.8 years (range, 33 to 33 years; SD 10.4) with 13.8% of patients younger than 50 years old and 45.4% younger than 60 years old. Body mass index (BMI) averaged 32.4 kg/m\(^2\) (range, 19.7-57.7 kg/m\(^2\); SD 6.0) with 47.4% of knees in patients having a BMI higher than 32 kg/m\(^2\), 27.6% with BMI higher than 35 kg/m\(^2\), and 10.9% higher than 40 kg/m\(^2\). Preoperatively, pain was isolated to the medial aspect in 65.5% of knees. Anterior knee pain was present in 28.7% of knees. Average hospital stay was 1.3 days (range, 0 to 4 days; standard deviation [SD] 0.6) and 97% of patients were discharged directly to home.

Average follow-up was 24 months (range, 1 to 51 months; SD 11.5). Six patients (7 knees) expired during the study period, all unrelated to the index procedure. Eighteen knees were revised for a survivorship of 94.8% at 50 months. Reason for revision was tibial aseptic loosening in 9 knees; 1 of which had positive cultures, tibial fracture/collapse in 4; femoral aseptic loosening in 1; pain, well-fixed in 3; and sepsis in 1. BMI and age were not predictive of failure. Anterior knee pain or isolated medial pain was not predictive of survival. At most recent evaluation, ROM averaged 119° (range, 85° to 140°; SD 8.0°), Knee Society (KS) pain score averaged 44.3 of 50 possible (range, 0 to 50; SD 11.1), KS clinical score averaged 91.3 of 100 possible (range, 37 to 100; SD 12.2), KS function score averaged 81.0 of 100 possible (range, –10 to 100; SD 21.1), and patient self-reported Lower Extremity Activity Scale\(^3\) averaged 10.9 of 18 possible (range, 4 to 18; SD 2.9), with 11 corresponding to “I am up and about at will in my house and outside. I also work outside the home in a moderately active job.” While the variables studied were not significant for failure, statistically higher KS scores were noted in patients with BMI > 32 (clinical, \( P = .03 \); function, \( P = .05 \)), age older than 50 years (pain, \( P = .03 \); clinical, \( P = .007 \)), isolated medial sided pain (pain, \( P = .03 \)), and absence of anterior knee pain (pain, \( P = .05 \)).

The need for revision appears unaffected by demographics and pain location. Knee scores are lower in patients with BMI > 32, younger than 50, and those with preoperative anterior knee pain or pain located other than on the medial side of the knee. Despite lower KS scores, MB-UKA may remain the best option in obese, younger, more active, or more demanding patients. In the knee with normal functioning anterior cruciate and medial collateral ligaments, knee kinematics can be restored with UKA. This outcome cannot be achieved by any available TKA device. Broader indications do not appear to affect the early survivorship of this device. The early failure rate is low, and the recovery is rapid with this conservative partial knee replacement procedure.

Our early results with potential for 2-year follow-up showed acceptable survivorship and outstanding function with the use of the Oxford partial knee device for the treatment of anteromedial osteoarthritis of the knee. Since evaluating these results, we have implemented a change in the surgical technique, specifically attempting to reduce posterior tibial slope. Excessive posterior tibial slope has been associated with early
failure of UKAs as described in the study by Aleto et al.\textsuperscript{4} Secondly, careful preparation of the tibial keel slot—using now a toothbrush-type saw blade to reduce the incidence of fracture or damage to the posterior cortex or deep cancellous bone of the tibia—has been implemented. Additionally, alphanumeric tibial baseplates became available around the time of conclusion of this first series of patients (Fall 2006). These tibial baseplates allow for a higher contact area and better fit of the implant on the cut surface of the proximal tibia. This would potentially reduce stress overload of the tibial cancellous bone, necrosis, and collapse. Last, the anatomic meniscal bearings, as shown, became available near the end of the timeframe of this study. With these changes in mind, we now have completed 983 medial UKA with this mobile-bearing device in 817 patients using the indications of the Nuffield Centre, and have enjoyed survivorship of 98.0%. The average time to failure in this initial experience was 14.3 months. Included in our overall series to date of 983 mobile-bearing UKAs are 600 knees that would have minimum 14-month follow-up. Therefore, we feel very confident that the changes to the technique and small refinements to the implant design have decreased the early failure and increased the excellent outcomes that we have seen.

References
Isolated patellofemoral arthritis can occur in as many as 9% of patients over the age of 40, and is particularly common in women, who often have subtle patellofemoral maltracking or malalignment. In fact, 24% of women with symptomatic knee arthritis have localized patellofemoral arthritis. Arthroplasty options can provide predictable pain relief, whereas other surgical measures for refractory patellofemoral arthritis—arthroscopic debridement, cartilage grafting, patellectomy, tibial tubercle unloading procedures—often have unsatisfactory results. While total knee arthroplasty (TKA) yields excellent results in over 90% of patients with isolated patellofemoral arthritis, it is not desirable in patients who are young and very active. Therefore, patellofemoral arthroplasty has a legitimate role in the treatment of isolated anterior compartment arthritis.

Early patellofemoral implants were plagued by a high incidence of patellar maltracking, catching, and subluxation because of design features of the trochlear components, inadequate soft tissue balancing, and component malposition. Improved contemporary designs, as well as refinement in surgical indications and improved surgical techniques and instrumentation, have and will continue to reduce the incidence of patellar maltracking and enhance the outcomes, leaving late tibiofemoral degeneration as the primary cause of “failure” of patellofemoral arthroplasties. Several long-term studies have shown a rate of tibiofemoral degeneration of approximately 20% at 15 years. Combining patellofemoral arthroplasty with biological resurfacing of full-thickness defects of the femoral condyles may expand the indications for the procedure and protect the tibiofemoral cartilage from degeneration.

Revisions of malaligned or older generation trochlear components can be successful if the revision is performed to address patellar maltracking, as long as there is no tibiofemoral arthritis or pain, the soft tissues are appropriately balanced, the trochlear component selected for the revision is more accommodating of patellar tracking, and the trochlear bone stock can support a trochlear component. Otherwise, revision to a TKA would be more appropriate. The results of TKA do not seem to be compromised by the presence of a prior patellofemoral arthroplasty.

References

Bicompartmental Replacement

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Introduction: Tricompartmental knee replacement has enjoyed great success throughout the world; however, knee replacement patients remain limited in their ability to resume desired activities.1,2 Improved postoperative function and more rapid recovery of function has been observed in both unicondylar knee replacement and in patellofemoral knee replacement.3-6 There remains a risk of reduced durability of partial knee replacement7; however, recent series have demonstrated improved survival of these devices,8-10 promoting interest in bicompartamental reconstruction as a means of obtaining higher levels of function without dramatically increasing failure rates.

Materials and Methods: We reviewed the literature concerning both survivorship and function of partial knee replacement. The theoretic advantages and disadvantages of bicompartamental arthroplasty will be discussed along with a review of some design
features of devices available today. The early outcomes of 17 patients undergoing bicompartamental replacement will be presented.

Clinical Results: Results of these cases have been good to excellent, with pain relief at least as good as that seen in total knee replacement patients. There have been no cases of incompatibility of the patellofemoral and femorotibial components in either medial compartment or lateral compartment arthrosis cases.

Conclusion: Early results with bicompartamental knee replacement using a nonlinked device remain encouraging. However, the number of patients available for review at this time is quite low and the time in situ in these cases is far too low to allow any prediction of expected durability.

References
Robotic Unicompartmental Replacement

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The results of unicompartmental arthroplasty are affected by a variety of factors, including the underlying diagnosis, patient selection, prosthesis design, polyethylene quality, and implant alignment and fixation. If we assume that patients are appropriately selected and an implant of sound design with good polyethylene is utilized, then the accuracy of implantation is likely the most important variable affecting whether an implant will perform well and survive as long as expected.

An excessive posterior tibial slope or tibial component or mechanical axis varus malalignment predisposes the prosthesis to early failure. Studies have shown that using conventional approaches and instrumentation, it is difficult to consistently accurately align the tibial component in unicompartmental knee arthroplasty (UKA). Outliers beyond 2° of the preoperatively planned alignment may occur in as many as 40% to 60% of cases using conventional methods. The problem is compounded when using minimally invasive surgical approaches, which is how most contemporary UKAs are likely performed. One study analyzing the results of 221 consecutive UKAs performed through a minimally invasive (MIS) approach found a large range of tibial component alignment, with a mean of 6° (SD ± 4) and a range from 18° varus to 6° valgus.

Computer navigation was introduced in an effort to reduce the number of outliers and improve the accuracy of UKA. However, even with computer navigation, the number of outliers (beyond 2° of the preoperatively planned implant position) may approach 15%. Robotic guidance was therefore introduced to capitalize on the improvements seen with computer navigation but also to further refine and enhance the accuracy of bone preparation, even with minimally invasive techniques.

The currently available system in the United States is a surgeon-interactive tactile guidance robotic arm that uses preoperative computed tomography images of the patient’s lower extremity to allow accurate preoperative planning, intraoperative navigation, and robotic assistance to prepare bone for implantation of UKA components. The system provides a stereotactic interface that constrains the surgeon in the preparation of the femur and the tibia.

A comparison of matched groups undergoing unicompartmental arthroplasties using minimally invasive approaches with either standard manual instrumentation or the robotic arm–guided implantation system found that the root mean square error of the tibial slope was 2.5 times greater and the variance was 2.8 times greater with the manual technique than with the robotic arm–guided technique. In the coronal plane, the average error was 3.3° using manual instruments compared to 0.1° when using robotic arm assistance. Additionally, consistently less bone is removed from the proximal tibia and thinner polyethylene inserts are used when surgery is performed with the robotic arm compared.
to conventional instrumentation. This may have important implications if revision to TKA is necessary in the future. These data show that tibial component alignment is significantly more accurate and less variable using robotic guidance compared to manual, jig-based instrumentation through MIS approaches. While these data support the use of this particular tactile guidance system for unicompartmental arthroplasty, similar benefits have not been observed in Europe or Asia with other robotic systems for TKA. Whether the tactile guidance system with which I have experience will be adaptable to bicompartmental and TKA will require further study.

References

Case Presentations and Discussion Panel
Richard A. Berger, MD; Adolph V. Lombardi, Jr, MD, FACS; Jess H. Lonner, MD; Ormonde M. Mahoney, MD