Minimally Invasive Total Knee Arthroplasty: Past, Present, and Future

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Abstract

Choices for a limited approach to total knee arthroplasty (TKA) now include the mini-arthrotomy, the mini-midvastus, the subvastus, and the quadriceps-sparing technique. These newer approaches suggest use of modified instruments at least smaller in overall size; call for early ambulation and range of motion with modified pain management protocols; demonstrate improved early recovery of the knee; and lead to less visualization and can contribute to an increase in outliers. Use of navigation for TKA remains controversial. Prophylaxis against deep venous thrombosis is necessary and is used at the discretion of the operating surgeon. Complications are sometimes higher with these approaches, and patient preference and choice of surgical technique are extremely important. Minimally invasive surgery approaches are still evolving for TKA, and long-term results are not available. These techniques are certainly not for all patients or all surgeons, and the indications are still being developed.

Standard total knee arthroplasty (TKA) has been evolving since it was introduced in 1974.[1,2] The techniques of balancing ligaments, equalizing flexion-extension gaps, and adjusting overall alignment have been perfected so that now the long-term results are very satisfactory, and follow-up studies are approaching 20 years.[3-8] Minimally invasive surgery (MIS) for knee arthroplasty began in the mid-1990s. Repicci's work with unicondylar knee replacement spurred further interest in both the limited surgical approach and in partial knee arthroplasty.[9,10] The logical extension of his work was to apply MIS principles to TKA. Some investigators implanted knee replacements using limited surgical approaches over the past 20 years, but no techniques survived the test of time or replaced the standard procedure. With the establishment of MIS techniques for unicondylar surgery, it became easier to develop approaches for TKA.

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Surgical Approaches

The choices for a limited approach to TKA now include the mini-arthrotomy,[11] the mini-midvastus,[12] the subvastus,[13,14] and the quadriceps-sparing technique.[15-17] All these newer approaches suggest use of modified instruments at least smaller in overall size.[18] Instrument modifications have generated some controversy and introduce new variables into the surgical procedure. During adoption of the instruments, there is a learning curve that can lead to a compromise in clinical results.[19,20]

The mini-arthrotomy approach is a modification of the original standard approach with a limited, 3- to 4-cm incision into the quadriceps tendon.[11] This approach can lead to less bleeding but does not change the immediate postoperative recovery. Most instruments for this technique are of a standard design, only decreased in overall size. Adopting this approach is not difficult, and the approach appears not to affect alignment of the prosthesis. Long-term results should not be significantly different with this technique.

The mini-midvastus approach is probably the most popular limited approach to TKA because it is not difficult to perform, and it favors a smaller incision. Results reported in the literature support good alignment and improved early recovery.[12] The instruments are not radically different, and most surgeons are familiar with them.

The subvastus approach was described in the early 1990s and modified over the past 2 to 3 years to accommodate a smaller incision.[13,14] This approach does not incise the quadriceps tendon or the vastus medialis muscle and does not divide the insertion of the vastus medialis into the medial aspect of the patella. The subvastus approach truly spares the quadriceps mechanism; however, it is more difficult to perform than the mini-midvastus approach and can lead to an occasional hematoma of the thigh if the release of the vastus medialis is extended too far proximally.

The quadriceps -sparing technique (limited medial approach) was developed during the period from 2001 to 2002 as a modification of the MIS unicondylar approach that had been popularized by Repicci.[9] It initially required instrument

modifications to accommodate the limited incision and was a more difficult technique to adopt. Published results show better early recovery, but prosthesis alignment is more difficult, and there are more outliers with this technique.[16] Recent advances have included a return to more standard instruments, better techniques for surgical exposure, and the addition of navigational referencing.

Limited Medial Approach

The limited medial approach uses a curvilinear medial incision from the superior pole of the patella to the tibial joint line. The capsule is opened parallel to the skin incision. The knee is placed in extension, and the posterior surface of the patella is removed either with a guide or a free hand. The patella is turned to a 90° angle but cannot be everted at this point.

A modified intramedullary instrument is used to cut the anterior and distal femur, and a standard cutting block is used to complete the femoral finishing. The extramedullary tibial guide that fits into the limited incision allows standard resection of the proximal tibia.

The flexion and extension gaps are then balanced, and the tibial and patellar surfaces are finished. The trial components are inserted, and knee range of motion and balance are confirmed. Modified MIS components are helpful because of the decreased size, but they are not required to complete the operation. The components are cemented sequentially, and the wound is closed in the standard manner.

Navigational Support

Use of navigation for TKA remains controversial. Many articles indicate that accuracy increases with use of computer support.[21,22] However, navigation increases expense; it requires more operating-room time, and there is a learning curve with its use. Line-of-sight technology appears to be the most accurate. The percutaneous pins used for the arrays often interfere with the exposure and can lead to fracture of the bone or infection. New plates have been designed (Smith & Nephew, Memphis, Tenn) that can be attached to the medial femur and the medial tibia within the surgical field to eliminate the percutaneous pins while permitting line-of-sight technology.

Postoperative Management

All of these techniques call for early ambulation and range of motion with modified pain management protocols. Prophylaxis against deep venous thrombosis is necessary and is used at the discretion of the operating surgeon. The author presently uses an enoxaparin protocol with Doppler ultrasound surveillance; however, this may be changed on the basis of the American Academy of Orthopaedic Surgeons (AAOS) guidelines introduced in May 2007.

Results

All of these techniques demonstrate improved early recovery of the knee. Complications are sometimes higher with these approaches, and patient preference and choice of surgical technique are extremely important. Limited approaches lead to less visualization and can contribute to an increase in outliers.

Conclusion

The MIS approaches are still evolving for TKA, and long-term results are not available. These techniques are certainly not for all patients or all surgeons, and the indications are still being developed.

Author's Disclosure Statement

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