Minimally Invasive Surgical Technique for Unicondylar Knee Arthroplasty

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ABSTRACT: Between August 1992 and December 1996, more than 700 unicondylar knee arthroplasty (UKA) procedures were done by the senior author (J.A.R.), using well-defined patient selection criteria, which is paramount to the outcome of the procedure. The UKA procedure described is done through a smaller incision than that required for total knee arthroplasty (TKA) (3 inches versus 8 inches), thus minimizing blood loss (less than 200 mL), avoiding normal tissue sacrifice (opposite compartment, patellar bone, and cruciate ligaments), and decreasing morbidity (no patellofemoral disruption). The UKA costs less because it is done as an outpatient procedure in 80% of cases; since postoperative physical therapy is minimal or unnecessary, recovery time is shorter (90% independent function at 2 weeks after operation). Whereas TKA can have universal application, UKA is patient specific and cannot replace TKA in all circumstances. Likewise, the techniques for TKA and UKA are not interchangeable. However, with the use of well-defined patient populations and surgical techniques, the intermediate results of UKA have paralleled reported outcomes of TKA.

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High tibial osteotomy, unicondylar knee arthroplasty, and total knee arthroplasty are three methods for treating various stages of the arthritic knee. Unicondylar knee arthroplasty (UKA) has long been considered an intermediate alternative between high tibial osteotomy (HTO) and total knee arthroplasty (TKA).[1] However, early results of UKA have been mixed, leading to controversy over the acceptance of UKA as a primary procedure for degenerative joint disease of the knee.[2-7] When

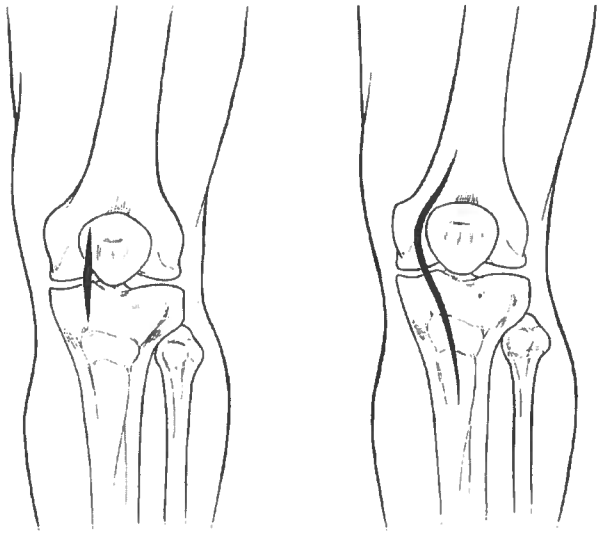

FIGURE 1. Comparison of minimal medial exposure for unicondylar knee arthroplasty *(left)* versus extensive midline exposure necessary for total knee arthroplasty *(right)*.

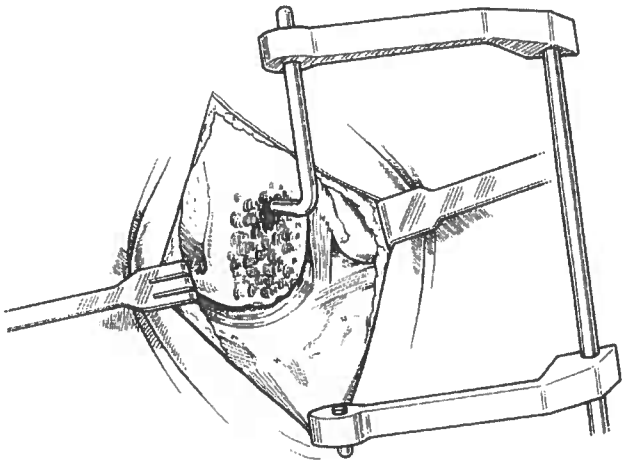

FIGURE 2. Completed exposure of medial compartment.

appropriate patient selection is combined with good surgical technique, UKA outcome has surpassed the expected longevity of HTO and, at a minimum, equaled the survival rates of TKA through 9 years.[2,7] However, techniques for UKA involve a large arthrotomy and patellar dislocation for adequate exposure.

This presentation describes a minimally invasive technique, without patellar dislocation, developed by one of us (J.A.R.) for UKA candidates, using the Repicci II UKA system (Repicci II, BIOMET Inc, Warsaw, Ind). A comparative assessment of the early postoperative management of patients treated by a routine patellar dislocation technique (n = 50) versus the described minimally invasive technique (n = 50) compares the number of physical therapy sessions and inpatient days between the two groups.

MATERIALS AND METHODS

Patient Selection

Between August 1992 and December 1996, one of us (J.A.R.) did more than 700 UKA procedures in accordance with well-defined patient selection criteria and surgical technique, which are paramount to the outcome of the procedure. Indications for UKA include articular destruction of either the medial or the lateral compartment of the knee joint, patient age >55 years, and normal patient weight. UKA is contraindicated in patients with any of the following clinical or subjective findings: tricompartmental disease of the knee, inflammatory disease, fixed deformities requiring corrective soft tissue releases, age <55 years or expectations of resuming unrealistic levels of daily activities (sports, heavy work).

Patient Preparation

Since medial compartment degeneration is more frequently encountered, this presentation will follow the technique for medial UKA. Pharmacologic prophylaxis for deep vein thrombosis (DVT) is not used in conjunction with this procedure. The prosthetic system is a surface replacement and does not require reaming of the femoral or tibial shaft. Independent ambulation 2 hours after surgery may also contribute to negating the need for DVT prophylaxis commonly used in conjunction with TKA.

The patient is placed supine on the operating room table, and the knee is placed in the basic arthroscopy position. A tourniquet and leg holder are applied to the proximal thigh, and the knee is positioned to allow full extension and unencumbered knee flex-

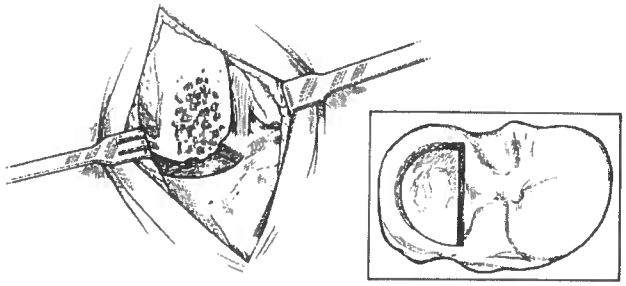

FIGURE 3. Articular surface of proximal tibia before mechanical preparation and after mechanical preparation (inset).

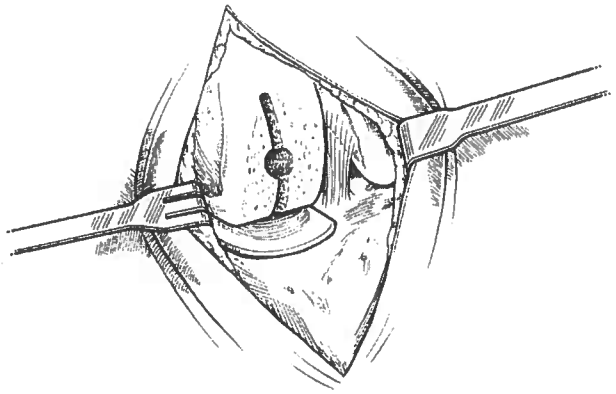

FIGURE 4. Medial view of distal femur shows articular surface after mechanical preparation.

ion beyond 115°. The leg is then prepared, draped, and exsanguinated in the usual manner for knee surgery, and the tourniquet is inflated.

Arthroscopic Confirmation

Arthroscopic confirmation is necessary to reduce early failures due to lateral compartment osteoarthritis. Also, the arthroscope facilitates the assurance of lateral meniscus function that cannot be visualized through the flexion gap during the open procedure.

The knee joint is distended with 30 mL of sterile saline, and an arthroscope is inserted through a medial portal for diagnostic evaluation of the knee compartments, verifying unicompartment involvement and sclerotic bone on the medial femoral and tibial condyles. The lateral compartment is evaluated for a reasonably well maintained and functioning meniscus. After this evaluation and confirmation, the arthroscope is removed from the joint and all associated instrumentation is removed from the operative field. There is no need for the arthroscopic system thereafter.

Exposure

A 3-inch medial parapatellar incision is made, extending from the proximal border of the patella to the proximal tibial region (Fig 1). Subcutaneous dissection is done to produce a 1- to 2-inch skin flap surrounding the entire incision to allow skin mobility. An underlying medial parapatellar capsular incision is then made from the proximal border of the patella to a point 1 inch below the tibial articular surface. A 1-inch transverse incision is then made, extending from the proximal tip of the patella medially at the vastus medialis capsular insertion. The medial capsule is then grasped with a Kocher hemostat and reflected medially. The medial capsule is detached from the proximal medial tibia for a distance of 1½ inches and reflected medially with a second Kocher hemostat. The joint is now widely exposed. The periosteum overlying the medial aspect of the patella is reflected laterally, and a longitudinal saw cut is done to remove any medial patellar osteophyte(s) and a portion of the medial facet, producing a bone fragment approximately ⅜ inch in width. This maneuver affords wide visualization of the femoral condyle.

An Army-Navy type retractor is used to reflect the infrapatellar fat pad laterally. The knee is then flexed to 115° and a narrow-bladed reciprocating saw is used to produce a horizontal cut, removing approximately 8 mm of bone from the posterior aspect of the femoral condyle. An osteotome is used to remove the sectioned portion of this posterior aspect of the femoral condyle. A large Steinmann pin is inserted to create a drill hole in the midportion of the medial femoral condyle, directed in line with the shaft of the femur. The Steinmann pin is then used to create a second drill hole at

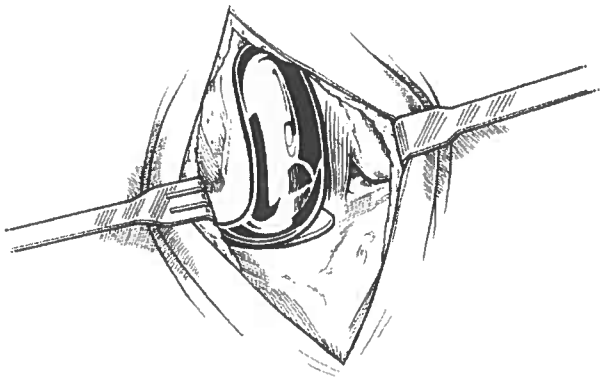

FIGURE 5. Implanted UKA device shows relationship of implanted components to open incision.

the proximal tibia to a depth of 1½ inches below the articular surface. The tibial drill hole begins medially on the exposed proximal tibia and is directed laterally across the tibial plateau toward the fibula. Curved distraction pins are then placed into the predrilled holes. The femoral distraction pin will lie in the sagittal plane. The tibial distraction pin will lie in a position angulated medially and approximately 45° in relationship to the sagittal position. A jointed laminar distractor is inserted between the two pins, the joint is opened by distraction, and the body of the distractor is placed laterally. Once stabilized by the surgical assistant, the tibia can be externally rotated, improving visualization of the posterior tibia. For further visualization, a rake retractor can be used to retract the medial capsule, or a pointed Homan retractor can be used in the interval between the medial tibial plateau and capsule (Fig 2).

Tibial Preparation

After a total medial meniscectomy is accomplished, a 4 mm power burr is used to round the posterior edge of the femur and is further used to develop an inlay within the proximal tibia for tibial prosthetic insertion. Care must be taken to preserve an adequate peripheral rim of sclerotic bone to support the tibial prosthesis. The posterior aspect of the proximal tibia must be deepened approximately 4 mm. Four millimeters of articular surface must be removed to create an adequate flexion gap for prosthetic insertion (Fig 3). Preservation of sclerotic bone generally requires a degree of medial tilting of the tibial component. Approximately 5° to 10° of medial tilt and 5° to 10° of posterior tilt is acceptable at the tibial level. A polyethylene tibial trial component is then inserted and fitted until stable and aligned with adequate sclerotic bone and peripheral supporting rim of the proximal medial tibia.

Femoral Preparation

The exposed sclerotic bone at the femoral level inherent to the disease process dictates the femoral prosthesis size (component coverage). The femoral trial guide with the handle attached is placed over the femoral condyle for fitting purposes. After completion of the prosthetic procedure, with the knee in full extension, the tibial component must remain in contact with the metal of the femoral component. The anterior margin of the prosthetic system can be marked, the trial components removed, and the knee extended to show adequate metal coverage of the femur. The medial femoral condyle is then stripped of remaining articular cartilage using a round power burr. Test holes are drilled to a depth of 2 mm into the femoral surface to determine the thickness of the sclerotic bone. If sclerotic bone exists for a depth of 2 to 3 mm, an additional 2 to 3 mm of femoral surface can be removed while maintaining an adequate sclerotic bone bed for prosthetic support.

The component is aligned while maximum coverage of sclerotic bed of the tibia is maintained for prosthetic support. Methylene blue is used to mark the desired center of rotation of the femoral component in relationship to the tibial component position. If present, medial osteophytes are used at the tibial level for additional support, and as a result, the medial rotation contact point at the tibial level can be shifted further medially (approximately ¼

inch). Methylene blue is used to mark the femoral condyle at the desired mid-point of articulation with the tibial condyle. A mark is also made on the femoral condyle corresponding to the desired center point of the femoral prosthesis. The femoral prosthesis is designed to allow medial angulation of the femoral prosthesis up to 15°. It is not necessary to insert the femoral component in a perfect perpendicular relationship to the tibia. The femoral template is manufactured with a large central slot for visualization in component alignment. Steinmann pins are placed at the anterior and posterior ranges of the slot for component stabilization. Any further contouring of the distal femoral condyle can be accomplished with a power burr and/or by gently tapping of the handle attached to the femoral template. The handle is then removed and the central bushing is applied to guide drilling of the central retaining hole. The femur is marked at the superior edge of the template. The Steinmann pins and template are removed, and the marked area is contoured with a power burr to allow fitting of the prosthesis beneath the remaining articular surface of the femur, thus avoiding patellar impingement. A keel-slot is produced at the midline of the central femoral mark with either a reciprocating saw or a power burr (Fig 4).

Component Insertion and Closure

All hardware is removed, and the wound is copiously irrigated with sterile saline. The femoral inserter is attached to the femoral trial prosthesis and is inserted with light tapping. The tibial trial prosthesis is then inserted into the tibial inlay preparation. The knee is brought into full extension and flexion to 115°. Without cement, the prosthetic system should be stable through the full range of motion. If the tibia should "pop-up" anteriorly, the flexion gap has been inadequately prepared, and the posterior aspect of the tibia must be deepened. The anterior cruciate ligament (ACL) should maintain normal tension through the full range of motion. If the ACL tension is excessive, either the posterior tibia or the femoral prosthesis can be slightly deepened. Overcorrecting the joint with a thick tibial polyethylene insert will also cause tension throughout range of motion and excessively load the lateral knee, causing accelerated degeneration of the good compartment.

After achieving satisfactory prosthetic alignment and normal knee joint tension, the femoral and tibial trial prostheses are removed, and the knee is thoroughly irrigated with sterile saline. The knee is then prepared for prosthetic fixation with cement. A sponge is placed in the suprapatellar pouch to absorb any excess fluid and is removed. A second sponge is placed in the suprapatellar pouch and left in situ until cementation is completed. The posterior capsule is then infiltrated with 0.25% bupivacaine HCl (Marcaine) with 0.5% epinephrine for postoperative pain relief and hemostasis. The injection must be done at this time because the area is not visible after prosthetic insertion. After the injection, a sponge is opened full length, creating a narrow strand that can be twisted upon itself in a rope-like fashion. The twisted portion of the sponge is then packed into the posterior aspect of the knee up and behind the posterior femoral condyle to produce a dry field posteriorly. A retraction hook is useful to hold the sponge medially and reflect the medial capsule during the cementation process. A sponge is then packed into the proximal tibia and into the preparation of the distal femur. The bupivacaine/epinephrine solution can be used on the sponge to aid in hemostasis if necessary. The tibial sponge is then removed, and the tibial prosthesis is cemented into place. Any excess cement is removed. The femoral sponge is removed, the femoral prosthesis is attached to the femoral insertion device, the femoral prosthesis is cemented into place, and any

excess cement is removed (Fig 5). The knee is then put through full range of motion. The prosthetic system is checked for excessive cement extruded through compression of the prosthetic devices through the range of motion check, and any excess is removed. The cement is allowed to cure with the knee in full extension. Once the cement mantle has hardened, any remaining osteophytes can be removed and irregularities of the patella and/or femur contoured. Notchplasty is done at this time if necessary.

The knee is then irrigated with sterile saline and antibiotic solution. All incised wound edges are infiltrated with bupivacaine/epinephrine solution, and the tourniquet is deflated and removed. A short ribbon suction type of drain can be inserted at closure. The wound is closed in layers, using 0 Vicryl sutures for the synovial capsule and subcutaneous closure. Skin closure is generally with 000 wire. Sterile dressing and a cold-compressive knee dressing are applied. The knee is immobilized, and antiemboli stockings are used bilaterally.

Postoperative Rehabilitation

The UKA procedure described can be done on an outpatient basis or during a 1-day hospital stay. Currently, 80% of the UKAs in this series have been outpatient procedures. Rehabilitation of the knee is guided by various time increments after the UKA procedure. Within 2 to 3 hours postoperatively, through the first postoperative day, with the knee immobilizer on, the patient is instructed to ambulate with a walker for stability and safety and to perform foot and ankle stretching exercises. The knee immobilizer is removed, and on postoperative days 2 and 3, the patient is instructed to do knee bending as tolerated. The walker is continued for stability and safety. Beginning with postoperative day 4, knee exercises are done three to four times per day, advancing to a cane for walking. Flexion to 90° should be achieved by the end of the first postoperative week. At this time, ambulatory aids should be discontinued unless patient stability is in question. Beginning with the second postoperative week, the patient may begin to resume normal activities such as stair climbing and driving, with the goal of returning to independence during this week. Postoperative exercises should be continued, though less frequently (twice per day), through week 6. By postoperative week 6, the patient will have returned to all normal activities of daily living. However, the patient is also advised to avoid unrealistically excessive or aggressive activities (sports, heavy work, etc).

Comparative Results

Between 1992 and 1993, 50 patients who had UKA by a patellar dislocation technique (group 1) were compared with the next 50 patients who had the described minimally invasive UKA procedure (group 2). Because the patient criteria are well defined for UKA, the two sample populations were equally matched for demographics and preoperative diagnoses. At the time, both UKA procedures were done on an inpatient basis; thus, the average length of stay for either group was not significantly different. Postoperatively, a drain system with a 60 mL bulb was used for blood collection. In group 2 (the minimally invasive UKA group), postoperative blood loss was insignificant and rarely >120 mL. Both UKA groups achieved 90° of flexion by the end of postoperative week 2. However, 600 physical therapy sessions (12.0 visits per patient) were required for group 1, whereas patients in group 2 required only 12 physical therapy sessions (0.2 visits per patient). The need for physical therapy relates to procedural involvement rather than surgeon decision. Eliminating eversion of the patella avoids damage to the suprapatellar pouch. Iatrogenic damage inflicted on the suprapatellar pouch and extensor mechanism by the surgeon during the process of

patellar dislocation for joint visualization may be the primary contributing factor for postoperative rehabilitation and physical therapy. Avoiding patellar involvement through dislocation as described reduces the morbidity of the surgical procedure, allowing the postoperative outpatient status.

The estimated total cost for a standard UKA procedure with patellar eversion, a hospital stay of 3 to 4 days, and the associated rehabilitation physical therapy expenses approaches $16,000. The estimated total cost for the minimally invasive technique for UKA as described averages $7,000. Because of the shortened time for return to normal activities of daily living and the likelihood of the UKA patient to be younger and therefore employed, the patient's return to work would also be significantly decreased. Unlike the early UKA done through a large arthrotomy with patellar eversion, the minimally invasive UKA described here is usually done as an outpatient procedure (80% of cases), with an average length of stay for all UKA procedures (inpatient and outpatient combined) of 1.2 days.

DISCUSSION

Treatment of single compartment degeneration of the knee (medial or lateral) is controversial.[2-7] To maximize the outcome of surgical procedures for those with end-stage degenerative joint conditions, patient selection is of paramount importance.[8,9] Current options for surgical intervention include HTO, UKA, or TKA. Primary TKA can be easily applied to the majority of end-stage conditions of the knee, but it requires the destruction of normal bone and soft tissues in knees with single compartment degeneration. Moreover, technical considerations involving bone cuts, posterior cruciate ligament retention/sacrifice, and joint line maintenance are introduced as a result of the TKA procedure. In obese, active, or younger patients, HTO offers a satisfactory short-term to intermediate-term outcome for the relief of pain and restoration of normal function.[10] Too often, HTO becomes a technically challenging procedure, leading to unreliable results with moderate short-term survival of function (less than 80%), and low expectation of survival beyond 10 years.[11,12] Unicondylar knee arthroplasty has been considered an intermediate step between HTO and TKA.[1] However, in patients with single compartment degeneration (older than 55, nonobese), UKA offers a logical primary choice for the relief of pain and restoration of function with survival rates parallel to those of primary TKA through 10 years.[2,7]

Until now, UKA required the same invasive surgical technique as TKA, involving a large arthrotomy, patellar dislocation, and extensive rehabilitation. The UKA procedure that we have presented involves a smaller incision (3 inches versus 8 inches), minimal blood loss (<200 mL), preservation of normal tissue (opposite compartment and patellar bone, ACL, PCL), less morbidity (no patellofemoral disruption), decreased cost via shortened hospital stay without readmission into a skilled nursing or rehabilitation facility (outpatient procedure in 80% of cases and minimal to no postoperative physical therapy), and shorter recovery time (90% independent function at 2 weeks after surgery) as compared with TKA in similar patients.

Whereas TKA can be applied universally, UKA is patient specific and cannot replace HTO or TKA in all circumstances. Criteria for UKA parallel those for HTO, but operative techniques for HTO are less uniform and involve wide variations in procedural and fixation methods. Likewise, the techniques for TKA and UKA are not interchangeable. Unicondylar knee arthroplasty is a compartment-replacing procedure that requires a well-maintained and functioning opposite compartment, whereas TKA can be used across the majority of end-stage

knee conditions. When the finality of TKA is applied to single compartment disorders of the knee, excessive bone is unnecessarily removed, decisions about PCL retention versus sacrifice are introduced, and soft tissue balancing techniques are used. However, by correctly applying and performing the described procedure, UKA becomes a logical primary procedure with significant cost benefits for the provider, the insurance payer, and the patient.

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References

1. Swank M, Stulberg SD, Jiganti J, et al: The natural history of unicompartmental arthroplasty. *Clin Orthop* 286:130-142, 1993
2. Heck DA, Marmor L, Gibson A, et al: Unicompartmental knee arthroplasty: a multicenter investigation with long-term follow-up evaluation. *Clin Orthop* 286:154-159, 1993
3. Insall JN, Walker P: Unicondylar knee replacement. *Clin Orthop* 120:83-85, 1976
4. Laskin RS: Unicompartmental tibiofemoral resurfacing arthroplasty. *J Bone Joint Surg Am* 60:182-185, 1978
5. Insall JN, Aglietti P: A five- to seven-year follow-up of unicondylar arthroplasty. *J Bone Joint Surg Am* 62:1329-1337, 1980
6. Padgett DE, Stern SH, Insall JN: Revision total knee arthroplasty for failed unicompartmental replacement. *J Bone Joint Surg Am* 73:186-190, 1991
7. Christensen NO: Unicompartmental prosthesis for gonarthrosis. a nine-year series of 575 knees from a Swedish hospital. *Clin Orthop* 273:165-169, 1991
8. Stern SH, Becker MW, Insall JN: Unicondylar knee arthroplasty. an evaluation of selection criteria. *Clin Orthop* 286:143-148, 1993
9. Thornhill TS: Unicompartmental knee arthroplasty. *Clin Orthop* 205:121-131, 1986
10. Holden DL, James SL, Larson RL, et al: Proximal tibial osteotomy in patients 50 years old or less. *J Bone Joint Surg Am* 70:977-982, 1988
11. Iversson I, Mynerts R, Gillquist J: High tibial osteotomy for medial osteoarthritis of the knee: a 5- to 7- and an 11- to 13-year follow-up. *J Bone Joint Surg Br* 72:238-244, 1990
12. Berman AT, Bosacco SJ, Kirshner S, et al: Factors influencing long-term results in high tibial osteotomy. *Clin Orthop* 272:192-198, 1991

EDITORIAL PERSPECTIVE: This article provides a significant experience with a new minimally invasive surgical technique. However, long-term outcome studies comparing this technique with more routine methods have not yet been done. We look forward to additional information from these authors and others that will define the exact surgical indications and long-term outcome for unicondylar knee arthroplasty.