Minimally Invasive Approaches to the Knee

Minimally Invasive Total Knee Arthroplasty – Midvastus Approach

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Introduction

Despite the intra-operative trauma inflicted to the knee joint, patients receiving traditional total knee arthroplasty (TKA) have demonstrated long-term success with regard to mobility and return to some activity – walking and stairs [2, 4, 8, 9, 14, 16, 17]. In addition to a large surgical incision of 8–12 inches, TKA also results in joint dislocation, patella eversion, quadriceps mechanism disturbance, tibiofemoral capsular dislocation, as well as extensive soft tissue disruption. Patient demand for a less invasive surgical approach reducing the trauma induced to the joint has resulted in the development of minimally invasive surgery (MIS).

Unfortunately, the clinical definition and criteria for MIS have not been firmly established. Various parameters can be used to define MIS, including length of incision, location of incisions, muscle-sparing approaches, reduced in-patient hospital stay, and rapid muscle recovery. However, the most definitive characteristics of MIS, which include reduced soft-tissue trauma and enhanced post-operative functional recovery, are often overlooked. Recent studies conducted with the MIS approach indicated that a VMO snip, a variation of the midvastus approach, may be the most universal MIS approach to TKA as it allows for adequate exposure of the joint cavity and improved post-operative recovery and pain relief [1–3, 13].

TKA performed through a reduced incision and with limited exposure is more difficult than the standard surgical approach to TKA. A successful MIS knee replacement requires that the surgeon possess a thorough comprehension and comfort level with the implants, instrumentation, and surgical techniques employed in this procedure. A graduated “evolutionary” approach, with regard to reducing the length of the incision, should be performed once the surgeon becomes comfortable with the MIS specific instrumentation. The objective of the paper is to provide an overview of various MIS TKA approaches and to describe the current approach utilized by the author with preliminary results.

Alternate MIS TKA Approaches

Several approaches have been described for MIS TKA. Vaughan et al. described the mini-TKA as a reduced incision with a standard median parapatellar approach with patellar eversion [19]. They performed this procedure in a group of selected patients with good pre-operative range of motion (ROM), and weight of less than 250 lbs. Post-surgical results observed in his patients identified a reduction in the number of post-surgical in-patient hospital days.

Tria performed a “quad sparing approach” (i.e. the subvastus approach) on a group of selected patients with good pre-operative ROM, low BMI, and minimal joint deformity [18]. Patients were discharged from the hospital at 2 days, however, they were required to spend an additional 5 days in an acute rehabilitation facility for in-patient therapy prior to final discharge.

Data collected from a study conducted by Scheibel et al., demonstrated that the subvastus approach in TKA increased a patient’s risk of injury to musculoarticular branch of the femoral artery, and the saphenous nerve [15]. Scheibel et al. also found that further mobilization of the surrounding tissues increased the risk of damage to the femoral artery and vein in patients when the subvastus approach was used.

In contrast to these MIS TKA approaches, a VMO snip is an excellent alternative and may serve as a uni-
versal approach to MIS TKA. This new approach, which does not evert the patella, allows for adequate exposure of the joint and improved post-operative recovery and pain relief. Trauma to the quadriceps muscle is reduced as only VMO is split along its fibers during this procedure. MIS-specific instruments were utilized to facilitate joint-cavity exposure.

Five articles have been published on midvastus with everted patella [6, 7, 11, 20, 21], albeit not solely for MIS techniques. Results from studies conducted by Maestro, White, Dalury, and Engh indicated that patients who received the VMO split had less post-operative pain, a faster return of the quadriceps mechanism, improved ROM, and reduced rate of lateral release. However, Keating reported on data, which detected no significant differences between a modified median parapatellar and midvastus approaches in his TKA patients [10]. Keating did not violate the quad tendon with his modified parapatellar approach explaining the similarity of results [10]. Cooper found that VMO muscle can be split up to 8.8 cm safely [5].

The Bonutti MIS TKA Surgical Technique

The MIS TKA surgical procedure requires cooperation between the patient, anesthesiologist, surgeon, and surgical assistants. An experienced surgical team is recommended as the MIS procedure produces challenging conditions, such as reduced visualization and increased operating-room time, for the surgeon.

To begin, the patient should be positioned either supine or with a suspended leg technique [1]. The suspended leg technique is similar to arthroscopic procedures and may have several distinct advantages including posterior joint and ligament balancing. Appropriate anesthesia should be administered to the patient to ensure optimal muscle relaxations. A spinal epidural or epidural was utilized in almost all of our patients.

Once the patient is properly positioned, place the affected leg in flexion and demarcate the tibial tubercle and patella. An adjustable leg holder to vary flexion and extension is recommended. A skin incision should be made slightly medial to the patella (approximately 1–2 cm), and proximal to the tibial tubercle. The length of the incision may be extended during the procedure as needed (Fig. 9.1).

After an incision is made, the knee should be placed in 70–90° of flexion to allow full exposure of the VMO fibers and capsule. A complete medial arthrotomy to the knee should be performed. A sharp VMO split of 1.5–2 cm is performed along the muscle fibers. Blunt dissection can split the VMO further – up to 8.8 cm safely [5] (Fig. 9.2).

A Hohmann retractor should be placed underneath the patella with the leg in full extension. Inferior capsular releases should be performed to remove a portion of the fat pad and additional attachments to the anterolateral tibia. Following this release, a proximal capsular release, underneath the quadriceps mechanism, should be done to release a portion of the proximal capsule. This combination of proximal and distal releases should mobilize the patella and allow it to slide laterally over the lateral condyle to expose the anterior femur and tibia (Fig. 9.3).

The knee should be placed into flexion again between 60° and 90° of flexion to avoid additional stress to the quadriceps mechanisms that result from evert ing the patella. Retracting the patella laterally should reduce the degree of stress to the entire quadriceps mechanism.

Tibial releases should be performed, followed by a tibial osteotomy using an extramedullary system and a downsized cutting jig (Fig. 9.4). The tibia should be cut from anteromedial to posterolateral in situ, without dislocating the tibiofemoral joint. The proximal tibial cut should be removed in a piecemeal fashion to expose the PCL. At this point, the PCL should either be maintained or resected.

It is the author’s preference to use anterior referencing instruments. However, posterior referencing guides...
could be used as well. The quadriceps is elevated to expose the anterior femur (Fig. 9.5). Because the establishment of rotational alignment of the femur in MIS TKA can be difficult, the following guides are recommended to attain appropriate rotational alignment:

1. custom L-shaped guide (position on medial epicondyle and intercondylar notch – indirectly pointing to the lateral epicondyle);
2. intercondylar axis;
3. tibial cut at 90° flexion;
4. posterior condyles;
5. anterior femur.

These rotational landmarks can be utilized to set appropriate rotation once the correct cuts have been made. The rotational orientation can then be evaluated against the “Grand Piano Sign” to ensure that the anterior femoral resection removes more anterolateral than anteromedial and does not notch the femur.

After completing the anterior cut to establish the rotational plane the distal femoral cut is made with intramedullary reference guide. The distal femoral cut should be made in approximately 50–70° of flexion to allow the quadriceps muscles to relax (Fig. 9.6) After sizing the medial condyle the femoral cuts are complet-
Part III - The Knee

Fig. 9.6. Exposure of anterior femur after distal and anterior femoral cuts

Fig. 9.8. Patella exposure and osteotomy in full extension

Fig. 9.7. Down-sized femoral 4-in-1 cutting block

Fig. 9.9. Distraction of an extremity in full extension to expose anterolateral tibia and femur

The patellar osteotomy can be done earlier should the surgeon experience difficulty positioning the femoral cutting block. With our approach, the surgeon has the option of resurfaced or unresurfaced patella. The patella osteotomy is done in full extension without everting it (Fig. 9.8).

Evaluation of the bone cuts, osteophytes, and loose bodies should be performed, both visually and manually through finger manipulations, when placing the leg through a range of motion. Additional evaluations should be executed by distracting the leg in full extension to allow better visualization and access to the lateral tibia and femur. Distracting the joint in full extension will allow not only the removal of laterally based osteophytes but also the surgeon to examine the lateral femur and tibia for complete tibial and femoral osteotomies (Fig. 9.9).

Before the prosthesis is implanted into the joint cavity, trialing and ligament balancing should be performed in flexion and extension. Implanting a cemented MIS TKA may be challenging. Appropriate cement techniques with direct anterior exposure, variable degrees of knee flexion allow enhanced visualization of
Chapter 9.1 - Minimally Invasive Total Knee Arthroplasty – Midvastus Approach

Fig. 9.10. Incision after all components cemented in position

the joint space and adequate cement pressurization, both in the tibia and femur. The tibial keel may also prove difficult to implant and caution should be exercised to avoid injuring the lateral femoral condyle. Impaction of the femoral component will require increased flexion and retraction of the patella laterally. Proper cement removal especially when excising lateral cement prior to implanting the patella is essential and deserves particular attention and detail. The “Scorpio” TKA is implanted (Fig. 9.10, note incision size). ROM and stability are evaluated and the wound is closed in flexion, one stitch in the VMO.

Post-operatively, patients start rehabilitation in the recovery room with a CPM to 100° of flexion. Physical therapy is initiated two times a day, with weight-bearing as tolerated on the first day post-operation.

Our research demonstrated that straight leg raises occurred in majority of patients by the first post-operative day. Patients were discharged from the hospital, on average, in 3 days post-operatively with 95° of flexion, independent transferring, and the ability to climb stairs [2]. Functional recovery appeared to be significantly more rapid. Over 75% of patients were ambulating with the occasional use of a cane 2 weeks post-operatively and almost all patients with unilateral TKA were ambulating independently 4 weeks post-operatively. In addition, most patients were able to perform an unassisted chair rise test by 4 weeks post-operatively. Other studies have not demonstrated similar successful results, with only 64% of patients capable of rising from a chair unassisted at 3 months [12]. Higher demand functional activities such as kneeling, squatting and quadriceps strength are currently under evaluation. MIS TKA patients with a minimum 2-year follow-up also scored an average Knee Society Score of 96 [3]. Case reports with patients undergoing standard TKA on one knee and MIS TKA on the opposite knee show recovery 2 months faster on MIS group.

Pitfalls and Complications

Clearly, MIS TKA is a more challenging procedure than the standard TKA. There is an increase in operating-room time with a greater risk for complications. Complications may be reduced with early radiographic reviews performed by an objective independent reviewer. Some general surgical risks to avoid include:

- excessive traction to the skin with skin breakdown;
- quadriceps trauma (stretching against the quadriceps mechanism which can cause intrinsic damage to the muscle or shredding of the muscle);
- inappropriate bone/osteophyte/cement removal due to decreased visualization;
- femoral malrotation;
- injury to the patella due to excess retraction;
- difficult tibial keel implantation (risk of damaging the lateral femoral condyle);
- flexion of the femoral component; and
- inadequate cement pressurization and implantation.

Re-operations in our first 500 MIS TKA included: 10 manipulations, 10 arthroscopies, and 8 open re-operations including 1 traumatic PCL, 2 infection/sepsis post colonoscopy, 1 patellar instability, 1 traumatic quad tear, 2 poly-exchange, 2 tibial component revisions. The number
Fig. 9.11. Immediate post-operative AP and lateral X-ray with arrows denoting staple line – incision length

Conclusions

MIS TKA continues to evolve and be redefined. After 500 consecutive TKAs, the non-patellar everting, muscle splitting VMO snip with downsized soft-tissue instruments, and in situ bone cuts may be performed on all patients regardless of age, weight, and joint deformities. An evolutionary and cautionary approach of gradually downsizing the incision should be taken to reduce the risk of trauma to the knee joint and surrounding muscles. Moreover, careful attention to detail during surgery and analysis of post-operative techniques and X-rays is imperative to successful patient outcomes. A MIS TKA with as little as a 2-inch (5.5 cm) incision – 9.1 cm average – can be performed (Fig. 9.11). The VMO muscle splitting technique appears to be universally accepted as a safe and effective approach to MIS TKA. Our progressive technique to TKA has been described at the (OCNA) Orthopedic Clinics of North America 2004 conference and presented with 2 year minimum follow-up [3] in addition to a Suspended Leg Technique Manual [1]. The suspended leg technique is similar to arthroscopic procedures and may have several distinct advantages including posterior joint and ligament balancing. Study results of up to 4-year follow-ups, suggest the MIS TKA technique merits further evaluation to confirm that the midvastus approach (VMO snip – non everted patella, in situ cuts, and downsized instruments) is a universal technique for MIS [3].

References