Chapter 21
Revision Total Knee Arthroplasty

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Abstract
Diagnosis of the failed total knee arthroplasty (TKA) should proceed in a systematic manner, with insight into the most common etiologies of failure. Other than infection, flexion instability has emerged as the most common reason for early revision TKA. Methods for reconstruction of bone loss include cement and screws and block augments for moderate defects, and large defects are managed with metaphyseal porous metal cones or partially porous modular stepped sleeves. Adequate short-term clinical results have been obtained with both methods. Registry data document a 22% reoperation rate at 10 years after revision TKA. Clinical outcomes of revision TKA in young patients and those undergoing revision for infection are associated with an increased risk of poor outcome. Patient satisfaction is also reportedly lower with revision TKA than with primary TKA, and is even lower for those undergoing revision for infection.

Keywords: revision total knee arthroplasty; revision total knee replacement; bone loss; metaphyseal cones; metaphyseal sleeves; outcomes; patient satisfaction

Introduction
With increasing annual rates of total knee arthroplasty (TKA), the current and projected incidence of revision procedures is expected to increase dramatically. One study reported projections that predict that the number of knee revision procedures in the United States will double from the year 2005 to 2015 and increase 601% by the year 2030.1 Compared with primary TKA, revision procedures are more technically demanding and generally have higher risks of complications. Therefore, it is critical that surgeons understand the principles of the evaluation, etiologies of failure, surgical reconstruction and clinical outcomes associated with revision TKA.

Diagnosis and Surgical Treatment of Revision TKA
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Despite the long-term clinical success of TKA, with reported survivorship greater than 95% at 15 years,2,3 some patients will experience clinical failure. Many etiologies of dysfunction and pain can be reported following TKA;4-6 however, they are often systematically grouped into two large categories to consider: intrinsic or intra-articular and extrinsic or extra-articular.

Systematic Approach
A stepwise approach to management of the painful TKA should use the history, physical examination, and plain radiographs to identify many of the causes. The history and physical examination can help identify and/or eliminate most extrinsic etiologies. The final requisite test is a plain radiograph, which can identify many of the intrinsic causes of pain, particularly if serial examinations are available. The radiographic evaluation of revision TKA varies and is not well described.7 However, a
recent update to the Knee Society Radiographic System has expanded to include recommendations for radiographic evaluation of the revision TKA. Every painful knee arthroplasty should undergo a full evaluation with plain radiography that should include weight-bearing AP, lateral, and Merchant (patellar) views. For most patients with a painful TKA, basic laboratory tests that include a complete blood cell count, erythrocyte sedimentation rate, and C-reactive protein can identify the possibility of an occult infection. If the etiology of pain has not been conclusively determined following those efforts, advanced imaging such as CT or MRI can be performed. Bone scanning is rarely indicated because of high false-positive and false-negative rates. Knee aspiration or injection may also provide further confirmatory evidence of a suspected etiology for pain.

**Flexion Instability**

Flexion instability has emerged as a leading early cause of revision, in addition to periprosthetic infection, in TKA. The diagnosis can be challenging, although it can be typically made with an appropriate clinical and radiographic evaluation. Patients present with pain and a sense of instability, typically on stairs or with flexion activities. A physical examination demonstrates increased anteroposterior translation or coronal plane instability with the knee at 90° of flexion as well as pes anserinus tenderness. Radiographs typically will demonstrate one or more of the following radiographic findings: increased posterior tibial slope, inadequate posterior condylar offset, or distalization of the femoral component typically resulting from inadequate distal femoral bone resection. One study described successful surgical correction that increased the posterior condylar offset, removed the posterior slope, and in some cases, raised the joint line. The published clinical reports document that successful surgical correction of patients with flexion instability with revision TKA will improve their function and outcomes. However, the degree of improvement in function after revision TKA for flexion instability will not typically be as great as that in patients who undergo revision for aseptic loosening and other traditional diagnoses, which is partly a result of unmet patient expectations.

**Establish Etiology Prior to Revision TKA**

It is critical to identify the etiology of the painful TKA before surgical intervention, particularly revision surgery. Use of a systematic approach as described previously will facilitate identification of the correct diagnosis and guide the surgical intervention, as well as help the surgeon to discuss and outline the appropriate expectations for the patient. Intra-articular lidocaine injection can be a useful adjunct to confirm intra-articular and extra-articular pathology, particularly aseptic loosening, soft-tissue impingement, and pes anserinus bursitis. It can also be a useful diagnostic modality to help differentiate psychosomatic issues from true pathology in certain patients. However, if the etiology for pain after TKA cannot be determined, revision TKA is not recommended. A low probability of success has been reported with revision TKA for unexplained pain.

The goals of revision TKA include proper axial limb alignment, accurate positioning and adequate fixation of prosthetic components, symmetric ligamentous balance in flexion and extension, satisfactory patellofemoral mechanics, and an acceptable knee range of motion. These goals, particularly proper ligamentous balance and prosthetic fixation, depend greatly on the management of bone loss. The magnitude of bone loss has important implications for decisions regarding the use of bone graft or prosthetic augmentation, choice of prosthesis sizing, selection of prosthetic articulating constraint, and need for supplemental stem fixation.

**Reconstruction for Bone Loss**

**Bone Loss Assessment**

The critical step in determining the appropriate reconstruction method in revision TKA is to accurately determine the quantity, location, and extent of the bone loss. After the components are removed, it is important to determine whether the defects are contained or uncontained (segmental). In addition, the location of supportive bone that surrounds the bone loss is essential because it determines the type and size of augmentation required. Smaller contained defects can be treated with either cement fill with screw augmentation or morcellized allograft fill, particularly in older patients. However, larger, uncontained defects typically require larger reconstruction measures such as modular block augments, bulk allograft, or highly porous metal metaphyseal cones.

**Cement and Screws**

The use of cement as a reconstruction augment has the benefits of being simple, inexpensive, and efficient because the revision TKA is already using the material for fixation in most instances. This reconstruction method is typically indicated for smaller, contained defects less than 5 mm deep, although some authors have advocated its use in larger defects with excellent clinical results. When cement is used for defects in revision TKA, augmentation with bone screws are typically recommended to enhance the biomechanical properties of the construct. A series of 609 revision TKAs reported an excellent survivorship of...
98.6% at 17-year follow-up in knees that received screws and cement augmentation for bone defects. The smaller, contained defects encountered in revision TKA, particularly in older or less active patients, are appropriate for the use of screws and cement, which is a viable, successful method of reconstruction that is inexpensive, relatively simple, and efficient.

**Structural Allograft**

Bulk structural allograft historically has been used to reconstruct large bone defects with the intention of providing mechanical support and reconstituting bone, which are considered advantages of this technique. However, the disadvantages are the potential for graft resorption, collapse, and graft-host nonunion. Patient factors, including health status, physiologic age, bone quality, and activity level, must be considered when contemplating this reconstruction technique over other strategies such as using porous metal cones. A retrospective study reviewed 65 knees that underwent revision TKA with bulk allograft for large bone defects and reported a 10-year revision-free survivorship of 76%. Sixteen patients (22.8%) had unsuccessful outcomes and underwent additional surgery; eight were a result of allograft failure, and three were a result of failure of a component unsupported by allograft. A recent review of the treatment of revision TKA using bony structural allografts (476 cases) and porous metal cones (223 cases) reported a decreased rate of loosening for porous metal cones in Anderson Orthopaedic Research Institute classification 2 and 3 defects. The overall failure rate was also substantially lower in the porous metal cone group than the structural allograft group. These reports suggest that reconstruction of bone defects in revision TKA are likely more reliable with modern porous metal augments.

**Porous Metal Metaphyseal Cones**

Highly porous metal metaphyseal cones have recently been developed for large tibial and femoral defects and were designed to avoid the incidence of nonunion and resorption associated with bulk allograft reconstructions. Highly porous metals, particularly porous tantalum, are biomaterials that offer several potential advantages over traditional materials and include low stiffness, high porosity, and a high coefficient of friction. These porous metal metaphyseal cones are designed to treat the various patterns of severe bone loss encountered during revision TKA, in addition to providing mechanical support with biologic integration and to avoid allograft nonunion and resorption. Initial excellent results were reported for highly porous tibial metaphyseal cones, with excellent radiographic osseointegration and clinical outcomes. Favorable early results have been recently supported, with longer term results on the tibial side. 66 revisions with porous tantalum metaphyseal cones were reported at 5- to 9-year clinical follow-up. One patient had progressive radiolucencies about the tibial stem and cone on radiographs. One patient had complete radiolucenties about the tibial cone, a concern for fibrous ingrowth. A revision-free survival rate for the porous metal metaphyseal cones greater than 95% was reported at latest follow-up. Recently, early results of the treatment of femoral metaphyseal bone loss with these porous tantalum cones has been encouraging. Porous tantalum cones were implanted in femoral metaphyseal defects during revision TKA and all cones were radiographically well fixed at a minimum 2-year clinical and radiographic follow-up. These encouraging results for durable short- and longer term fixation in the setting of bone loss have resulted in a substantial increase in clinical use with surgeons who perform revision TKA.

**Partially Porous, Stepped Metaphyseal Modular Sleeves**

Noncemented, partially porous, tapered titanium sleeves have been used to treat larger metaphyseal tibial and femoral defects in revision TKA. The indications for these titanium sleeves are similar to those for metaphyseal porous metal cones discussed in the previous section. The advantages of these implants are the ease of insertion with an aggressive and accurate broaching system, as well as a robust modular taper connecting the sleeve to the tibial and femoral components, which obviates the need for cement to unite the sleeve and bearing implant.

Excellent clinical results with the noncemented, partially porous titanium sleeves have been reported and early-term success was demonstrated. A prospective study followed 121 patients with 193 titanium sleeves that included 119 tibial and 74 femoral sleeves for a mean of 3.6 months; of these, 14 patients underwent revision: 3 for infection and 11 for loosening, instability, or mechanical failure. In another series, 35 revision TKAs in 34 patients were reported at a minimum clinical and radiographic follow-up of 2 years. Stem extensions were used in only a portion of the procedures in which bone loss was more severe. In the revision TKAs performed for mild or moderate bone loss, only the sleeve and cemented tibial tray or femoral component were used for fixation without the use of a stem extension, and only one revision was reported for femoral cone failure at 3 years postoperatively. In a 2013 series of 40 revision TKAs using a tibial porous coated titanium sleeve for Anderson Orthopaedic Research Institute type 2B or 3 defects, 10 patients were lost to follow-up and no mechanical
failures related to the tibial cone were reported at a minimum follow-up of 2 years.39

The surgical techniques described previously vary and include allowing the tibial baseplate to sit proximal to the tibial metaphyseal bone surface as long as the titanium sleeve is rotationally and axially stable, as well as allowing the sleeve to be implanted without stem extensions in cases of adequate sleeve mechanical stability.25,26,29 However, these practices should be followed cautiously because of the short-term follow-up of these reports and the unknown clinical consequences of surgical techniques that place large stresses and forces at the taper junction of the sleeve and tibial or femoral component via unsupported implants or lack of stem extensions that engage the femoral or tibial diaphysis. One series reported two cases of implant failure because of mechanical breakage at the stem-sleeve junction, likely secondary to fatigue failure.25 Therefore, it is recommended that stem extensions be used, along with careful optimization of the tibial and femoral component cementation technique to ensure interdigitation with the host bone at the joint level to avoid large cyclic in vivo loads at the modular taper junction interfaces over the long term.

Cemented or Noncemented Stems

The use of cemented or noncemented stems to augment tibial and femoral prosthetic fixation remains controversial. It is generally accepted that for revision TKA performed in the setting of bone deficiency, stem augmentation is required to supplement implant fixation by bypassing the deficient bone and achieving fixation in the viable metaphyseal or diaphyseal bone. Also, when additional tibiofemoral constraint is used, it is accepted that stem supplementation is necessary to help resist the articular forces transmitted from the constraint to the implant fixation interface. Adequate long-term results have been reported with both cemented and press-fit noncemented stem fixation in revision TKA, with greater than 90% survivorship at 10-year follow-up with both fixation types.30–32 However, given the lack of comparative studies, the choice of cemented or noncemented stems remains a choice based on personal philosophy, past experience, and intraoperative judgment. Irrespective of fixation type, close attention should be given to cement techniques to ensure adequate implant stability. However, if supplemental press-fit noncemented stem fixation is used, it is advised to ensure adequate tibial or femoral prosthesis cementation into the metaphyseal region while achieving intimate endosteal contact and interference fit of the noncemented stem into the metadiaphyseal region.31,32

Clinical Outcomes

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Understanding the results of revision TKA is problematic.33 Confusion exists in the literature regarding what comprises a revision arthroplasty: some series include single-component revisions or modular polyethylene exchanges and others do not. Few series have a minimum 10-year follow-up. Cases are divided differently as to the cause of failure: the results of septic and aseptic revisions differ, as do the results for tibiofemoral instability and poor motion. No consistency exists for describing mode of failure, even among registries.34 Radiographic reporting is not uniform.7 An unwitting bias exists against the publication of poor results and many series report the experience with a specific prosthesis, which suggests a selection bias, of cases that were appropriate for the device studied.

Only registries in Australia15 and New Zealand16 regularly publish the results of revision arthroplasty. Australia reports only first revisions and only those performed for aseptic failure. With this optimistic bias, aseptic first revisions are re-revised at 10 years in more than 22% of cases (29.7% if the first revision was insert only, 25.2% for femur only, 22.2% for tibia only, and 24.3% for complete revisions). The discrepancy between registry data and published series suggests that superior results should not be assumed without requisite knowledge and experience.

Registry data are a tremendous, but imperfect resource17,38 that may be skewed by the fact that to be identified as a failure, a revision will have to be re-revised. Some failures will be abandoned as inoperable and so become “successes” in registry data. Registries do not track procedures that indicate failure such as amputation, arthrodesis, and resection arthroplasty. Many clinical series that describe new techniques for complex surgical problems lack control subjects and are extremely difficult to evaluate.39 Other series evaluate variables (such as joint line position and patellar resurfacing) that are confounding variables associated with the severity of the failure being treated.

The failed unicompartmental knee arthroplasty (UKA) has unique challenges. A case-control study from the New Zealand Joint Registry reported 205 UKAs revised to TKA and 31 revised to UKA. When UKA was revised to another UKA, the rate of re-revision was 13 times higher than for primary TKA. The re-revision rate for UKA converted to TKA was four times higher than for primary TKA. The study concluded, “The poor outcome of a UKA converted to a primary TKA compared with a primary TKA should contraindicate the use of a UKA as a more conservative procedure in the younger patient.”36 An
alternative might be a more aggressive approach to revision of the failed UKA, similar to revision of a failed TKA.

Revision TKA in the Younger Patient
The young patient is at higher risk of poor outcome. As with primary TKA, age is a strong predictor of revision arthroplasty failure. In one study, 84 patients younger than 50 years were matched for date of surgery, sex, and body mass index. The most common reason for the original revision in the younger group was aseptic loosening (27%) and infection in the older group (30%). Of 25 re-revisions in patients in the younger group and 26 in patients in the older group, 32% and 50%, respectively, were performed for septic failure. Cumulative survival rates were comparable: 71.0% for the younger group and 66.1% for the older group, which indicates a large burden of failed arthroplasties. Infection and body mass index in excess of 40 kg/m² were associated with higher risks of failure overall. Another study noted similar problems with revision TKA in patients younger than 55 years, when compared with a control group of young patients matched for age, sex, body mass index, and comorbidities undergoing primary TKA. Revision arthroplasties required re-revision in 17% of cases at a mean of 4.6 years. Although the rates of minor complications and UCLA activity scores were similar in the two groups, improvements in Knee Society Score (KSS) were lower in the revision group. Periprosthetic infection and instability were the most common problems in the revision group. A failed revision TKA is ominous in the young patient; subsequent revisions fail at an even higher rate in all patients, and patients in the younger group generally have higher levels of physical activity for longer periods following revision. Revision TKA in the young patient is technically demanding, with little allowance for poor decisions or technique.

Predictors of Outcome Following Revision TKA
Several studies have identified risk factors for adverse results after revision TKA. The outcome of revision for infection is worse than for aseptic failure by several criteria, including mortality rates. When 88 septic revisions were compared with matched aseptic revisions, the overall mortality rate at median 4 years was 10.7%. However, the mortality after septic revision (18%, 16 patients) was six times higher than that of aseptic revision (3%, 3 patients) \((P = 0.003)\). In one study, the risk of readmission to hospital within 30 days of revision TKA was associated with female sex, general anesthesia, and a past history of transient ischemic attack.

Preoperative dialysis was associated with minor complications within 30 days of revision TKA and male sex, increased age, American Society of Anesthesiologists classification higher than 2, wound classification higher than 2, emergency surgery, and pulmonary comorbidity were factors associated with major complications. The risk of prosthetic joint infection developing after aseptic TKA revision was 1.0%, 2.4%, 3.3%, and 5.6% at 1, 5, 10, and 20 years, respectively. Male sex, constrained implants, increased surgical times, increased Charlson Comorbidity Index, and a history of liver disease were significantly associated with prosthetic joint infection; less strongly associated factors were cardiovascular disease, endocrine disorders, and renal disease.

In a retrospective study of 175 revision TKAs, male sex, lower Charlson Comorbidity Index, and higher preoperative functional KSS predicted superior functional outcome as measured by using KSS. Lower preoperative pain and higher clinical KSS were associated with better outcome as measured by the pain scale of the Western Ontario and McMaster Universities Osteoarthritis Index score 2 years postoperatively.

Patient Satisfaction After Revision TKA
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Patient Expectations and Characteristics
Patient satisfaction begins with the patient’s expectations as they begin their surgical process. More importantly, it is necessary to define and contrast patient expectations and patient desires. One study found patient expectations to be the scenario that the patient likely thinks will occur in the surgical scenario, contrasted to patient desires, which are the patient’s wishes that a given event occurs. One study reported patient expectations to be highly indicative of improved postoperative outcomes and satisfaction after total joint arthroplasty. Patients who expected fewer complications and complete pain relief had better pain relief and functional improvement than those who expected complications or lack of pain relief. Expectations can differ by region. The expectations of patients undergoing TKA in the United States, United Kingdom, and Australia were compared and differing levels of expectations were reported, ranging from pain relief to functional outcome. These differences could not be explained by sociodemographic factors, clinical characteristics, or pain and functional status. A study on satisfaction after knee arthroplasty, including some knee revisions, reported regional variations after primary and revision knee arthroplasty. In addition, lower level of education, presence of obesity, and revision surgery were factors reported to be associated with lower patient satisfaction.

Of similar importance as expectations, certain patient factors can affect outcome after total joint arthroplasty.
One prospective study reported preoperative depression and anxiety symptoms to predict more pain at 1 year after TKA. Furthermore, heightened preoperative pain was found to be an independent risk factor for poor outcome. A 2012 meta-analysis reported that in TKA, low preoperative mental health and increased pain resulted in worse outcomes and increased pain after surgery. A 2015 retrospective study evaluated patient-reported allergies as they relate to postoperative patient satisfaction and outcomes after lower extremity arthroplasty and reported that increasing patient-reported allergies were associated with less satisfaction and decreased pain and function scores after lower extremity arthroplasty.

Although these are average values and trends and do not apply to every patient in every scenario, it must be recognized that patient satisfaction after surgery cannot simply be measured by proper alignment of the prosthesis. The patient as a whole must be assessed and the patient should be educated on what to expect postoperatively. Further, these studies are based on primary total joint arthroplasty and must be evaluated in that context.

**Patient Satisfaction With Primary TKA**

TKA has a high level of success. One study reported 15-year clinical survivorship of 94.6% in the total condylar knee. Using the Hospital for Special Surgery Knee Score, which measures satisfaction by rates of pain and function, good results were reported in 34% of patients and excellent results were reported in 58% of patients. A 2015 meta-analysis found patient satisfaction to generally be high after TKA: approximately 75% of patients were satisfied, and 79.5% would undergo the surgery again.

**Patient Satisfaction With Revision TKA**

Although primary TKA offers objective goals and typically follows standard intraoperative and postoperative protocols, revision arthroplasty performed for any reason has many more variables. These variables provide less definitive information for the patient and can leave many questions unanswered before the procedure. Therefore, a retrospective review was conducted of the differences between 60 revision TKAs and 199 primary TKAs. The study compared preoperative and postoperative pain, function, and satisfaction scores between the two groups and concluded that patient-reported satisfaction at 2-year follow-up was inferior in revision cases when compared with primary cases. One retrospective study analyzed prospectively collected patient-reported outcome measures in 24,190 patients with 23,393 TKAs and 797 aseptic revision TKAs. Almost twice as many patients rated their postoperative results as “excellent” in primary TKA than did patients undergoing revision TKA (22% versus 13%; \( P < 0.001 \)). Overall, 83% of those undergoing primary TKA were satisfied; 66% reporting being satisfied following revision TKA. General well-being was assessed using the EuroQol Five Dimension score and the highest postoperative scores in revision cases were found in those patients with revision for aseptic loosening or lysis. The lowest scores were found in patients who underwent revision for stiffness. In contrast, another prospective study found that although physical function scores improved significantly from preoperative scores for both primary and revision TKA, mental scores did not statistically improve from preoperative to postoperative.

The study followed 100 consecutive TKAs and 60 revision TKAs and compared preoperative pain, function, and mental scores with those obtained at 6 months and 12 months postoperatively. However, the mental scores showed no significant change from preoperative levels in both primary and revision cases. This study highlights the potential differences in patient pain and function compared with patient satisfaction. In a study of 175 consecutive patients, functional and satisfaction outcomes were reported in patients undergoing aseptic revision TKA. In all patients, approximately 37% were “very satisfied,” 32% were “somewhat satisfied,” 27% were “somewhat dissatisfied,” and less than 5% “very dissatisfied.” Although revision for both aseptic loosening and instability provided improvement in patient satisfaction, revision for instability did not provide the level of satisfaction in patients undergoing revision for aseptic loosening. Of all patients, 63% said they would undergo the procedure again, 16% would not, and 21% were “unsure.” A prospective study of 94 patients undergoing revision TKA over a 5-year period reported on the health-related quality of life. Those patients undergoing their first revision had higher health-related quality of life than those undergoing a second revision and those undergoing more than two revisions (postoperative KSS was 138, 131, and 110, respectively). Similarly, those patients undergoing revision for septic reasons had lower health-related quality of life than those undergoing revision for aseptic reasons (postoperative KSS was 113 and 128, respectively). Finally, those patients who were revised to constrained prosthesis achieved the lowest health-related quality of life scores (postoperative KSS, 103).

Many studies compare satisfaction after aseptic revision to satisfaction after septic revision. A clinical outcomes study compared 33 revision knee arthroplasties with 15 revised for sepsis. The patients were followed for 30 to 130 months, and overall, patients with revisions for sepsis were less satisfied than those with revisions for aseptic reasons. Furthermore, although aseptic revisions...
had significantly better knee scores and range of motion than did septic revisions, the difference in pain and functional scores did not differ significantly. However, both septic and aseptic revisions had an overall satisfaction after surgery of approximately 85%. In a prospective series of revision TKAs performed at three centers, patient satisfaction and outcomes were compared in cases treated for septic and aseptic reasons. No significant difference in pain scores was reported between the two groups. Patients treated for septic causes were more likely to be dissatisfied with their ability to return to activities of daily living compared with those with aseptic revisions; however, overall “dissatisfaction” ratings with the results of surgery were similar between the two groups (12% and 11% for septic and aseptic revision, respectively; P > 0.5). One study followed 54 patients who underwent septic or aseptic revision TKA for 40 months. Regarding functional score, revisions for patellar maltracking and loosening had the highest preoperative functional scores (KSS, 44.8) and improved to the highest postoperative functional scores (KSS, 82.2). In addition, these patients had the highest preoperative and postoperative Medical Outcomes Study 36-Item Short Form (SF-36) scores at 60.8 and 60.2, respectively. Comparing the septic revisions with aseptic loosening and aseptic stiffness, revision for infection had the largest improvement from preoperative to postoperative scores in KSS (35.1 to 77.1) and SF-36 mental (42.3 to 55.5). Revision for stiffness started with the lowest preoperative satisfaction and resulted in the lowest postoperative satisfaction, with those patients achieving only a 4-point gain in preoperative SF-36 mental score (from 42 to 46). A study compared 47 septic TKA revisions with 55 aseptic revisions and found similar postoperative SF-12 mental scores between the two groups (53.7 and aseptic 49.1, respectively; P = 0.105). However, the report used a four-item score and found that septic revision cases had a nonsignificantly higher score (71.7) than did aseptic cases (55.7; P = 0.025). The results may be a result of the fact that the center was a tertiary referral center and many of the infected patients had chronic incapacitating conditions that could elevate satisfaction after surgery.

A study reported on 93 patients who underwent either septic or aseptic revision knee arthroplasty and were followed for 2 years. Preoperative mental health scores rated using the SF-36 form showed that infected patients had nonsignificantly lower scores than noninfected patients. However, postoperative mental health scores of patients in the infected group were nonsignificantly higher than noninfected patient scores. The infected patients had higher pain and lower functional scores preoperatively. Mental health scores do not necessarily predict function or pain after revision TKA.

**Summary**

The basic principles of revision TKA are to ensure an accurate diagnosis and etiology via a detailed systematic approach, with subsequent reconstruction with modern methods such as highly porous metal metaphyseal cones or partially porous modular stepped sleeves. Patients and surgeons should be aware that clinical outcomes and patient expectations are diminished compared with those for primary TKA. However, if an appropriate reconstruction is performed for an identified diagnosis, revision TKA can result in improved clinical outcomes.

**Key Study Points**

- Flexion instability is the leading cause of revision TKA; clinical and radiographic evaluation are critical for diagnosis.
- Porous metal metaphyseal cones and partially porous modular stepped sleeves are modern reconstruction options associated with favorable early results.
- Patient satisfaction can be associated with certain patient factors and trends, and is higher with primary TKA than with revision TKA.

**Annotated References**


6. Sharkey PF, Hozack WJ, Rothman RH, Shastri S, Jacoby SM: Insall Award paper. Why are total knee arthroplasties...


A uniform method of evaluating radiographic findings associated with revision TKA is needed to optimize treatment and standard of care.


A system to track correct documentation of radiographic parameters was developed.


A 10-year follow-up study was performed to determine frequency and cause of failed TKA. In comparison with earlier results, fewer revisions are performed for polyethylene wear, instability, arthrofibrosis, malalignment, and extensor mechanism deficiency.


This study recommends a stepwise approach to surgical correction of instability in flexion after TKA: reduction of tibial slope, correction of malalignment, and improvement of condylar offset.


Outcomes after revision TKA for flexion instability were improved, with a significant increase in mean posterior condylar offset ratio and a significant decrease in tibial slope. Level of evidence: IV.

12. Grayson CW, Warth LC, Ziemba-Davis MM, Michael Meneghini R: Functional improvement and expectations are diminished in total knee arthroplasty patients revised for flexion instability compared to aseptic loosening and infection. *J Arthroplasty* 2016; March 10 [Epub ahead of print]. Medline DOI

Compared with revision undertaken to manage aseptic loosening and infection, revision for flexion instability led to modest improvement in function.


Although revision TKAs using screws had more defects, revision with screws plus cement for correction of defective revision TKAs is recommended.


According to a systematic review of the literature, the porous implant group had a significantly decreased loosening rate according to Anderson Orthopaedic Research Institute classification 2 and 3 defects, and the overall failure rate was also substantially lower than the structural allograft group.


At 5- to 9-year follow-up, porous tantalum tibial cones had good clinical results and radiographic fixation, with the potential for successful long-term structural support in knee reconstruction.


Porous tantalum metaphyseal femoral cones were found to provide good structural support for femoral implants in revision TKA, but long-term follow-up is needed.


Direct cementless metaphyseal fixation with sleeves was found to be a good option for revision TKA.


In this study of 35 revision TKAs with metaphyseal sleeves, the KSS was excellent or good and radiographic results were satisfactory.


In a follow-up study of 83 sleeves used for tibial revision, only 2 tibial components required revision for aseptic loosening.


In a retrospective review of 51 patients who underwent revision TKA with a metaphyseal sleeve, final follow-up showed stable osteointegrated components with no component migration or clinically significant osteolysis.


In a retrospective review of 30 revision TKAs using a porous titanium tibial sleeve, components were well fixed with osseous ingrowth.


34. Niinimäki TT: The reasons for knee arthroplasty revisions are incomparable in the different arthroplasty registries. *Knee* 2015;22(2):142-144. Medline DOI

Standardization of the structure of the arthroplasty registries is needed because the reasons for knee arthroplasty revisions are categorized differently across registries.


The authors studied whether survival and functional outcome data for revised UKA were comparable to those for primary TKA.


Although registries provide valuable information to help improve patient care, physicians interpreting data should be aware of the shortcomings of these registries.


Because revision is not an objective measurement, it should not be used to compare implant types in knee joint registry data.


In 14 patients who underwent low-dose irradiation and constrained revision for arthrofibrosis after TKA (15 procedures), no significant complications were noted at a mean follow-up of 34 months.

According to this study of revision and mortality rates in 4,668 patients undergoing primary total hip and knee replacement between 1989 and 2007, patients younger than 50 years at the time of surgery are more likely to require a revision than die, and those older than 77 years have a greater than 90% likelihood of dying without requiring a revision.


Improvement in implant fixation and treatment of infection in young patients who undergo revision TKA is needed for better outcomes.


Independent predictors of increase mortality after revision TKA were increased age, higher American Society of Anesthesiologists classification, and septic revision.


An American Society of Anesthesiologists classification of 3 or higher, increased surgical time, older age, and greater body mass are predictive factors affecting development of postoperative complications, and patient age and diabetes increased mortality risk after primary total unilateral knee arthroplasty.


In a study of short-term outcomes after revision TKA, major complications were associated with male sex, older age, American Society of Anesthesiologists classification higher than 2, emergency surgery, and pulmonary comorbidity.


Factors associated with periprosthetic joint infection include male sex, a history of liver disease, and use of constrained implants.


Body mass index and higher preoperative functional scores are predictors of functional outcome after revision TKA. Level of evidence: II.


Psychologic factors that affect outcomes of TKA include low preoperative mental health and pain catastrophizing.


Patient-reported allergies are significantly associated with poor patient satisfaction after TKA and increased length of hospital stay.


Epidemiology and risk factors for knee replacement are reviewed.


Health-related quality of life after TKA was assessed. Improvement in pain and function was reported, leading to patient satisfaction. Level of evidence: I (therapeutic).

Quality of life and satisfaction outcomes of patients undergoing primary and revision TKA were evaluated and compared. Outcomes were better after primary TKA than revision TKA.


Differences in patient-reported outcomes and level of satisfaction between primary and revision TKA were studied to find out if the reason for revision has an effect on these outcomes. Level of evidence: III (therapeutic).


Outcomes were better in patients undergoing septic revision TKA than in those undergoing aseptic revision TKA. However, revision TKA for stiffness in those undergoing aseptic revision TKA was associated with the poorest outcomes.


A significantly poorer functional outcome was observed with revision for instability, whether or not a new device was chosen. Functional outcome was not influenced by the level of constraint. Level of evidence: II.


Outcomes were better after primary TKA than revision TKA.