Session 27: Revision TKA: Surgical Techniques

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

1. Understand the sequence of steps involved in exposure and component removal during revision TKA; assess bone loss and learn important anatomic landmarks for positioning of revision TKA components in order to reestablish the joint line, implant rotation, sizing, and resulting flexion-extension gaps.

2. Understand important considerations for the management of bone loss, pros and cons for use of cemented vs uncemented revision TKA components, as well as the importance of various exposure and ligamentous balancing options to improve motion and stability of the knee.

Moderator
David G. Lewallen, MD
Professor of Orthopaedic Surgery
Mayo Clinic College of Medicine
Chair, Division of Joint Reconstruction
Department of Orthopaedic Surgery
Mayo Clinic
Rochester, Minnesota

Revision TKA Techniques: A Surgical Algorithm

Thomas K. Fehring, MD
Orthopaedic Surgeon
OrthoCarolina Hip and Knee Center
Charlotte, North Carolina

The goal of this talk will be to discuss preoperative planning, surgical exposure, and implant removal for a revision total knee arthroplasty.

Preoperative planning is essential for success in revision knee arthroplasty. The surgeon must understand what the problem is, however, before he or she can entertain solving the problem. Exploratory surgery in revision total knee arthroplasty is contraindicated. Once it is established that infection or referred pain is not the cause of the problem, the key surgical variables in preoperative planning are the current alignment, bony deficiency, and ligamentous integrity. A hip-knee-ankle view can help establish alignment and define any abnormal bony architecture that would compromise long stem fixation. Bony deficiency can usually be predicted preoperatively. The surgeon must envision what bone will be left following extraction. If osteolysis is present radiographically, the lesion is
always larger than it appears on the radiographs. Morcellized allograft, structural allograft, or metallic augmentation must be available if bone loss is anticipated. Ligamentous stability can usually be diagnosed by careful physical examination preoperatively. Stress views on occasion can be helpful in defining collateral ligamentous insufficiency or cruciate ligamentous insufficiency. An adequate array of insert options must be available for revision surgery ranging from posterior stabilized inserts to hinged arthroplasty depending on the specific situation.

Adequate surgical exposure is an essential part of revision knee surgery. The ability to remove implants without risk to bone stock or integrity of the patellar tendon is of paramount importance. However, prior to bony exposure, choosing an appropriate skin incision is essential in the safe management of a revision knee. The surgeon must understand that the vascular anatomy of the anterior knee causes the blood supply to come in from the medial to lateral side. Therefore, if there is a lateral incision present, this should be used routinely in a parallel situation. Using the most medial incision risks jeopardizing the skin between the two incisions. Additionally, the concept of measuring 6 to 8 cm between incisions to ensure safety is dangerous and should be avoided. Alternatively, very large flaps can be raised laterally as long as you stay in the subfascial plane.

A variety of exposure options exist, including tibial tubercle osteotomy, quad snip, VY quadricepsplasty, and finally the patellar inversion method. The patellar inversion method should be the most commonly used exposure method. It is applicable in over 90% of the cases. Extensile measures are the exception rather than the rule in revision knee surgery.

Implant removal should be done in a stepwise fashion trying to preserve as much bony architecture as possible following extraction. The polyethylene insert is removed first, followed by the femur, then the tibia, and finally the patella if necessary. Exposure techniques and implant removal techniques will be demonstrated in this presentation along with special extraction circumstances that require a variety of special techniques to avoid compromising bone stock.

Management of Bone Defects

David G. Lewallen, MD
Professor of Orthopaedic Surgery
Mayo Clinic College of Medicine

Chair, Division of Joint Reconstruction
Department of Orthopaedic Surgery
Mayo Clinic
Rochester, Minnesota

Session 27
Stem Fixation: Press Fit or Cement

Raymond Kim, MD
Orthopaedic Surgeon
Colorado Joint Replacement
Denver, Colorado

Diaphyseal-engaging stems are extremely common in the revision total knee arthroplasty (TKA) setting and are indicated with weakened condylar bone, structural allografting, periprosthetic fractures, and malunions or nonunions. There are advantages and disadvantages to both press-fit and cemented stems.

Advantages to cemented stems include the ability to deliver local antibiotics with antibiotic-impregnated cement, the ability to achieve satisfactory fixation with a large intramedullary canal diameter or severe osteopenia, and greater freedom to make intraoperative adjustments to accommodate for anatomic deformities or an increased flexion gap. Disadvantages include greater difficulty with component removal during resection, with potentially greater bone loss and risk of periprosthetic fracture, and the inability to depend on the stems to guide component alignment.

The benefits of press-fit stems include the relative ease of use, ease of component removal with less bone loss during resection, ability to utilize the diaphyseal alignment to dictate component alignment, and compatibility with most intramedullary based revision instrumentation system. Disadvantages include cortical hypertrophy with “end-of-stem” pain, possibly inferior fixation, distortion of correct condylar implant positioning with anatomic distortion of the metaphysis or diaphysis, and risk of cortical perforation or fracture during implantation.

Clinical results regarding press-fit stem fixation have been evaluated. Haas et al studied 74 revision TKAs using cementless stems with an average follow-up of 3.5 years and observed 84% good or excellent results with an 83% survivorship at 8 years. Another study by Gofton et al reviewed 91 revision TKAs with a 93.5% survivorship at 8.6 years.

Studies have also been performed to evaluate cemented stems. Murray et al reviewed 40 revision TKAs with cemented stems at an average follow-up of 58 months and observed no reoperations for mechanical loosening. Whaley et al reviewed 38 revision TKAs and found the 11-year component survivorship free of revision for aseptic loosening to be 95.7%.

A comparative retrospective study was performed by Fehring et al of 113 revision TKAs with 202 stems and observed loosening or possible loosening of 7% of cemented stems and 29% of press-fit stems.
References:

Evaluation and Treatment of the Stiff Knee

Douglas A. Dennis, MD
Adjunct Professor
Department of Biomedical Engineering
University of Tennessee

Assistant Clinical Professor
University of Colorado Health Sciences Center

Clinical Director
Rocky Mountain Musculoskeletal Research Laboratory
Denver, Colorado

*Background and Premise:* The magnitude of motion constituting knee stiffness is variable and dependent on individual patient functional demands. The reported prevalence of stiffness after total knee arthroplasty (TKA) varies from 1.3% to 6.3%.\(^1,2\) The etiology can be categorized into patient factors, technical errors, and postoperative complications.

*Patient Factors:* Patient factors affecting knee flexion following TKA include preoperative range of motion,\(^1,3-5\) body habitus, excessive intra-articular scar formation, and patient compliance with postoperative rehabilitation. Numerous studies have demonstrated that postoperative flexion is statistically correlated with the degree of preoperative knee flexion.\(^1,4,5\) Obese patients with short stature often gain less flexion because of earlier impingement of posterior soft tissues. Some patients may form increased amounts of cutaneous and intra-articular scar tissue during healing. Providing adequate analgesic medications, particularly in the early phases of rehabilitation, is critical to maximize postoperative knee motion.
Technical Errors and Complications: Common causes of postoperative flexion contracture include failure to remove posterior femoral osteophytes or release a contracted posterior capsule and extension gap tightness. Technical errors resulting in reduced flexion include prosthetic “overstuffing” of the patellofemoral joint, flexion gap tightness, improper ligamentous balancing, joint line elevation, and excessive tightening of the extensor mechanism at arthrotomy closure. Creation of a tight flexion gap can result from positioning the femoral component too posteriorly, excessive component malrotation, or selection of an oversized femoral component. Insertion of a tibial component with excessive thickness results in flexion contracture and limited flexion. Lastly, tibial resection with an anterior slope tightens the flexion gap and often limits flexion. Postoperative complications associated with stiffness include infection, component loosening or failure, periprosthetic fracture, reflex sympathetic dystrophy, and heterotopic ossification.

Stiff TKA Treatment: Early management includes aggressive physiotherapy with adequate analgesia, dynamic splinting, and closed knee manipulation under general anesthesia in some cases. Treatment of a chronically stiff TKA is difficult because of the presence of significant capsular contracture. Surgical intervention often is required to obtain substantial gains in knee motion. Operative options include arthroscopic or open arthrolysis, component revision, and soft-tissue expansion. Results of revision TKA for knee stiffness have been widely variable with some demonstrating minimal improvement and others demonstrating reduced pain and modest gains (20°-50°) in flexion in a high percentage of patients. The best management of TKA stiffness is prevention by providing thorough preoperative patient education, aggressive postoperative physiotherapy, and avoidance of technical errors.

References:

Evaluation and Treatment of the Unstable Knee

R. Michael Meneghini, MD
Director, Center for Joint Preservation & Replacement
New England Musculoskeletal Institute
Assistant Professor of Orthopaedic Surgery
University of Connecticut Health Center
Farmington, Connecticut

Abstract: Instability is an increasingly recognized source of pain and patient dissatisfaction following total knee arthroplasty and is the etiology of up to 22% of knee revisions. Instability has been reported in both cruciate-retaining and posterior-substituting designs. Successful treatment can alleviate the patient’s symptoms and improve function; however, an accurate diagnosis and determination of etiology is critical to enacting a successful outcome with revision knee arthroplasty.

Instability can occur in both the patellofemoral and tibiofemoral compartment. Patellofemoral instability may occur secondary to inadequate balancing of the extensor mechanism or component malposition. There are 4 main types of tibiofemoral instability: symmetric extension instability, asymmetric extension instability (varus/valgus), flexion...
instability, and genu recurvatum. Tibiofemoral instability is typically due to neurologic disease, ligament incompetence, component malposition, or incorrect balancing of the tibiofemoral joint.

A thorough history, physical examination, a detailed review of prior surgical procedures and radiographic analysis are required to properly make the diagnosis. Patients most commonly complain of pain and instability, particularly during stair ascent and descent, as well as recurrent effusions. Careful physical exam will reveal the position and characterization of instability and radiographs will assist in confirming the pathologic etiology.

Surgical treatment of clinically significant instability is warranted and the success depends on the accurate identification of the offending etiology. Collateral ligament incompetence can be successfully treated with ligament reconstruction or revision to a more constrained implant. Flexion instability requires revision knee arthroplasty and may even require a semiconstrained or constrained implant, depending on the severity. Instability due to component malposition can be successfully treated with revision knee arthroplasty and may be successful without the use of increased tibiofemoral constraint.

This presentation will detail the etiology, evaluation, diagnosis, and surgical management of instability after total knee arthroplasty, as well as the expected outcomes after revision knee arthroplasty.

References:
Tips to Keep Revision TKA Simple

Giles R. Scuderi, MD
Director
Insall Scott Kelly Institute for Orthopaedics and Sports Medicine
New York, New York

Revision total knee arthroplasty is a complex situation, which requires skill and meticulous technique to restore a functional outcome. A successful revision needs to account for ligamentous balance, bone loss, alignment, and fixation. Before considering a revision total knee arthroplasty the etiology of failure should be defined.

Conceptually, the objective of revision arthroplasty is the same as primary surgery—to restore the original anatomy of the knee, regain function, and provide stability.

Following component removal, the goal of revision TKA is to create equal flexion and extension spaces. This usually is achieved by assessment of the residual femoral and tibial bone, which will be the foundation for the subsequent reconstruction. In most cases the soft tissue envelope and collateral ligaments are intact and by re-establishing tension these supporting structures, stability is achieved. In managing the bone defects, adjustments on the femoral side can affect the knee in flexion or extension, whereas any adjustments on the tibial side will affect both. The surgical technique involves recreating the femur, including size and rotation; rebuilding the flexion space on a flat tibial surface; and reestablishing the extension space.

Since the tibia is the foundation of the revision, a flat tibial surface perpendicular to the mechanical axis must be created. Minimal bone should be resected to achieve this goal. If there is bone loss, a modular augmentation wedge or block, or even a structural allograft may be needed. Care should be taken to position the provisional tibial component in the proper rotation.

Once the appropriate-sized femoral component is set in the correct rotation, the objective is to restore the distal joint line. The femoral epicondyles again provide a valuable landmark, because the distance from the epicondyles to the distal and posterior condyles is reproducible. On average, the joint line is 25 mm from the lateral epicondyle and 30 mm from the medial epicondyle. Treatment of the femoral bone loss depends on the severity of the deficiency and includes cement, metal augmentation, and structural allografts. Final adjustments to the position and size of the femoral component may be needed as the flexion and extension spaces are balanced.

As mentioned above, the goal of total knee arthroplasty is to create equal flexion and extension spaces. During the trial reduction with the provisional components, several situations may arise. When both spaces are equal, then no additional adjustments are necessary. Symmetrical tightness in both spaces requires reducing the thickness of the tibial component, whereas symmetrical looseness necessitates a thicker tibial component.

Session 27
When the knee is tight in flexion and loose in extension, there are a few options. If the femoral component is the correct size, distal femoral augmentation is added until the extension space is equal to the flexion space. Caution should be taken not to move the joint line too far distally because this may adversely affect patella tracking. When that happens, an alternative is to downsize the femoral component and use a thicker tibial component. Finally, the sagittal position of the femoral component should be checked. If it is positioned too posterior, then the component could be moved anteriorly with an off-set stem, but caution should be taken not to overstiffen the patellofemoral joint because this may adversely affect motion and patellofemoral tracking. The most common problem encountered is a flexion space that is larger than the extension space. If the knee is loose in flexion and tight in extension then the solution is to go through a series of checks and adjustments. The first step is to check the distal position of the femoral component. It is at this point that the distal augmentation is reduced or more distal femoral bone is resected, moving the femoral component more proximal. Next, the sagittal position of the femoral component is checked. If it is positioned too anterior then the use of an off-set femoral stem should be considered, which will move the femoral component more posteriorly and reduce the flexion space. Finally, the size of the femoral component should be checked. If it appears to be too small, the next larger size should be chosen, but care should be taken to not oversize the femur because of the adverse effect on motion.

It is preferable to use the least constrained prosthesis, such as a posterior-stabilized implant. However, if there is functional loss of the medial collateral ligament or lateral collateral ligament; inability to balance the flexion and extension spaces, or a severe valgus deformity, then a constrained condylar prosthesis is necessary. Hinged implants are useful in patients with global instability, deficient extensor mechanism, and severe bone loss after fracture or tumor resection.

Modern cemented modular implants with press fit stems allow for versatility to deal with most problems accounted during revision total knee arthroplasty. Cement used about the core prosthesis fills the uneven bony surfaces and defects as much as 5 mm, allowing immediate and reliable fixation. Press fit intramedullary stem extensions enhance component fixation, transfer loads distally and assist component alignment. Modular augments assist in treating bone defects. Most patients undergoing revision surgery can be treated with a posterior stabilized articulation, however there are times when a CCK articulation is necessary to address collateral insufficiency and flexion and extension imbalance.

References:

Case Presentation & Discussion Panel
Thomas K. Fehring, MD; Raymond Kim, MD; Douglas A. Dennis, MD; R. Michael Meneghini, MD; Giles R. Scuderi, MD

Please note that not all article abstracts for this session were available at time of printing.