5 Points on
Unicompartmental Knee Arthroplasty

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Despite the long-term survivorship and clinical effectiveness of total knee arthroplasty (TKA), the percentage of patients who indicate dissatisfaction with their procedures (little improvement in pain and function) can be as high as 15% to 30%.[1-3] Although early reports on survivorship of unicompartmental knee arthroplasty (UKA) were discouraging, recent studies assessing modern implant designs and surgical techniques have found 10-year survival rates of 90% to 98%.[4] The number of UKAs performed over the past decade has increased by 30%, as numerous studies have demonstrated shorter hospital stays, decreased perioperative morbidity, faster functional recovery, increased range of motion (ROM), and improved knee kinematics compared with TKA.[4]

UKA involves isolated replacement of the patellofemoral, medial, or lateral compartment of the knee. Here we use UKA to refer to isolated replacement of the medial compartment, as it is the most common UKA, and the lateral and patellofemoral UKAs have unique indications and surgical techniques. Although UKA as a procedure continues to evolve, 5 surgical and technical aspects of medial UKA that affect clinical outcomes are outlined.

1 Patient Selection

As with all surgical procedures, appropriate patient selection is very important for satisfactory clinical outcomes. However, the indications and contraindications for UKA are controversial, which makes it difficult for practicing clinicians to adhere to one specific algorithm.

In 1989, Kozinn and Scott[5] provided UKA candidate criteria (**Table**). Patients who fit these strict criteria had excellent clinical outcomes after UKA. In a review of 4021 knees, however, Ritter and colleagues[6] noted that only 4.3% of patients with varus osteoarthritis fit the guidelines. Areas of evolving controversy are patient age, weight, patellofemoral joint status, and anterior cruciate ligament (ACL) integrity.[7,8]

Kozinn and Scott[5] presented the age cutoff of less than 60 years as a contraindication to UKA, yet more recent studies have reported excellent survivorship after 10 years, compared with prior studies in patients younger than 60.[9] Improved outcomes in younger patients can likely be attributed to enhanced implant design and surgical technique. Furthermore, if the index UKA is performed well (with limited bony resections and a focus on bone preservation), future revision of UKA to TKA can be less technically demanding than revision of primary TKA. In addition, whether implant survival is the appropriate outcome to assess in comparing UKA with TKA remains an area of debate, as recovery rate and return to preoperative function may be more meaningful clinical measures. Furthermore, as younger, more demanding patients have had excellent outcomes with modern UKA designs, age should no longer be considered a strict contraindication. The same is true of weight greater than 82 kg. UKA may be more technically demanding (in terms of surgical exposure and implant positioning) in patients with higher body mass index, but obesity should no longer be considered a strict contraindication. However, the data remain controversial. In addition, in obese patients, often other knee compartments have degenerated. Thus, careful assessment is needed before indicating an obese patient for UKA.

Patellofemoral joint status is another area of controversy. Contrary to Kozinn and Scott,[5] it has recently been proposed that exposed bone or radiographic arthritis in the patellofemoral joint can be ignored.[8] As the rate of revision for unexplained pain continues to be much higher in UKA than in TKA, and there are concerns regarding future patellofemoral symptoms in UKA, caution should be taken with respect to the patellofemoral joint. For a patient reporting anterior knee pain, difficulty ascending or descending stairs, or a positive patellofemoral grind test, UKA is, we believe, contraindicated. In addition, even in the absence of clinical patellofemoral symptoms, we hesitate to perform UKA if radiographic signs of patellofemoral arthritis are present, or

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Table. Summary of Indications and Contraindications for Unicompartmental Knee Arthroplasty[a]

Indications	Contraindications
Unicompartmental osteoarthritis or osteonecrosis	Inflammatory arthritis
Age >60 years, low demand for activity	Age <60 years, high demand for activity
Weight <82 kg	Weight >82 kg
Minimal pain at rest	Pain at rest (may indicate inflammatory component of arthropathy)
Angular deformity <15°, passively correctable to neutral	Patellofemoral pain or exposed bone in patellofemoral or contralateral compartment
Range of motion arc >90° with <5° flexion contracture	Limited range of motion

[a]As proposed by Kozinn and Scott[5]

if exposed bone is found during surgery. However, studies have shown that patients with exposed bone on the medial patellar facet or medial trochlea, in the absence of anterior knee pain or patellofemoral grind, have excellent outcomes after mobile- or fixed-bearing UKA.[8] Lateral patellofemoral disease and clinical patellofemoral symptoms remain contraindications to medial UKA.

The importance of ACL integrity with use of fixed-bearing UKA designs continues to be an area of debate as well. A deficient ACL remains a contraindication to mobile-bearing designs but also raises concerns about increased instability and wear in fixed-bearing implants. However, in both biomechanical and clinical studies, UKA has had favorable outcomes in ACL-deficient knees when the tibial component was implanted with a posterior slope of less than 7°.[10] Robot-assisted navigation systems, including Robotic Arm Interactive Orthopedic (RIO) system (MAKO Surgical Corp, Ft. Lauderdale, Florida) and NavioPFS (Blue Belt Technologies Inc, Pittsburgh, Pennsylvania), and fixed-bearing designs can reliably decrease the posterior slope of the tibial component to improve anteroposterior stability, and thus fixed-bearing UKA may still be performed in the presence of a deficient ACL. However, in patients with functional knee instability or posteromedial wear from chronic anterior tibial subluxation secondary to long-standing ACL insufficiency, UKA is not advisable.

UKA indications and contraindications are clearly evolving. In a review of 1000 UKAs, Pandit and colleagues[8] found that 10-year survival was better in patients with one of the contraindications proposed by Kozinn and Scott[5] than in patients considered ideal candidates for the procedure (97.0% vs 93.5%), while no significant difference was present in the mean Oxford knee score or American Knee Society Score between the 2 cohorts. The authors concluded that thresholds for age, weight, activity level, and patellofemoral joint status should not be considered contraindications to UKA. More conservatively, we believe that the most important criteria for UKA candidates are isolated anteromedial compartment osteoarthritis in the absence of clinical patellofemoral symptoms and functional cruciate instability, and preoperative ROM that allows adequate intraoperative exposure and satisfactory postoperative ROM.

2 Implant Fixation

Despite the excellent clinical outcomes of UKA, concerns remain about the long-term causes of failure, including aseptic loosening, polyethylene wear, and adjacent compartment degeneration.[11] In an analysis of 1135 revised UKAs from the Swedish registry, the main reason for revision was component loosening (43%), followed by progression of adjacent compartment arthrosis (26%), and other mechanical problems (15%).[12] Although the causes of aseptic loosening are multifactorial, and include polyethylene wear, poor component positioning, and malalignment of the lower extremity, poor initial implant fixation (of the tibial component, in particular) is one of the most important factors leading to aseptic loosening in UKA.

Several factors can affect tibial component fixation, including degree of conformity of the articulating surface and the resultant stress transfer to the bone–implant interface, but perhaps the most important factor in modern implant designs is cementation technique. After the tibial resection is performed, with use of either a keeled or a pegged tibial component, 2.5-mm holes may be drilled into any sclerotic bone to facilitate interdigitation of the cement. The tibial surface is thoroughly irrigated and cleared of any debris, and a clean sponge is used to dry the surface. A thin layer of cement is applied to the posterior aspect of the tibial component, and a periosteal elevator is used to apply a small amount of cement to the bony surface, posterior to anterior (to prevent extrusion of cement behind the tibial component). Similarly, during implantation of the tibial component, the posterior aspect of the component is set first, then rolled forward, posterior to anterior, to allow cement to be extruded anteromedially rather than posteriorly. An offset tibial impactor is then used to further secure and pressurize the tibial component. The femoral and polyethylene components

are then inserted, and the knee is brought into 30° of flexion to further pressurize the cement. Bringing the knee into full extension before cement hardening can inadvertently cause the implants to extend, and can cause posterior lift-off. With more surgeon experience and a consistent cementation technique, early micromotion and future aseptic loosening of the tibial component can be minimized.

3 Lower Limb Alignment

Optimal postoperative alignment in UKA is another controversial area. We believe there is adequate evidence supporting the goal of undercorrection of mechanical alignment, with a final alignment of 2° to 5° of varus (**Figures A, B**). Proponents of restoration to neutral, overall alignment point to the increased risks for accelerated polyethylene wear and tibial component loosening with undercorrection of the lower extremity. However, Hernigou and Deschamps[10] demonstrated that postoperative mechanical alignment between 0° and 10° of varus correlated with superior implant survivorship and clinical scores. In addition, Berger and Della Valle[4] noted that overall undercorrection of the varus deformity decreases the risk for opposite compartment degeneration without increasing the risks for tibial component loosening, wear, and subsidence.

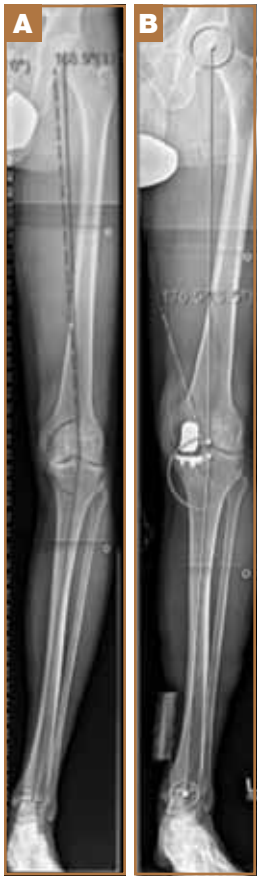

Figure. Standing, anteroposterior, hip-to-ankle radiographs show varus deformity corrected from 11.1° before surgery (A) to 3.5° after surgery (B).

Furthermore, recent data presented by Bellemans and colleagues[13] showed that 32% of men and 17% of women had knees with a natural mechanical alignment of 3° of varus or more, described as "constitutional varus." Thus, restoration of these cases to neutral alignment would in fact be abnormal and likely require some degree of medial soft-tissue release.

4 Soft-Tissue Balance—Retensioning the Medial Collateral Ligament

The ability to perform soft-tissue balancing is limited in UKA, unlike in TKA. In TKA, coronal plane balancing is performed through soft-tissue releases in the medial and lateral compartments. In contrast, in UKA, controlled undercorrection of the overall mechanical alignment can be achieved only by working in the medial compartment. In varus osteoarthritis, pseudolaxity of the medial collateral ligament (MCL) is a commonly appreciated finding, and the surgeon must assess whether a fixed for flexible varus deformity is present before surgery. In the setting of flexible deformity, the native tension of the MCL can be restored with appropriate implant positioning and sizing and correction of the varus deformity.

During surgical exposure, a medial parapatellar arthrotomy is begun at the superomedial aspect of the patella and is extended distally along the medial edge of the patella tendon. Based on surgeon preference, the proximal aspect of the arthrotomy can be extended superomedially for a midvastus approach, which improves femoral exposure. The most important aspect of either approach is to not perform a large posteromedial capsular release along the proximal aspect of the tibia. In addition, the insertion of the deep MCL on the tibia should be preserved. Exposure of the proximal tibia should be limited to what is needed for tibial cutting guide placement, and for adequate retractor placement to protect the medial soft-tissues. This limits the possibility of overrelease and the potential for overcorrection of lower extremity mechanical alignment.

Although MCL retensioning is crucial in UKA and provides a reference point for implant sizing and optimal mechanical alignment, achieving adequate tension of the MCL is challenging even for the most experienced knee surgeons. In 168 medial UKAs, Campbell and colleagues[14] used a ligament-tensioning device to perform both the femoral resection and the tibial resection, based on MCL tension. Robot-assisted UKA also relies on soft-tissue tensioning for implant sizing and component positioning but incorporates 3-dimensional imaging and intraoperative mechanical alignment to help minimize errors associated with mechanical limb-tensioning devices.[15] Nevertheless, whether mechanical tensioners or computer navigation is used, the principles of performing a minimal medial soft-tissue release during exposure and adequately re-tensioning the MCL after component placement remain crucial to a successful outcome.

5 Fixed- Versus Mobile-Bearing Designs

Advances in implant design have played a significant role in the resurgence of unicondylar knee arthroplasty. Although each bearing surface has its variations, 2 different designs are available for UKA: mobile-bearing and fixed-bearing. Mobile-bearing implants can be fully or partially congruent and are designed to reduce contact stresses and prevent catastrophic wear, as was observed in early UKA designs.[16] Mobile-bearing implants provide a large contact area between the femoral component and the tibial polyethylene while minimizing contact stress points. In addition, use of a fully congruent mobile-bearing with a constant radius (Oxford Partial Knee; Biomet Orthopedics, Warsaw, Indiana) offers 2 additional potential advantages. First, use of a mobile-bearing with limited contact stresses may allow use of a thinner polyethylene, which may decrease the depth of the tibial resection. Second, presence of a constant radius increases the margin of error during

implantation, as, theoretically, small changes in component rotation and alignment should have a minimal effect on bearing-surface contact and edge loading.

The main advantage of fixed-bearing surfaces is that dislocation risk is minimized. In addition, a fixed-bearing surface provides more stability in the setting of a deficient ACL. Although these designs use a round-on-flat or slightly dished geometry—increasing the risk for focal, contact stresses—developments in polyethylene manufacturing and sterilization methods have minimized the risk for catastrophic wear. However, more attention must be paid to appropriate component positioning and to tracking of the femoral component on the tibial polyethylene, as the risk for edge loading may be increased. Several studies have compared fixed- and mobile-bearing implants with respect to survivorship, revision rates, and knee function, but neither implant type has proved superior, with excellent outcomes being reported for each.[4,17] However, data from the Swedish and Australian registries have shown improved survivorship of fixed-bearing designs[18,19]; on the other hand, survivorship registry data are clearly multifactorial, as patient selection and surgical technique remain crucial. We believe that avoiding edge loading in a fixed-bearing round-on-flat device is essential for long-term survivorship. We currently use robotic assistance to optimize implant congruence, but various surgical techniques can be used as well.

Conclusion

With the increased use of UKA, several relevant issues are being studied and questioned to determine how to optimize clinical outcomes. We believe the 5 points we have discussed here will aid surgeons in achieving an optimal outcome when performing UKA and will increase their understanding of a few of the relevant points in UKA.

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