Aseptic Complications After Total Knee Arthroplasty

Jess H. Lonner, MD, and Paul A. Lotke, MD

Abstract

Aseptic complications after total knee arthroplasty are occurring less frequently than they did one or two decades ago. This is related in part to technical advancements, design improvements, and changes in perioperative management. Extensor mechanism dysfunction is the most frequent complication and the most commonly cited reason for secondary surgery after total knee arthroplasty. Mechanical wear, tibiofemoral instability, periprosthetic fracture, thromboembolic disease, compromised wound healing, neurovascular problems, and stiffness are less common, but nevertheless troublesome, sources of dysfunction after total knee arthroplasty. Complications compromise outcomes, and the most effective way of dealing with complications is prevention.


Aseptic complications after total knee arthroplasty are occurring less frequently than they did one or two decades ago. This is related in part to technical advancements, design improvements, and changes in perioperative management. Extensor mechanism dysfunction is the most frequent complication and the most commonly cited reason for secondary surgery after total knee arthroplasty. Mechanical wear, tibiofemoral instability, periprosthetic fracture, thromboembolic disease, compromised wound healing, neurovascular problems, and stiffness are less common, but nevertheless troublesome, sources of dysfunction after total knee arthroplasty. Complications compromise outcomes, and the most effective way of dealing with complications is prevention.


Extensor Mechanism Complications

Over the past three decades, the incidence of extensor mechanism complications has decreased from approximately 12% to 1.5% as a result of design modifications, technical advancements in attaining proper rotational and axial alignment of the individual components, and improvements in soft-tissue balancing. Nonetheless, the patellofemoral joint remains the most common source of pain and dysfunction after total knee arthroplasty. Patellofemoral instability, component dissociation or loosening, patellar fracture, residual anterior knee pain, component wear, osteonecrosis, patellar “clunk,” and patellar tendon rupture account for up to 50% of secondary surgical procedures after total knee arthroplasty.

Patellofemoral Instability

Patellar instability is the most common reason for secondary surgery after total knee arthroplasty. The reported incidence of patellar maltracking (tilting, subluxation, or dislocation) varies from 0.5% to as high as 29%. Patellar maltracking may be related to prosthetic design, extensor mechanism imbalance, asymmetric patellar resection, malrotation of the femoral or tibial component, or patellar malpositioning.

Component design is important for stable patellar tracking. To accommodate either a resurfaced or a nonresurfaced patella, the femoral component should ideally have a broad trochlear groove that extends proximally to accommodate the patella in full extension. The trochlea should be directed toward the lateral side to engage the patella early in flexion. Distally, patellar tracking is enhanced when the trochlear groove is narrowed and deepened to contain the patella, limiting lateral subluxation in flexion.

Dr. Lonner is Assistant Professor, Department of Orthopaedic Surgery, University of Pennsylvania School of Medicine, Philadelphia. Dr. Lotke is Professor of Orthopaedic Surgery, University of Pennsylvania School of Medicine.

Reprint requests: Dr. Lonner, Department of Orthopaedic Surgery, Hospital of the University of Pennsylvania, 2 Silverstein, 3400 Spruce Street, Philadelphia, PA 19104.

The authors or the departments with which they are affiliated have received something of value from a commercial or other party related directly or indirectly to the subject of this article.

Copyright 1999 by the American Academy of Orthopaedic Surgeons.
et al. evaluated the data on total knee arthroplasties performed with implants of two different designs and found that the results were comparable except for the incidence of postoperative patellofemoral complications (10% for one design and 0.7% for the other). They attributed this disparity to the striking differences in femoral component morphology between the two designs.

Patellar component design (e.g., dome-shaped buttons, “Mexican hat”-like buttons, and asymmetric components), medialization of the component to approximate the anatomic center axis, the accuracy and extent of patellar bone resection, and restoration of patellar thickness may all affect patellar tracking. Excessive resection of the patella so that the remaining thickness is less than 10 to 15 mm may predispose it to fracture; insufficient resection may limit flexion and contribute to maltracking.

Proper tracking requires a normal Q angle, which is affected by the axial and rotational alignment of the femur and tibia. An excessive Q angle may result from medialization of the tibial tray, excessive valgus alignment of components, or internal rotation of either component. Patellofemoral maltracking may also result from soft-tissue imbalance if the lateral retinaculum is contracted or the medial retinacular sleeve is lax.

Correct axial femoral component alignment, perpendicular to the mechanical axis, is paramount to prevention of patellar maltracking. The femoral component should also be implanted with enough external rotation to establish a rectangular flexion gap and to facilitate patellar tracking. In addition, it should be appropriately sized in the anteroposterior dimension to avoid “overstuffing” the patellofemoral compartment.

A variety of methods have been developed for determining the appropriate rotational alignment of the femoral component (Fig. 2). Using the posterior femoral condyles as a reference, the examiner should assess the knee for severe deformity or condylar hypoplasia. In the presence of severe valgus deformity, deficiency of the posterior lateral femoral condyle may erroneously place the cutting jig in relative internal rotation. Proper rotation of the tibial component, so that its center is in line with the medial third of the tibial tubercle, and avoidance of medialization of the tibial component will enhance patellar tracking (Fig. 3).

Patellar tracking is most accurately assessed with the tourniquet deflated, to eliminate the binding effect of the tourniquet on the quadriceps. Without closing of the medial retinaculum or forcing of the patella medially (“the rule of no thumbs”), the patella should track congruently within the trochlear groove without tilting or subluxating. If the patella tilts or subluxates, a lateral retinacular release should be performed. If patellar subluxation still occurs, rotation, alignment, patellar composite thickness, and button position should be evaluated.

Treatment of patellar maltracking is based on the cause of the instability. Nonsurgical treatments for patellar subluxation or dislocation are generally unsuccessful. Surgery must be directed at the underlying cause of the problem. In the absence of component malpositioning, a lateral retinacular release may be all that is necessary to improve patellar tracking. A lateral retinacular release is performed from the inside out in an attempt to preserve the blood supply of the skin flap as well as the lateral superior genicular vessels. Distal to the vessels, the lateral retinaculum is released in a direction perpendicular to the joint line. Proximally, an oblique limb is directed 45 degrees anteriorly, relieving lateral traction by the iliotibial band in flexion. Distal realignment involving tibial tubercle osteotomy has been advocated, particularly when an excessive Q angle is present. However, when there is significant component malalignment, tubercle osteotomy is less effective than component revision.
Patellar Fracture

Patellar fracture after total knee arthroplasty has a variety of causes, including abnormal stress concentrations, osteonecrosis, and patella baja. The patella is susceptible to failure when the bone has been weakened and high stresses are applied. Direct trauma to the patella after total knee arthroplasty is uncommon. Compressive loads across the patellofemoral articulation approach four to seven times body weight in certain activities, such as squatting and stair descent. Furthermore, when the transition zone between the trochlear region and the condylar region of the femoral component is abrupt, the localized stress concentration can be quite severe. Overstuffing the patellofemoral joint with an oversized femoral component, an anteriorly offset femoral component, or a femoral component placed in excessive extension can also overload the patella. A similar phenomenon may be seen with insufficient resection of the patella or use of a thick button.

Excessive patellar resection can predispose to patellar fracture as well. Reuben et al have demonstrated that a residual patellar thickness of less than 15 mm can substantially increase anterior patellar strain.

Osteonecrosis of the patella may lead to late fracture and fragmentation of the patella (Fig. 4). Anatomic studies of patellar blood supply have mapped out an extensive system of both extraosseous and intraosseous arterial systems. There are contributions from all the genicular vessels (Fig. 5). Each of these vessels is potentially at risk during the surgical approach, soft-tissue dissection, and subsequent patellar resurfacing. The standard medial parapatellar arthrotomy will divide the superior and inferior genicular arteries as well as the descending genicular artery. Additionally, the lateral inferior genicular artery is commonly sacrificed during lateral meniscectomy. When a lateral retinacular release is subsequently performed, the lateral superior genicular artery is at risk, particularly when not dissected free and protected.

Aggressive resection of the infrapatellar fat pad can theoretically compromise the traversing branches that supply the inferior pole of the patella. However, this has not resulted in an obvious decrease in patellar perfusion. Diminished patellar vascularity has been observed acutely on technetium bone scans, but follow-up studies suggest that patellar revascularization may occur as early as 60 days after the surgical procedure.

Elevation of the tibiofemoral joint line as a result of proximal femoral resection and posterior cruciate ligament release will cause relative patella baja. This creates a nonanatomic patellofemoral articulation, which may result in patellar impingement on the tibial insert in late flexion and ultimately in patellar fracture. Considering the proximal shift in the joint line seen with standard posteriorly stabilized total knee arthroplasties, it has been postulated that there may be a higher risk of patellar fracture with these implants.

Treatment of patellar fractures is dependent on fracture pattern, location, remaining bone stock, integrity of the component-cement-bone interface, and competence of the extensor mechanism. The classification by Goldberg et al is helpful for planning appropriate intervention. Type I fractures are avulsion-type fractures, generally involving the periphery of the patella but not the implant, cement, or quadriceps mechanism. Type II fractures disrupt the cement-prosthesis interfaces or the quadriceps mechanism. Type III-A fractures involve the inferior pole of the patella with disruption of the patellar ligament. Type III-B are nondisplaced fractures of the inferior pole of the patella with an intact patellar ligament. Type IV fractures are fracture-dislocations of the patella.

Nonoperative treatment is preferred when fractures are nondisplaced. Unfortunately, the definition of displacement used in the literature has varied from 2 mm to 2 cm, and clinical experience in treating patellar fractures after total knee arthroplasty has generally been
Hozack et al. reviewed 21 patellar fractures after total knee arthroplasty. Nonoperative treatment of nondisplaced or minimally displaced fractures (6 to 8 weeks of cast immobilization) yielded satisfactory results. The results of surgical treatment were variable, but more predictable outcomes were associated with partial or complete patellectomy than with attempted open reduction and internal fixation. Goldberg et al. reported comparable results in their experience treating 36 patellar fractures after total knee arthroplasty. Type I fractures, which had been treated in a cast in extension, had satisfactory results. Unfortunately, fracture patterns categorized as types II, III-A, or IV generally had unsatisfactory outcomes despite surgical intervention and appropriate postoperative physical therapy.

Windsor et al. noted that comminuted patellar fractures, regardless of the extent of fragment displacement, can be treated in a cylinder cast, unless there is compromise of the prosthesis-patella composite. In the latter scenario, a patellectomy has better results than attempted open reduction and internal fixation, which may predispose the patella to osteonecrosis or nonunion. Another option for these comminuted fractures is to remove the patellar component and allow healing of the comminuted bone fragments in a cast. Transverse fractures with displacement by more than 1 cm and/or an extensor lag greater than 30 degrees may be treated with cerclage tension-band wiring, provided the patellar component is intact and the native bone stock is adequate. Otherwise, patellectomy is preferable.

Displaced avulsion fractures of either the proximal or the distal pole of the patella with an intact patellar component and a viable patella can be stabilized with heavy nonabsorbable sutures passed through the quadriceps tendon or patellar tendon and secured to the patella through drill holes. To protect the repair, a checkrein-type figure-of-eight stitch may be tied over the anterior aspect of the extensor mechanism. After fixation, patellar tracking and component stability should be assessed. Postoperatively, passive knee motion may be allowed.

**Patellar Tendon Rupture**

Rupture of the patellar tendon after total knee arthroplasty is uncommon, occurring in 0.17% to 1.45% of cases. This injury can be devastating for the patient, as the results of treatment are frequently suboptimal. The most common cause of extensor mechanism disruption is intraoperative tendon avulsion off the tibial tubercle that occurs when excessive tension is used when trying to obtain adequate exposure. Late rupture may result from manipulation, distal tubercle realignment procedures, direct trauma, or impingement on the tibial insert.

Considering the relatively poor results of treatment of this complication, even with surgical intervention, it is preferable to be extremely careful when handling the tendon at the time of primary arthroplasty. A knee with limited motion or intraarticular scarring, particularly when associated with patella baja, is at greater risk. When exposure is difficult, graduated extensile exposure is initiated with posteromedial dissection and external tibial rotation. If necessary, a modified quadriceps...
V-plasty, quadriceps snip, or tibial tubercle osteotomy should be considered to protect the patellar tendon insertion. In addition, a pin or drill bit may be inserted into the distal patellar tendon insertion to protect it from avulsing. Manipulation of a stiff knee under anesthesia may be complicated by rupture of the patellar tendon or supracondylar fracture of the femur. The risk of these complications can be reduced, in part, by performing manipulation within 6 weeks of arthroplasty.

If distal ligament avulsions involve less than 30% of the tibial tubercle insertion, a primary repair of the medial capsuloretinacular sleeve should suffice, without any need for alteration in normal postoperative physical therapy. For complete avulsions, primary reattachment has been relatively unsuccessful, with a high incidence of rerupture and functional impairment. Primary suture repair of attritional or traumatic ruptures is typically ineffective. In general, there are two methods of patellar tendon reconstruction that may be effective in these circumstances. The decision of which to use is influenced by the quality of the remaining native patellar bone stock. When there is adequate patellar bone stock, primary repair and augmentation with an autogenous semitendinosus graft is effective. With the technique modified from Cadambi and Engh and Ecker et al, the standard total knee incision can be used to harvest the semitendinosus, leaving its insertion point on the pes anserinus intact. The attached graft is then routed proximally along the medial aspect of the patellar tendon, passed transversely through the patella, and sutured back to its pes anserinus insertion. Postoperatively, the knee is immobilized in extension for 6 to 8 weeks before progressive rehabilitation is started.

An extensor mechanism allograft can be considered when the patellar bone stock and soft tissue are deficient (Fig. 6). Emerson et al reported satisfactory results with the use of an allograft quadriceps tendon, patella, patellar tendon, and tibial tubercle bone block. The allograft tibial tubercle is fitted into a trough in the tibial tubercle, placed so that the patella will be positioned appropriately with respect to the joint line, and is then secured with screws. The patella may or may not be resurfaced. The quadriceps component of the allograft is tensioned and secured to the host quadriceps tendon with nonabsorbable sutures. The graft should have a moderate amount of tension with the knee fully extended, allowing approximately 60 to 70 degrees of flexion against gravity. The native host tissues are sutured over the allograft to

Fig. 6  A, Lateral radiograph shows patella alta due to insufficiency of the patellar tendon after total knee arthroplasty. B, Intraoperative photograph of an implanted extensor mechanism allograft in a patient with patellar tendon rupture and inadequate patellar bone stock. The tibial trough is made after establishing the appropriate position of the patella relative to the joint line. The bone plug is secured with one or two cortical screws. The allograft is sutured peripherally to the remaining undersurface of the host extensor mechanism with nonabsorbable suture. The native tissues are then closed over the allograft. C, Postoperative lateral radiograph after reconstruction. The allograft patella was not resurfaced.
minimize the risk of soft-tissue slough and to promote healing. Postoperatively, passive range-of-motion exercises may begin immediately. Progressive rehabilitation should be initiated carefully. Although the 2-year results with this technique are encouraging, longer-term follow-up is necessary.

Soft-Tissue Impingement

The “patellar clunk syndrome” occurs when a fibrous nodule or proliferative synovium forms at the insertion of the quadriceps tendon and impinges on the patella. The symptoms include snapping, pain, crepitus, and sometimes secondary patellar instability. This condition occurs almost exclusively in patients with posteriorly stabilized implants. The fibrous nodule may lodge within the intercondylar notch of the femoral component in flexion and catch on the femoral component as the knee proceeds into extension, causing the characteristic symptoms.

When a posteriorly stabilized knee prosthesis is used, the peri-patellar synovium around the quadriceps tendon insertion should be excised (Fig. 7). The prosthesis design may also play a role in the development of patellar clunk syndrome. Newer femoral components have a lower box and a more posterior position of the femoral cam, which minimizes the risk of soft-tissue impingement within the box.

Nonoperative treatment of early patellar clunk syndrome or retro-patellar scarring should include a trial of anti-inflammatory medications. Use of intra-articular corticosteroid injections after total knee arthroplasty is ill advised. In the event that nonoperative measures fail to adequately relieve the patient’s symptoms, arthroscopic debridement or arthrotomy with debridement and excision of hypertrophic tissue is recommended. Arthroscopic debridement is effective; however, care must be taken to avoid scratching the implants. Arthrotomy may be necessary if extremely dense peripatellar adhesions make arthroscopic visualization difficult.

Patellar Component Wear and Loosening

Patellar component wear is common, but loosening of the patellar component is uncommon, reportedly occurring in approximately 1% of cases. Considering the high compressive shear stresses transmitted across the patellofemoral articulation, it is surprising that the incidence of loosening of patellar components is not higher. Risk factors for patellar component loosening or dissociation include deficient bone stock, component malpositioning, patellar maltracking, patellar osteonecrosis, asymmetric bone resection, altered joint line, osteolysis due to reaction to metal debris, failure of bone ingrowth in porous-coated designs, and obesity.

Metal backing was introduced to help dissipate joint contact forces. Unfortunately, metal-backed implants commonly failed because of failure of bone ingrowth, delamination of the polyethylene from the metal backing, and rapid polyethylene wear, with subsequent metal-on-metal contact and generation of metallic debris.

Fig. 7  A, Arthroscopic view shows hypertrophic synovium on the posterior aspect of the quadriceps tendon, impinging within the intercondylar housing of the femoral component beyond 70 degrees of flexion. B, Impingement of the scar was eliminated after arthroscopic excision of the hypertrophic tissue.
Failure of the patellar component may present with a variety of symptoms, ranging from a painless effusion to retropatellar pain, clicking, or instability. Radiographic findings may be subtle, although the outline of a dissociated patellar component may be visualized on a Merchant view, or thinning of the polyethylene may be seen. In cases of failure of a metal-backed component, the metal base plate may be seen articulating with the femoral component, or metallic stippling within the soft tissues (“metallic synovitis”) may be seen.

Failed Patellar Component
Revision of a failed patellar prosthesis can be difficult and must be individualized, depending on the remaining patellar bone stock and the condition of the articulating femoral component. If the native patellar bone stock is insufficient, either patellaplasty or patellectomy should be considered. Resurfacing of an inadequate patella may result in osteonecrosis or fracture. Isolated patellar component revision has yielded mixed results, with high complication rates. Berry and Rand reported good or excellent results in 30 of 36 knees (83%) at follow-up 2 to 8 years after isolated patellar component revision. Nonetheless, complications were observed in 14 of 36 knees (39%). Failure of a metal-backed patellar component may result in burnishing or scoring of the femoral component, necessitating its revision as well. Thorough joint debridement to remove the metal-stained synovium and inspection of the implant-bone interfaces are necessary to ensure that significant osteolysis or loosening has not occurred.

Tibiofemoral Flexion Instability

Equal flexion and extension spaces are critical to ensure stability and prevent postoperative subluxation. Tibiofemoral instability in flexion may occur in the immediate postoperative period, or it may have a delayed onset. There are several potential causes of this problem, including excessive recession or delayed incompetence of the posterior cruciate ligament in cruciate-retaining knee implants, excessive resection of the posterior femoral condyles, asymmetry of the flexion space, incompetence of the medial collateral ligament, or overzealous release of soft-tissue restraints. Late polyethylene wear of the tibial insert may create further instability in flexion. Rupture of the extensor mechanism may result in posterior instability.

Tibiofemoral instability occurs as a consequence of late posterior cruciate ligament failure or polyethylene wear, changing to a thicker insert may be adequate to address the problem. In that situation, an insert with sagittally curved topography should be utilized. If significant flexion instability persists, revision to a posterior stabilized implant is recommended.

Wound Complications
Compromised wound healing may increase the risk of infection and subsequent failure. The vascular anatomy of the knee, biomechanical factors, selection of surgical incisions, surgical technique, and