Avoiding the Potential Pitfalls of Minimally Invasive Total Knee Surgery

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The performance of TKA through less than traditional visualization presents a new set of problem areas.

Total knee arthroplasty (TKA) is one of the most beneficial procedures performed by orthopedists today. The pain relief and improvement in quality of life provided by TKA is dramatic in the overwhelming majority of cases.

The long-term results of TKA have also been outstanding. Keating et al reported a 0.18% femoral failure rate and a 0.46% overall failure rate at 17-year follow-up of primary cruciate retaining TKA. Ritter, in a report on the same group of patients, demonstrated no osteolysis in their direct compression molded components.

The overall survivorship in this group of >4000 cruciate retaining primary TKA has been reported to be 98.86% at 15 years. This is echoed by Worland et al and Emerson et al who describe a 97% survivorship at 14 years and 95% survivorship at 11 years, respectively. Similar outstanding longevity has been reported for posterior stabilized TKA when direct compression molded polyethylene is used. In a minimum 5-year follow-up study, we have previously reported no revisions for aseptic loosening in either a posterior stabilized or cruciate retaining design. It is these outstanding results that must not be compromised as we move forward into an era of minimally invasive TKA.

The only way to avoid pitfalls is to know where they lie. Even in TKA via an open or traditional approach, there exist many potential pitfalls. Minimally invasive techniques do not necessarily alter these, but the location of these problem areas may change. This article attempts to define and familiarize the surgeon with the individual problems that may be encountered and group...
them logically so they can be avoided. The performance of TKA through less than traditional visualization presents a new set of problem areas.

**REVIEW**

The background for minimally invasive TKA is in the instrumentation. This concept is supported by Tria in his recent review of minimally invasive TKA. Minimally invasive arthroplasty began with medial unicompartmental knee arthroplasty (UKA) in 1991. Instead of depending on instrumentation, minimally invasive UKA could be performed using a resurfacing design without the use of instrumentation as we know it.

Total knee arthroplasty presents a different set of challenges for minimally invasive surgery than that faced during UKA. Total knee arthroplasty requires instrumentation and ditionally, the entire operation of minimally invasive TKA is a dance of retractor management. The choreography of the dance is learned with experience and performed by the entire surgical team. Pitfalls encountered in minimally invasive TKA are no different than those in open TKA: surgeons are simply more aware of these dangers with an open technique because we frequently can see them coming, and thus steer clear.

**PITFALLS THAT CAN RESULT IN INJURY**

There are three structures in and around the knee that present nearly irreparable catastrophes if injured: popliteal vessels, patellar tendon, and medial collateral ligament (MCL). The major vessels in the popliteal space lie in close proximity to the posterior femoral condyles. Injury to various positions of flexion and extension for the tibial and femoral resections during minimally invasive TKA. They also recommend proximal tibial resection as the first step without dislocation of the tibiofemoral joint. This poses two potential risks to the vital structures. First, a blind resection towards the back of the knee should be performed with the utmost caution. Second, placement of a Hohmann-type retractor blindly behind the posterior cruciate ligament (PCL) can be dangerous and should only be performed by the operating surgeon who has a direct view into the knee (Figure 1). Assistants should never place or replace retractors into the knee during minimally invasive TKA. Distal femoral resection should be performed in at least partial flexion as full extension brings the vital structures even closer to the posterior capsule.

The second structure for which no solid solution exists shouldiatrogenic injury occur is the infrapatellar tendon. In the hands of experienced total joint surgeons, this complication occurs in up to 0.17% of cases. This structure is at risk from two modes of injury, of which the first is traction. Vigorous retraction, especially with a laterally placed retractor, can place an enormous force on the tendon insertion. The surgeon should place each retractor, tension it to the appropriate level necessary for his or her visualization, and then let the assistant take hold. This passing of the retractor is done without a change in the retraction force. The necessary force to retract the patella when it is not inverted is more than needed through an open approach, and repeated examination of the insertion point is vital. Should any tissue be observed to peel from the insertions, the retractor should be replaced and tension reapplied. If the tension remains too great, the surgeon has two options: 1) perform the patellar resection and apply a protective cover to avoid crushing the cancellous bone and 2) extend the exposure, lessening the tension on the extensor mechanism.

During the initial approach, the posterior one-third to onehalf of the fat pad may be excised to allow better visualization of the lateral compartment. The approach can be performed without fat pad excision; how-
ever, this may obscure the visualization of the patellar tendon and more lateral structures. The authors have not found it necessary to remove more fat pad than through the open approach. The entire fat pad does not need to be removed as this provides at least some vascularity to the patella. No long-term negative consequences have been seen with partial fat pad excision.

The tendon insertion is also at risk during patellar preparation. Regardless of the preparation technique, the “nose of the patella” or tendon origin should be exposed and protected. Again, vigorous inversion can place the insertion onto the tubercle at risk. The tendon is also at risk during tibial preparation. Blind saw cuts should be avoided and retractors should always be placed in such a way that errant throws of the saw blade cannot result in patellar tendon injury (Figure 1). The surgeon, under direct visualization, places this retractor. The appropriate location is determined by visualizing where the saw blade will travel and placing the retractor in direct opposition to the saw blade damaging or hitting the tendon.

The third pitfall is medial collateral ligament (MCL) injury that can occur in up to 2.6% of primary TKA. This iatrogenic injury results from either excessive anterior subluxation of the tibia without adequate release (avulsion) or by sharp injury. While favorable reports of repair and postoperative bracing have been published, injury to the MCL is obviously better prevented than treated. Adequate medial release to allow exposure and correctly balance the TKA is necessary to protect this structure during exposure. When release posterior to the midline is not necessary for balance, cautious subluxation is recommended. Injury can also occur during any of the multiple resections that are performed during TKA. Proper retractor placement is again critical to maintaining the continuity of this structure (Figure 1).

**ERRORS IN ALIGNMENT OR ROTATION**

The second category of pitfall is error in alignment. Tibial resection into varus has been shown to be a risk factor for failure in long-term follow-up study. This is likely a result of varus tibial cancellous overload and subsequent loosening of the component. This error in alignment occurs frequently in open TKA and special attention is warranted for tibial resection in minimally invasive techniques as well. Templating the preoperative anteroposterior radiograph with a right angle template will demonstrate the appropriate exit point where the central axis of the tibia lies (Figure 2). This is the point onto which the extramedullary alignment guide should be positioned (Figure 1). The tendency in smaller incisions is to place the tibial cutting jig too far medially on the face of the anterior tibia. When the distal portion of the alignment guide is placed in the center of the ankle, a varus resection and possible over-resection of the posterior lateral aspect of the tibia result. Care should be taken to place the extramedullary guide in the exact location of the center axis of the tibia observed on templating, thus avoiding a varus resection.

External rotation of the femoral component has been shown to be important in patellofemoral tracking.
priate external rotation has been shown to decrease the need for lateral retinacular release and decrease patellofemoral complications. Various anatomic landmarks can be used, and have been described as accurate for determination of the appropriate amount of femoral external rotation. These include the anteroposterior axis (Whiteside’s line), the posterior condylar axis, and the transepicondylar axis (Figure 3). With the reduced exposure of minimally invasive techniques, particularly laterally, the transepicondylar axis can be difficult to accurately identify. Whiteside’s line is easily referenced with the available view of the distal femur and should be referenced along with the posterior condylar axis. Special care should be used and an effort made to use all three landmarks when valgus deformity or a hypoplastic lateral femoral condyle is present on the preoperative radiograph.

Due to the presence of the lateral soft tissue, there is a tendency to place the femoral component in a medial position on the end of the femur. This is easily avoided by beginning with the tibial resection, the distal femoral resection, and then the “four-in-one” cuts in this way, the knee is decompressed and the lateral femoral condyle can be visualized. This aids in sizing of the femoral component as well. If the femoral component is placed too far medially, patellofemoral tracking is affected and a lateral retinacular release may be required unnecessarily. The key is to bring the femoral component to the patella by lateralizing without overhang (Figure 4) and by external rotation.

Tibial component rotation is important to both the patellofemoral kinematics and the femorotibial biomechanics of TKA. With less invasive techniques, there is a tendency to internally rotate the tibial component because of the soft tissue draped across the front of the knee. Since the patella is not everted, the tendon and overlying skin are draped across the front of the knee. This can force the tibial component “lollipop” (sizing guide) into internal rotation. Minimally invasive instruments should allow for appropriate external rotation of these guides. This can be accomplished with a cut-out area designed to curve around the patellar tendon and soft tissue, or with tibial preparation guides that use a modular and removable handle (Figure 5). Once the trial components are placed, tibial rotation relative to the femoral component can be checked as well. In cruciate retaining designs, the insertion of the PCL and the tibial tubercle can be used as anatomic landmarks for tibial rotation. In posterior stabilized designs, the sulcus where the PCL was can be used. Tibial sizing can be an issue as well. This step should be performed towards the end of the procedure when adequate visualization of the postero-lateral corner of the tibia can be achieved. This avoids undersizing and lateral overhang of the implant.

The authors’ current bias is towards performing the patellar preparation as the final step to avoid damaging the soft cancellous bone that is exposed. If adequate subluxation and visualization can be achieved without early resection, the patella can easily be held in the vertical position for preparation later on during the procedure once the knee has been decompresed by the femoral and tibial resections. The sequence of bony resections can vary depending on the patient anatomy and surgeon preference. If the patella is too bulky to allow initial lateral subluxation, it can be resected as the first step. Additionally, the lateral facet may partially be resected to allow easier patellar subluxation.

Once the bony resections have been made and the knee is balanced in the normal fashion, the implants are inserted. For cemented TKA, this poses another pitfall, retained cement. The use of modularity is of great assistance in this regard. The trial tibial polyethylene insert can be removed and the back of the trial baseplate visualized, making removal of cement easier. Care should be taken to remove cement from the supra-patellar pouch as it can be pushed into or under the synovium. The lateral condyle should be cleared of all overhanging cement that could cause irritation of the soft tissues. The posterior recesses behind the condyles should be cleared of all cement that could cause impingement and decreased range of motion. Ad-
ditionally, third-body wear can result from retained cement, and copious pulsatile lavage is used to clear away any debris. The use of high viscosity cement is helpful in preventing extrusion of a more liquid material into the knee. Cement with a distinguishing color can also be beneficial, either from the addition of methylene blue dye or prefabricated colored cement.

CONCLUSION

The potential pitfalls in performing minimally invasive TKA are iatrogenic injury and malposition. Knowing where these pitfalls lie allows the surgeon to avoid falling into them and may prevent devastating complications from occurring. The basis for avoiding the pitfalls is retractor management and operative team choreography.

Every postoperative radiograph should be reviewed stringently for alignment, fixation, and position of implants (Figure 6). This allows the surgeon to make necessary adjustments.

Debate continues as to the best or most efficient surgical approach to use for minimally invasive TKA, and there are advantages and disadvantages to each approach. We use a mini-arthrotomy or abbreviated median parapatellar approach as this is the most familiar, simple, and easily extensible approach with the longest clinical track record for routine TKA.

The same surgical principles to avoid the potential pitfalls in minimally invasive TKA apply for the subvastus, midvastus, and medial quadriceps-sparing approaches.

REFERENCES


