Minimally Invasive Unicondylar Knee Arhtroplasty: the Surgical Technique

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ABSTRACT

The unicondylar knee arthroplasty (UKA) has first introduced in the early 1970s with a wide range of reported clinical results from high failure rate to excellent outcome. This controversial results have caused many orthopaedic surgeons a reluctant to perform this procedure for nearly 30 years. Since the first time UKA was introduced, the surgical approach for this procedure has been a standard medial or lateral parapatella approach. Regarding some of its advantages over total knee arthroplasty, a rebirth of UKA was originated with a modified surgical technique. This new procedure, minimally invasive unicondylar knee arthroplasty (MIUKA), provides minimal damage to the extensor mechanism of the knee. With a small incision approach, the patella is not dislocated and the suprapatellar synovial pouch remains intact. This procedure facilitates better patient's clinical results than the convention one in term of postoperative pain, range of motion, ambulation, hospital stay and rehabilitation. Indications and contraindications for surgery are described as well as the principle of surgery for MIUKA. The surgical technique is discussed in detail.

INTRODUCTION

The unicondylar knee arthroplasty (UKA) is a surgical procedure that resurfaces the medial or lateral compartment of the tibiofemoral joint. This procedure is sometimes used as an alternative to tibial osteotomy (HTO) or total knee arthroplasty (TKA) when only one side of the knee has been damaged by osteoarthritis. Many surgeons have interested in UKA because the prosthesis, itself, was designed to be placed on the subchondral bone of the specific part of joint compartment that will not interfere with both cruciate ligaments and any other structures around the knee joint. Theoretically, all UKAs were designed to yield a knee with more normal kinematics than TKA. This provides patients' ability to retain their normal balance and the natural stability of the healthy half of their knee joints.

Since the first time that UKA has been introduced, the surgical approach for this procedure is a standard medial or lateral parapatella approach. With this approach, it is necessary to evert the patella and cause some quadriceps violence. The minimally invasive surgery (MIS) for UKA is one of the improvements in medical sciences that modified the surgical technique and instrumentation to provide minimal damage to the extensor mechanism. With this approach, the patella is not dislocated and the suprapatellar synovial pouch remains intact. This procedure rapidly facilitates patient's clinical results in term of postoperative pain, ambulation, hospital stay and rehabilitation.

History of UKA

Marmor[1] has first introduced UKA in the early 1970s. With the use of standard knee arthrotomy, he reported 75% good to excellent results in 56 UKAs with a minimum four years

of follow-up. The published articles reporting clinical results of UKA have been in a wide range. Insall and Walker,[2] reported on 24 UKAs followed for two to four years. Only 58% of patients had good to excellent results. Laskin[3] reported only 65% of satisfactory pain relief following medial UKA in 37 knees using the Marmor design. According to Marmor's study,[1,4,5] poor results were usually associated with use of a polyethylene tibial component of insufficient thickness. Regarding unfavorable UKA outcome, some surgeons believed that this procedure is inferior to TKA and should not be preformed.[2,3] On the other hand, some researches showed evidences of positive results that support the UKA. Thronhill[6] reported 92% good to excellent results at 42 months follow-up. Mallory and Dolibois have reported similar good results using the Marmor UKA.[7] Comparing UKA to TKA, some studies showed that it provided better range of movement of the knee.[8-10] The pain relief was as good or better and the knee feels more natural. The recovery time of patients who underwent UKA is shorter than that in TKA. The patellofemoral tracking is not affected as well. Although excellent clinical results have been reported, UKA has been previously reported about the disadvantage that the medium and long-term revision rates are generally higher than for TKA.[11-13] UKA is therefore considered by some surgeons to be pre-knee replacements, and is only expected to last for a short period. However, recent published studies have shown higher long-term survival rate of UKA that is comparable to TKA.[14-17] These controversial results have caused many orthopaedic surgeons a reluctant to perform this procedure for nearly 30 years.

Minimally Invasive UKA

Minimally invasive UKA (MIUKA) has been reported recently. According to Reppici et al[18] and Price et al[19], the MIUKA provides a smaller incision scar, an earlier weight bearing ambulation than that used in the conventional method. Patients can be home in the same day after surgery or may have only one night hospital stay. With minimal pain postoperatively, patients can have range of motion of the operated knee more than 90 degrees within a few days. In addition, this procedure causes blood loss less than 100 ml.

Indications for UKA

To maximize the postoperative clinical results after MIUKA, one should have appropriate indications for surgery. Previously, the standard UKA is indicated for the elderly. According to Kozinn and Scott, [20] the ideal candidate for UKA is a patient with unicompartment knee osteoarthritis, physiologic age older than 60, relatively sedentary lifestyle, weight of less than 180 pounds, minimal pain at rest, and more than > 90° of knee flexion. Regarding deformity, a flexion contracture of less than 5°, a varus or valgus deformity of less than 15 degrees are indicated for good results. In a study of patients undergoing total knee arthroplasty, Stern et al[21] found that if the strict indications of Kozinn and Scott for unicondylar knee arthroplasty were followed, only 6% of patients were candidates for unicondylar knee arthroplasty. With improving of implant designs and surgical techniques, there have been reports of good to excellent UKA results in patients whose ages were less than 60 year old.[22,23] Recently, some authors recommend the MIS: UKA for patients with younger age group who have the same knee pathologies as those indicated in the older age group.[24,25]

Contrandications for UKA

The absolute contraindications for UKA are:

1. Inflammatory or crystal induced arthritis, such as rheumatoid arthritis
2. Established bi or tri-compartment arthritis

3. Anatomic deformity > 10-15° in any plane
4. Limited rang of motion (flexion <90 degrees)

To avoid early failure of the UKA, one should consider these relative contraindications before surgery:

1. Unhealthy anterior cruciate ligament
2. Advanced patellofemoral arthritis
3. Subluxation and ligamentous laxity
4. Obesity (>250 Lbs or 114 kg)

Principle of Surgery for MIUKA

1. Technical Demand

The soft tissue approach is critical for the MIUKA exposure and for the associated rapid patient recovery. The minimum wound size that provides appropriate room has to be determined. To complete an adequate exposure with minimal soft tissue injury, surgeons have to adjust the extension of the proximal quadriceps tendon incision until the patellar can be retracted just beyond the midline of the distal femoral condyle without any patellar eversion.

2. Undercorrection of the Deformity

Unicondylar arthroplasty is primary bony surgery. Usually, peripheral osteophytes of the femoral condyle and the tibial plateau are present. These osteophytes, especially in the medial compartment, may prevent passive correction of the varus or valgus deformity because of relative shortening of the capsule and collateral ligaments as they pass over the osteophytes. Removal these osteophytes may allow passive correction of the deformity. Slight medial or lateral soft tissue release is accepted, however, no extensive soft tissue release recommended. The principles of ligament balancing and overall alignment of the knee cannot be applied completely to UKA. If this procedure is necessary, it implies a more severe knee deformity, which probably requires bicompartmental or tricompartmental replacement. There is a major risk of overcorrection with deterioration of the healthy compartment.

3. Gap and Bone Cut

It is critical to realize that the depth of the distal femoral cut determines the space in full extension. Increasing the space in full extension can correct flexion contractures and enables the surgeon to decrease the associated depth of the tibial cut, sparing valuable bone on the tibial side. The tibial cut can be angled from anterior to posterior. The depth and the slope of the cut also affect the flexion-extension balancing.

4. Joint Laxity after Correction

After unicompartmental replacement, the joint space should open up to 2 mm when valgus or varus stress is applied with the knee fully extended. Similarly, the flexion space should open up to 2 mm when a spacer is applied with the knee flexed at 90 degrees. It is suggested not to over tighten the joint and to accept greater rather than less laxity. Excess tightness may lead to early polyethylene failure and also contributes to increase pressure transmission to the contralateral compartment.

Surgical Technique

Anesthesia

The operation is performed under general, spinal, or epidural anesthesia. Other regional techniques are appropriate according to the experience of the anesthesiologists. It is important for the anesthesiologists to understand that early ambulation is part of the surgical program and

the patients will be asked to walk and begin knee flexion within two to four hours after the surgical procedure.

Special Equipments

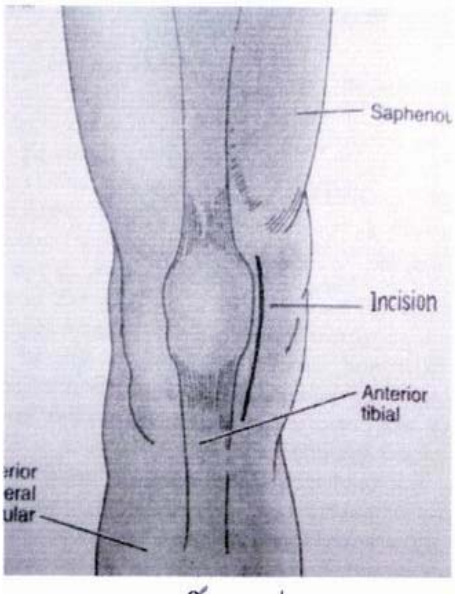
The surgeon should be comfortable for the procedure with or without tourniquet control. The leg holder or other positioning devices should be used to simplify the approach. Throughout the operation it will be necessary to shift the position of the knee many more times than with the conventional open arthrotomy.

Exposure

Make a 3-inch longitudinal skin incision from the medial or lateral pole of the patella to the medial or lateral side of the tibial tuberosity. This incision can be used for medial and lateral unicompartmental replacement respectively. The incision starts at the superior pole of the patella and continues distally to the tibial joint line (Fig. 1).

With a medial parapatellar approach, a transverse incision to join the arthrotomy incision as a "T" is performed to allow adequate exposure of medial compartment of the knee during knee flexion (Fig. 2). Raise a periosteal sleeve from the anteromedial aspect of the tibia. The deep MCL is elevated from the tibial plateau for visualization of the joint, not for the purposes of release. Excise the medial meniscus to visualize tibial plateau margin. Laterally, carry progressive dissection to the infrapatellar fatpad to allow a room for sagittal tibial bone cut with a vertical saw.

Similarly, during lateral compartment replacement, there is no horizontal "T" incision. The vertical incision is taken down to the tibial plateau and the iliotibial band (ITB) is subperiosteally released from Gerdy's tubercle posteriorly back down to the tibial plateau margin. Excise the lateral meniscus to visualize tibial plateau margin and the infrapatellar fatpad to allow a room for sagittal tibial bone cut with a vertical saw.



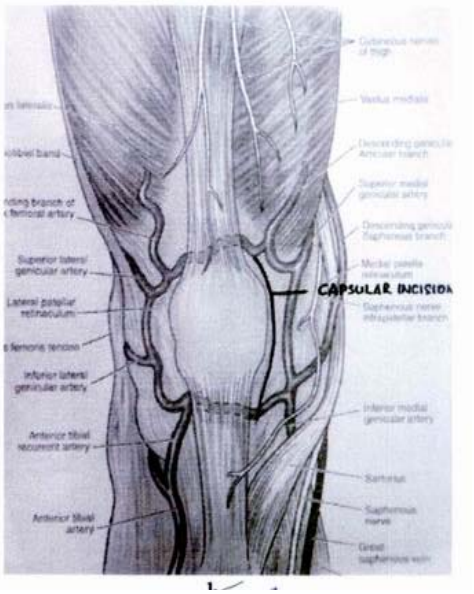


Fig 1. (Left) A 3-inch longitudinal skin incision from the medial pole of the patella to the medial side of the tibial tuberosity for medial unicompartmental arthroplasty. For lateral unicompartmental replacement, the incision is performed with the same fashion on the lateral side.

Fig. 2 (Right) Capsular incision with a medial parapatellar approach provides a better surgical field if a transverse incision to join the longitudinal incision as a "T" is performed.

With the completion of the arthrotomy, the osteophytes can be removed from the affected femoral condyle and tibial plateau. Remove peripheral osteophytes will allow passive correction of the varus or varus deformity. It is recommended to remove intercondylar "kissing" osteophytes which developed as the tibial spine impinges on the intercondylar aspect of the femoral condyle. Remove these osteophytes will prevent impingement that may cause postoperative pain on weight-bearing.

Bone Cut and Prosthetic Sizing

According to surgeon preference or instruments, one may choose to cut tibia of femur first without a significant difference. Cutting the tibia first may be beneficial. The cutting surface can be an additional reference line for femoral cut. There are two types of alignment guides to cut the proximal tibia and distal femur, the extramedullary and the intrtamedullary system. Both systems use the same principle as that used in TKA.

The tibial cut is mostly made with an extramedullary instrument. This cut should be perpendicular to the long axis of the tibia in the frontal plane (Fig.3). Most systems are set for 5 to 7 degree posterior slope cut. If the flexion contracture is up to 10 degrees, the slope of the tibial cut should be decreased from the anatomic slope of the tibia to provide more space in extension while maintaining the same flexion gap. The tibial tray size should be determined by the coverage of the entire surface of the cortical rim. Generally, overhang is not desirable.

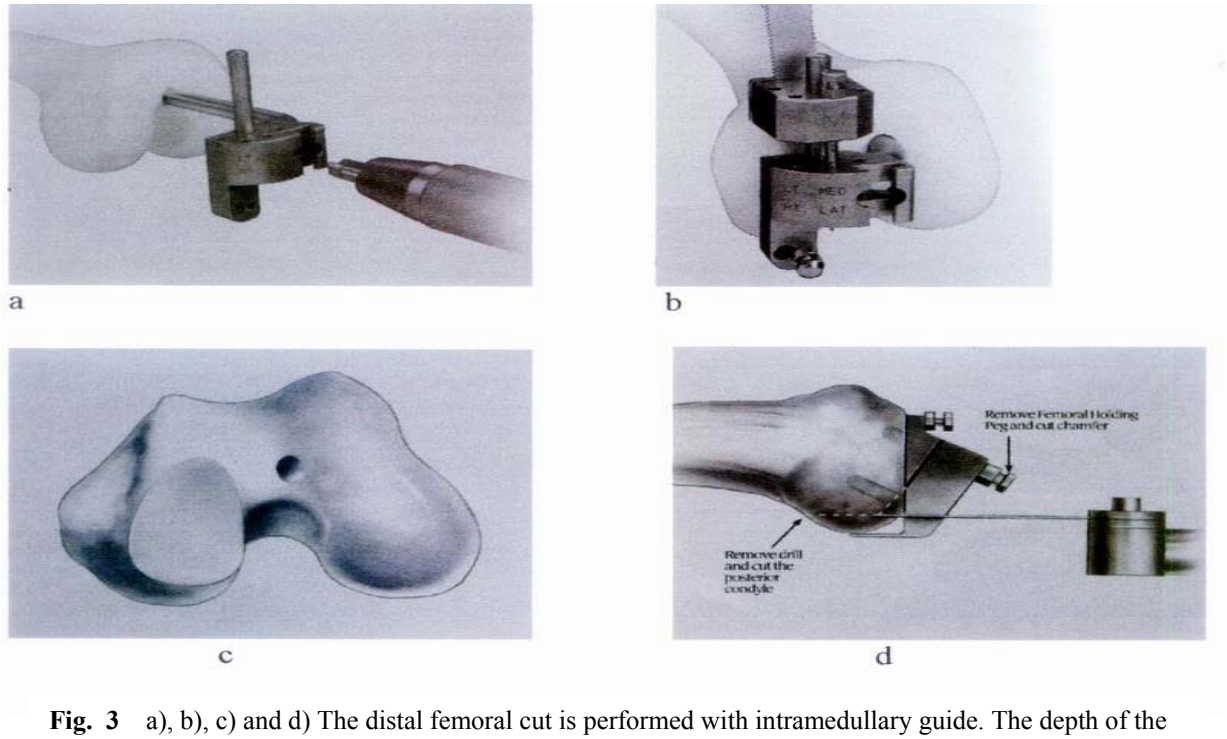


Fig. 3 a), b), c) and d) The distal femoral cut is performed with intramedullary guide. The depth of the cut and the valgus angle of the cut must be selected according to individual implant system. The appropriate femoral size is determined and the remainders of the femoral cut are completed with the size-matched cutting blocks.

The distal femoral cut is also made with either an extramedullary or an intramedullary guide. The intramedullary technique may require some more room for drilling an entrance hole to the area above the roof of intercondylar notch. The depth of the cut and the valgus angle of the cut must be selected. The depth of the cut determines the space in full extension, while the angle of the cut determines the perpendicularity of the distal cut to the anatomic axis of the femur.

According to Tria's technique,[25] in the varus knee, if the distal femoral valgus is 5 degrees or less, the standard amount of bone is removed. If the distal femoral valgus is 6 degrees or more, 2 mm of additional depth cut are selected in order to decrease the excess postoperative femoral valgus and to increase the space in full extension. In the valgus knee, the distal femur is always cut with the use of standard cutting guide. The lateral femoral condyle is the less prominent condyle. With the standard distal cut, it will not take a risk to increase the tibiofemoral angle postoperatively. After the distal femur is cut, femoral sizing is determined and the remainder of the femoral cuts can be completed with the size-matched cutting blocks (Fig. 4).

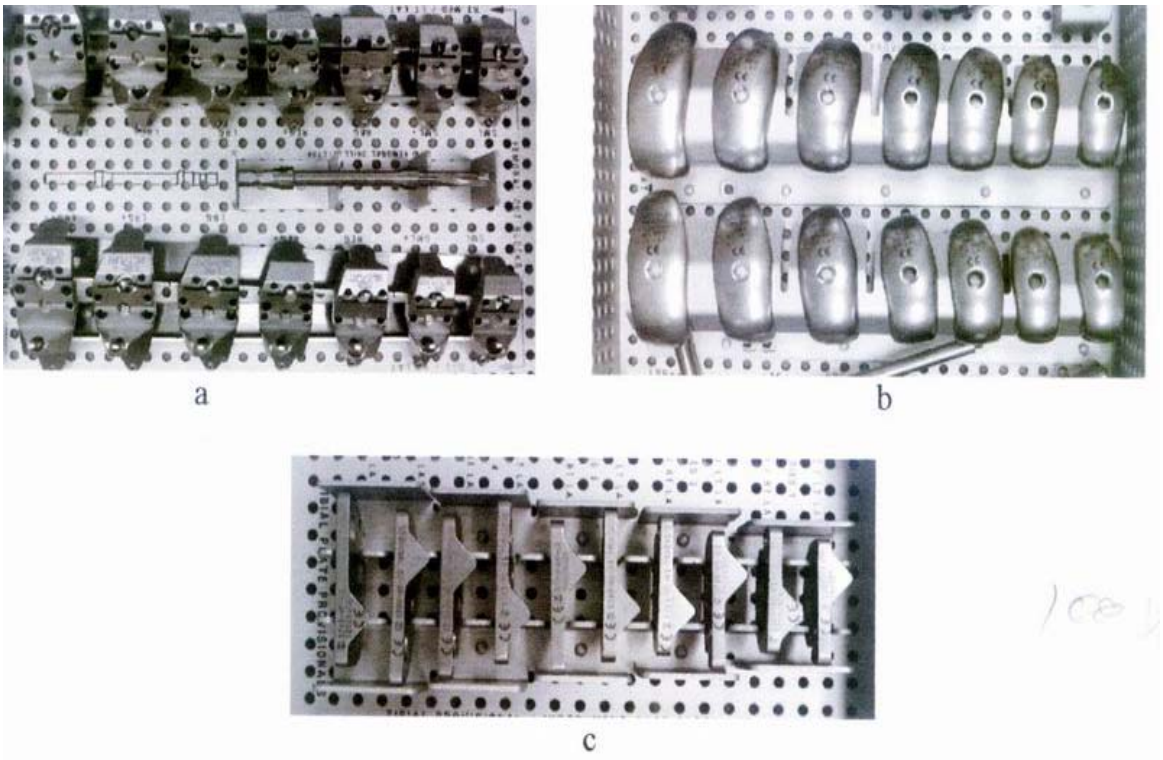


Fig . 4 Implant sizing guides and trial components are provided in many dimensions depending on individual unicompartmental knee system.
a) Femoral component sizing and cutting guides
b) Femoral trial prostheses Tibial modular trays
c) Tibial modular trays

The author prefers using intramedullary guide for distal femoral cut as described by Tria. The UKA instrument system, which the author uses, provides 6-millimeter femoral cutting guide for standard cut. The distal femoral valgus cut is usually set at 4 degrees for medial UKA and 6 degree for lateral UKA. The femoral component is designed to accept a tilt in frontal plane up to 18 degrees. This system also provides an intramedullary retractor, which can be used to retract the patella.

Gap and Joint Laxity Test

After bone cuts are completed, the flexion-extension gap should be tested with the trial components in position. The appropriate thickness of polyethylene should be selected base on a 2-millimeter laxity in both flex and extend positions (Fig. 5). If the gap is not symmetric, it should be corrected. If the extension space is smaller than the flexion space, the tibial recut with decreasing the slope angle is recommended. If the space in extension is larger than the flexion space, this can be corrected by tibial recut with increasing the slope.

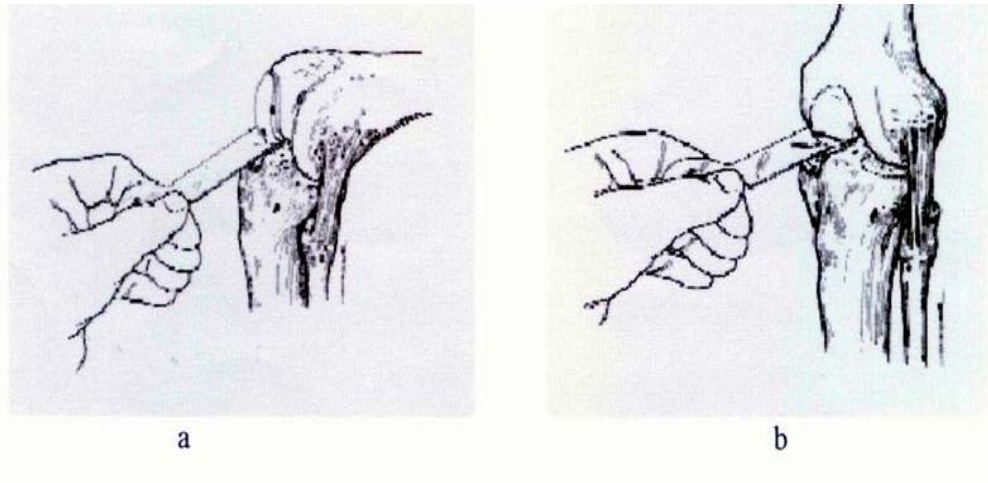


Fig. 5 a) and b) The appropriate gap for an selected thickness of polyethylene should allow a 2-millimeter laxity in both flex and extend positions.

In general, the femoral component should reproduce the anteroposterior dimension of the normal femoral condyle. It should not protrude anteriorly otherwise it may disrupt patellar tracking. In frontal plane, it should be perpendicular to the tibial plateau at ninety degrees of knee flexion and should be in the middle of the condyle.

Prosthesis Placement

It is recommended to cement the tibial component first and, then, the femoral. This permits better exposure and evacuation of cement from the posterior aspect of the joint. The all polyethylene tibia has advantage with increased thickness but it blocks the visualization of posterior of the joint during the cementing. It is easier to examine the posterior knee if the tibial tray is modular. However, the polyethylene should be inserted last.

Closure

The tourniquet is released before the closure and adequate hemostasis is established. The closure of the arthrotomy is performed with non-absorbable sutures in an interrupted

fashion over a single drain. The vastus closure should be anatomic without over tightening or residual laxity. The patellar tracking should be checked before closing the subcutaneous tissues.

Postoperative Management

Initially, a compressive dressing and a knee immobilizer are worn to relieve pain and to decrease postoperative hemorrhage. Ice can be applied to the knee for the same reasons. Range-of-motion exercises are encouraged postoperatively, with or without the assistance of a CPM machine. Dangling the legs over the side of the bed is used to promote flexion. The postoperative rehabilitation protocol includes lower extremity muscle strengthening, concentrating on the quadriceps; gait training with full weight bearing and instruction in performing basic activities of daily living.

CONCLUSION

To perform a successful UKA, one should follow indications and absolute contraindications. Relative contraindications should be considered as an individual case. The surgical technique and the principle of UKA are mandatory for success. In early postoperative period, MIUKA provides more satisfactory clinical outcome than that performed with a conventional method. However, it is necessary to balance between the less invasive approach and the adequate surgical field. Inappropriate concern in minimal soft tissue injury with too limited room for the procedure may cause complications related to operative technique.

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