Tips and tricks in total knee arthroplasty

Bhavuk Garg*, Gaurav Sharma**, Rajesh Malhotra***

*Assistant Professor, **Senior Resident, ***Professor
Department of Orthopaedics
AIIMS, New Delhi

INTRODUCTION

TKA is one of the most successful orthopaedic procedures considering its longevity and ability to relieve pain. However despite substantial advances in primary TKA patient selection, surgical technique, and implant design, numerous studies indicate only 82% to 89% of patients are satisfied with their primary total knee arthroplasty1-4. Attention to technique is therefore of utmost importance in achieving good results following total knee arthroplasty.

The authors have attempted to present a step by step account of total knee arthroplasty and review common problems and certain tricks which could help improve outcomes.

Incision

Classically an anterior longitudinal midline incision is used for TKA. This incision may sacrifice the infrapatellar branch of the saphenous nerve, causing an area of lateral numbness; the patient should be warned about this possibility before the surgery5.

The incision is made with the knee in 90 degrees of flexion. Flexion tenses the skin and retracts the skin margins as the incision is made.

Arthroscopy can be performed by the medial parapatellar approach, the midvastus approach or the subvastus approach. The medial parapatellar approach provides excellent exposure and is associated with a very low incidence of tibial or femoral complications. Caution: Avoid subvastus or midvastus approach in obese patients, previously operated, patella baja and extensive revision.

Previous skin incisions

Patients with multiple scars around the knee can present an operative dilemma, as the surgeon must choose the approach of least risk. A pre-existing transverse incision should be crossed as close to perpendicular as possible. When multiple parallel longitudinal incisions exist, the general rule is to use the most lateral incision possible, as the medial blood supply to the skin covering the anterior knee predominates over the lateral. It is best to provide at least a 7-cm skin bridge between incisions to avoid tram tracks6-7.

Tip: If in doubt, use "Sham incision technique" wherein an incision is given, flaps raised and sutured back without implanting components. If no necrosis of skin edges occurs, knee arthroplasty can be performed through the same incision 4 to 6 weeks later.

Tip: Skin expanders can be used in the presence of tight adherent skin and subcutaneous tissues.

EXPOSURE

With sharp dissection or cautery, a subperiosteal layer that includes the deep medial collateral ligament (MCL) is raised carefully from the medial tibial flare to the sagittal midline of the tibia. The dissection must not be extended more than 2 to 3 cm distal to the medial joint line8. Caution: In short obese patients special caution should be exercised to avoid inadvertent over release and incompetence of MCL.

Caution:

Avoid injury to MCL

Tip: While excising medial meniscus, leave a 1mm rim of meniscus attached to MCL to avoid injury to latter. Be very careful while excising posterior horn of medial meniscus to avoid MCL injury.

Tip: While developing proximal medial tibial sleeve, keep the scalpel tangential to tibial bone to avoid injury to MCL.

Tip: Excising a part of fat pad can improve exposure of upper tibia (Fig 1).
Difficulty in evert ing the patella:
To permit full eversion of the patella, the capsular folds of the suprapatellar pouch proximal to the patella are released. If the patella does not evert, the incision in the proximal quadriceps is examined to see whether it has been opened proximally enough. Division of the lateral patellofemoral ligament makes it easier to evert the patella. Release of a portion of the medial portion of the patellar tendon may help. Additional tips include lateral gutter debridement and lateral release and/or performing medial exposure before patellar eversion. If it is still not possible or in case of a stiff knee, a quadriceps snip should be performed (Fig. 2).

Caution:
Beware of patellar tendon avulsion during difficult patellar eversion.

Tip: A smooth pin inserted in patellar tendon attachment can prevent patellar tendon avulsion. Make sure to keep the pin out of the way of tibial preparation.

Completing the exposure:
The ACL is excised, allowing further anterior translation of the tibia. When combined with external rotation as the knee is flexed, complete anterior subluxation of the tibia from beneath the femur can be accomplished. With the tibia completely subluxed anteriorly, the medial and lateral menisci are excised and the PCL exposed.

An anterior synovectomy is performed to expose the supracondylar region of the femur. This is important to allow for proper and precise sizing of the femoral implant and to prevent notching.

Tip: Suprapatellar pouch should not be violated as far as possible.

BONE CUTS TO THE PERFECT TOTAL KNEE

Tibial cut:
Controversy remains in the orthopedic community as to whether the intramedullary or extramedullary tibial alignment guide is more accurate in executing the tibial cut. A study of British orthopaedic surgeons found that 75.6% prefer extramedullary and 20.3% prefer intramedullary jigs when determining tibial alignment with the remainder using both or neither.

The published literature is divided as to which jig is superior. Rottman et al9 found no difference in alignment between intra- and extramedullary alignment in TKA in a retrospective series of 55 patients. Reed et al10 performed a randomized prospective trial, which showed that intramedullary guides were superior to extramedullary guides in determining coronal alignment of the tibial component.

The extramedullary guide is more adaptable in tibial deformities such as bowing or previous fractures, but can often be less effective in patients with excessive soft tissue as in obesity. Another consideration is that the external tibial
alignment guide may suffer with respect to locating the true center of the ankle joint. The center of the talus is located slightly medial to the midpoint between the medial and lateral malleoli (usually 3 mm), and this needs to be taken into account when using external alignment guides\(^1\).

Intramedullary tibial alignment devices also have some potential disadvantages that the surgeon must account for. The hole created may compromise the entry point of a press-fit central system, and it must be plugged if the central stem is cemented. There is also the risk of fat embolization especially if intramedullary devices are used on both the femur and tibia\(^1\). Our approach is to use extramedullary jig but in cases where tibial stem extension is required, we use intramedullary jig as the seating of tibial component on the prepared tibial surface is more accurate in those cases.

Rotation of the tibial cut is critical as inappropriate rotation can lead to more posteromedial or posterolateral bone resection. Excessive internal rotation is one of the most common errors of tibial component position and leads to patellar maltracking. Also, once a sloped cut is made, further changes to component rotation add varus or valgus to the overall alignment. To avoid this error, the jig should be centered on the medial third of the tibial tuberosity.

Finally, when the tibial base plate is seated and is seen from above, the posteromedial tibia should be uncovered while the posterolateral tibia should be completely covered (Fig. 3)\(^1\). This is because the medial tibial plateau is anatomically longer than the lateral, so a symmetrical baseplate cannot cover both equally.

Ten mm of cartilage and bone is removed from the least involved plateau. The bone resected should have approximately the same thickness as the final tibial component, including the metal base plate and polyethylene liner.

Tip: A preoperative planned resection (Fig. 4) on X-ray can provide a clue to ratio of medial and lateral tibial plateau resection, which can be confirmed intraoperatively.

Fig 4. Preoperative planning of the tibial cut can provide a clue to the ratio of medial and lateral tibial resection

Tip: In case of posterior cruciate retaining TKA, a 10 mm osteotome may be wedged in tibia anterior to PCL to prevent saw blade driving into PCL and causing injury.

**Sizing tibial component:**

The size of tibial component is determined by anteroposterior dimensions of the lateral tibial plateau.

Tip: Lateralization of tibial component improves patellar tracking and combined with downsizing the tibial component may address medial tibial bone defect/ help release MCL by excising overhanging medial bone.

**Caution:**

Avoid posterolateral tibial component overhang to prevent impingement on popliteus.

**Distal femur cut:**

Starting point for femoral IM rod insertion is made 1 cm anterior to the origin of the PCL, slightly medial to the midpoint of the intercondylar notch\(^3\).
Tip: Start at junction of patellofemoral and tibiofemoral joints in line with lateral border of medial femoral condyle. A starting point that is too medial or too lateral will increase valgus and varus angulation respectively. Similarly, incorrect rod placement can lead to flexion or extension of femoral component.

It is important not to push the intramedullary guide too far in, as the femoral bow will add some extension to the distal cutting block and may lead to notching and fracture.

Tip: Over drilling the entry hole, irrigation and suction of femoral canal before rod insertion can reduce the risk of fat embolism.

We routinely measure the degree of valgus cut on pre-operative scanograms and accordingly adjust the cutting block at 5, 6 or 7 degrees. This cut should never exceed 7 degrees, otherwise the Q angle will increase leading to patellar subluxation. The thickness of distal femoral cut matches the distal thickness of prosthetic femoral component. The depth of the distal femoral cut (with the tubial cut) sets the extension gap.

Tip: A correct thickness of distal femoral cut just skims the roof of intercondylar notch.

**Femoral sizing:**

Femoral sizing in total knee replacement is important. Undersizing introduces the risk of anterior notching and oversizing can cause overstuffing of the flexion gap or patellofemoral joint depending on the position in the sagittal plane. When posterior referencing is used and the size of the femoral component is in between two sizes, the smaller size should be selected because mild notching is more palatable than overstuffing the patellofemoral joint.

Tip: Look for jigs with provision for anteriorizing (Anti-notch feature) the anterior femoral cut.

Ng et al.\(^2\) carried out a study on the precision and accuracy of femoral sizing and the effect of measurement at different landmarks over the distal femur. They found that regardless of the experience of the surgeons, measurement of the femoral size using the anterior referencing tools is very accurate. Placing the stylus of the femoral sizer at the middle and 2 cm above the proximal margin of the anterior femoral condyle best reflects the actual size of the femur (Fig. 5).

Setting the rotation of the femoral component can be done by using the Whiteside's line, Transepicondylar axis or 3° external rotation to posterior condylar axis.

Tip: Closely watch the anterolateral femoral cortex. Excessive external rotation or a smaller femoral component may notch.

**Anterior and posterior femoral cuts:**

The AP sizing guide is used to set 3 degrees of external rotation of the femoral component in relation to the posterior condylar axis. External rotation means counterclockwise rotation for the right knee and clockwise rotation for the left knee. Adjust the stylus that indicates where the anterior cut exits the femur. Pass the anterior cut tangential to the anterior femoral cortex to avoid notching.

Tip: A perfect anterior cut will show "Grand Piano sign". During posterior sawing, the knee should be maximally flexed to reduce chances of injury to the posterior neurovascular bundle. A common error is to injure the posterior cruciate ligament (PCL) or the medial collateral ligament (MCL), so a narrow saw blade may be used for this cut. The assistant's medial retractor should be raised up parallel to the saw-cut to protect the MCL (Fig. 6).

Tip: Some jigs provide saw capture, which does not allow blade to wander out of jag and prevents ligament injury (Fig. 6).

**Anterior and posterior chamfer cuts:**

These are essential for the prosthesis to fit over the distal femur and are usually made through the same cutting block as the anterior and posterior femoral cuts.

**Patellar cut:**

A caliper is used to assess the patellar thickness before the cut and after the patella is resurfaced to ensure that the patellar...
thickness is equal to the original thickness and that at least 12mm of bone stock remains. Decreasing the overall thickness of the patella can result in extensor mechanism weakness. Underresection can lead to overstuffing of the patellofemoral joint.

**Tip:** A perfect patellar cut is usually flush with the lateral patellar facet and attachments of quadriceps and patellar tendons.

A distal placement of the patellar button can lead to impingement on the tibial insert, and a lateral placement makes tracking difficult. The button should therefore be placed medial and superior.

**Intercondylar Box Cut**

**Tip:** Mark the centre on junction of anterior and distal cuts. Avoid too much lateralization or any medialization.

**Balancing flexion and extension spaces: (Table 1)**

**Varus knee**

**Trial reduction:**

Trial reduction is an integral part of the procedure. It is the last step that is done before the components are implanted and the knee is closed. Perhaps because it is the last step, it gets less attention than it deserves. It is important to realize what the trial reduction really represents: the last chance to get it right.

The femoral component is placed onto the distal femur and fitted securely, without any toggle. Next, a tibial sizing tray that matches the surface area of the tibial cut is inserted with a spacer of the proper height and the joint reduced.

By applying varus and valgus stresses, one can determine the stability of the knee and the appropriate thickness of the tibial insert.

Patellar stability is then checked. Two commonly described techniques are used to assess intraoperative patellar tracking during TKA are the "no thumb test" and "towel clip test". The no thumbs test is performed by reducing the patella and taking the knee through the full flexion arc without applying any medial force with the thumb to keep the patella in position. Extensor mechanism balance has been achieved if the patella does not tilt, subluxate or dislocate during flexion.

**Tip:** Always check patellar tracking without tourniquet.

The towel clip test is done by re-approximating the vastus medialis and medial retinaculum to the medial border of the patella using a towel clip or a stitch. The knee is again taken through a range of motion. Any elevation of the medial edge of the patella is considered a positive test. Doing this eliminates slight tilting or subluxation that occurs with the no thumbs test and avoids an unnecessary lateral release.

**Component fixation:**

The gold standard in fixation of total knee arthroplasty is with the use of polymethylmethacrylate. Drilling of the tibial plateau in the sclerotic parts with a 2.5mm drill bit is useful to allow cement penetration. The application of a tourniquet minimizes the bleeding from bone, which improves fixation. Pulsed lavage enhances penetration better than manual flushing alone, as this provides more effective debridement.

**Tip:** Use cement early when bone sclerotic, late when bone is osteoporotic.

Knee is extended after cementing the implants and inserting trial liner. However, the knee should not be hyperextended in an attempt to pressurize the cement further as this could tilt the tibial component.

Vanlommel et al. compared five different cementing techniques for the tibia in an anatomical open pore sawbone model (n = 25), using a contemporary total knee arthroplasty design and standard polymethylmethacrylate cement. They
demonstrated that applying cement to both the undersurface of the tibial baseplate and as well as onto the tibial bone, either by a spatula or fingerpacking technique, leads to an optimal cement penetration of 3 to 5 mm. When cement is applied only onto the tibial component, penetration is insufficient. When a cement gun is used, cement penetration is too excessive.

Vaninbroux et al.\(^2\) compared four cementing techniques for the femoral component in an anatomical open pore sawbone model (n=20), in order to investigate the influence of cementation technique on overall cement penetration as well as length of the cement mantle over the different cuts. The technique, which included cement application onto the anterior and distal bone surfaces, as well as the posterior flanges of the prosthesis, was statistically superior to the other techniques. They therefore advocate this technique as the standard for cementing the femoral component.

**Closure:**

Traditionally, the surgical wound closure following a TKA has been performed with the knee in full extension. However, some authors have suggested that closure of the knee in flexion may be advantageous. Smith et al.\(^2\) in a systematic review found that when TKA wounds are closed in flexion, flexion range of motion might be greater and domiciliary physiotherapy requirements less, when compared to wounds closed in full extension. According to these authors, there does not presently appear to be a difference in functional outcome, length of hospital stay, pain scores or post-operative complications between TKA wounds closed in these two different positions.

Recently, a bi-directional, barbed suture (Quill SRS; Angiotech, Vancouver, British Columbia, Canada) has been introduced that affords surgeons the ability to close soft tissue layers in a running fashion without the need for knot tying (Fig. 7). The bi-directional nature of the barbs allows for simultaneous closure from the wound center, therefore offsetting the increased cost per suture by the decreased number of sutures used and the time saved in the operating room to close the incision.\(^22\)-\(^25\)

We routinely use the barbed suture for closure, and close the knee in flexion after deflating the tourniquet.

**Injection:**

We prefer to inject periarticular tissues with local anesthesia for better postoperative pain relief. This has been shown to reduce the requirements for postoperative analgesia and improve patient satisfaction with no apparent risks following TKA in randomized controlled trials\(^26\),\(^27\).

**Drain:**

We routinely use a closed suction drain in TKA. Be careful not to fix the drain from within the wound while closing the wound.

<table>
<thead>
<tr>
<th>Extension space</th>
<th>Flexion space</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tight</td>
<td>Tight</td>
<td>Resect more proximal tibia</td>
</tr>
<tr>
<td>Tight</td>
<td>Loose</td>
<td>Resect more distal femur, and, Larger femoral component with thinner poly</td>
</tr>
<tr>
<td>Loose</td>
<td>Loose</td>
<td>Thicker poly</td>
</tr>
<tr>
<td>Loose</td>
<td>Tight</td>
<td>Downsize femoral component with thicker poly</td>
</tr>
<tr>
<td>Loose</td>
<td>Just right</td>
<td>Augment distal femur, or, Smaller femur with thicker poly</td>
</tr>
<tr>
<td>Just right</td>
<td>Loose</td>
<td>More distal femoral resection with thicker poly, or, Larger femoral components with posterior augments</td>
</tr>
<tr>
<td>Just right</td>
<td>Tight</td>
<td>Downsize femoral component</td>
</tr>
</tbody>
</table>

(Fig. 7).
The drain is removed after 24 hours. When the drain is removed, meticulously examine the end from within the joint to ensure that it is not broken through one of the holes thereby leaving a part inside.

**POST OPERATIVE CARE**

We use above knee TED stockings after knee replacement surgeries to prevent venous stasis.

**DVT Prophylaxis:**

Thromboprophylaxis is initiated in the form of low molecular weight Heparin that is given 12 hours after surgery and continued until the patient begins to mobilize.

The patient is encouraged to start early range of motion exercises on day 1 and is made to stand with support on day 2 and encouraged to walk with walking frame. A physical therapist assists the patient with knee flexion exercises and straight leg raises.

Patients are usually discharged 5 to 7 days after surgery. The walking frame can be discontinued after two to four weeks after which the patient gains independence in activities of daily living as tolerated.

**REFERENCES**

5. Operative techniques in Orthopaedic Surgery Sam W. Wiesel (publisher) Lippincott Williams & Wilkins 1st Edition (2011)
11. Brooks P. Seven cuts to the perfect total knee. Orthopedics. 2009 Sep;32(9).