

UNICOMPARTMENTAL KNEE ARTHROPLASTY

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INTRODUCTION

Isolated arthritis of one compartment of the knee poses a difficult clinical challenge. Unicompartmental knee arthroplasty (UKA) has been advocated as a potential treatment for this condition. Although early reports of UKA were unfavorable^{1,2}, several authors have recently reported excellent clinical results at long term follow-up, by using more stringent selection criteria, improved surgical technique, and more precise instrumentation.³⁻⁵

HISTORY

The first unicompartmental arthroplasties were implanted in the early 1950's. The original procedures involved a hemiarthroplasty resurfacing of the tibia.^{6,7} The major source of failure in these implants was articular cartilage loss on the femoral side. Marmor, based on experience with these tibial plateau prostheses, addressed the femoral side with a metal component and thus inserted the first cemented unicompartmental knee replacement in the United States.⁸ The all polyethylene Marmor tibial component was modeled on the tibial plateau prostheses. In 1978, Goodfellow and O'Connor designed the Oxford implant, a meniscal bearing prosthesis, with a spherical femoral component, a flat metallic tibial component, and a fully congruent polyethylene liner to allow rotation and translation of the liner between the femur and tibia.^{9,10} During the early years of their development, many of these prostheses were used on both the medial and lateral side of the same knee.^{8,11-13} These bicompartmental, modular arthroplasties proved to be more technically difficult and less reliable than standard total knee arthroplasty and fell out of favor by the early 1980's. Recently, there has been a resurgence of interest in UKA in the United States, based on

good long-term results and the potential advantages of this operation over alternatives such as high tibial osteotomy and total knee arthroplasty.

INDICATIONS

Kozinn and Scott put forth the most widely accepted indications for UKA in 1989.¹⁴ Their criteria included age greater than 60 years, weight less than 180 lbs., low activity level, and minimal pain at rest. They advocated a minimal arc of motion of 90°, with no greater than a 5° flexion contracture, and correctable angular deformity of not greater than 10° varus or 15° valgus. The anterior cruciate ligament is felt by many authors to play a critical role in the success of UKA. This is particularly true in certain designs such as the Oxford meniscal bearing implant, as soft tissue laxity can lead to displacement of the central polyethylene bearing. Patient weight is also an important factor in success of UKA. Heck *et al.* analyzed risk factors for failure after UKA.¹⁵ In a series of 294 knees, the average weight of patients requiring revision was 90.4 kg (199.3 lbs.) compared to 67 kg (147.7 lbs.) in non-revised cases. Many authors continue to perform UKA in spite of the presence of patellofemoral chondromalacia.^{3,14,16} However, in our experience, patients who have complaints of predominantly anterior knee pain at rest, anterior pain with squatting and stair climbing, or who have a positive patellar apprehension test may be better treated with tricompartmental knee arthroplasty. Patients with chondrocalcinosis or inflammatory disease such as rheumatoid arthritis are best treated with total knee arthroplasty due to the risk of progression and ongoing synovitis.

UNICOMPARTMENTAL KNEE ARTHROPLASTY COMPARED TO HIGH TIBIAL OSTEOTOMY

High tibial osteotomy (HTO) has traditionally been indicated in young, active patients with unicompartmental arthritis of the medial compartment. In comparison to UKA, results after HTO have been inferior. Several studies have shown statistically better long-term outcomes after unicompartmental arthroplasty compared with high tibial osteotomy in similar patient populations. A direct comparison of HTO to UKA was performed in Bristol, UK^{17,18} and reported by Broughton *et al.* at 5-10 years and by Weale and Newman at 12-17 years. They compared a group of 49 knees with UKA (average age at latest follow-up = 80) to a group of 42 knees treated with HTO (average age at latest follow-up = 74). Preoperative characteristics were similar between the groups. At 12 to 17 year follow-up, pain was absent or mild in 80% of the UKA group and only 43% of the HTO group. The HTO patients

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had a higher reoperation rate than the UKA group (35% vs. 12%). There was a higher complication rate in the HTO group with more wound problems, neurovascular complications, and higher rate of deep vein thrombosis (DVT).¹⁸

MINIMALLY INVASIVE SURGERY

The term minimally invasive surgery has been used to describe operations with small skin incisions and less muscle dissection. Repicci and Eberle showed that it was possible to resurface one compartment of the knee using a three inch incision extending from the proximal medial tip of the patella to a point 1 inch below the tibial articular surface.¹⁹ A one-inch proximal transverse capsular incision was also made, extending from the medial edge of the patella in combination with a 1.5 inch incision of the medial capsule from the tibial plateau (Figure 1). Using this technique, 80% of their patients were able to have an outpatient procedure. These authors advocated preoperative arthroscopic examination to evaluate for involvement of other compartments. Using this technique, the estimated average cost of UKA was \$7000 compared with \$16,000 for UKA with a standard knee incision and arthrotomy with patellar eversion.¹⁹ Price *et al.* prospectively compared the technique of UKA through a short medial incision without patellar dislocation to UKA through a standard open incision with patellar eversion, and to TKA through a standard incision.²⁰ Recovery in the minimally invasive group was twice as rapid as the open UKA group and three times as rapid as the TKA group. Robertsson *et al.* performed a cost analysis of UKA to TKA by comparing matched patients from the Swedish Knee Registry.²¹ They determined that for UKA, mean hospital stay was shorter with lower cost, and the cost of the UKA implants was approximately one-half of the cost of TKA implants.

FUTURE DIRECTIONS

Few studies in the literature have investigated the biomechanical behavior of unicompartmental knee replacement. Range of motion, walking, and stair climbing have been studied in clinical reports of UKA, but the kinetics and kinematics of UKA have not been well quantified *in vitro*. The effect of implant alignment and orientation likely plays an important role in cartilage contact pressures and motion in the uninvolved compartments. Additionally, although the importance of an intact ACL in knee joint function after UKA has been reported in clinical studies, this has not been studied directly in the laboratory. Such quantitative data would be a significant help to surgeons in improving indications, materials, designs and ultimately the clinical results of UKA. In future studies carried out by this lab, a robotic testing system will be used to quantify the effect of UKA on knee kinematics and contact forces in various compartments of the knee (Figure 2). The data from these studies may help to optimize the biomechanics of UKA and provide guidance for future high flexion UKA designs.

SUMMARY

Unicompartmental knee arthroplasty is an effective and reliable surgical treatment for localized knee arthrosis.

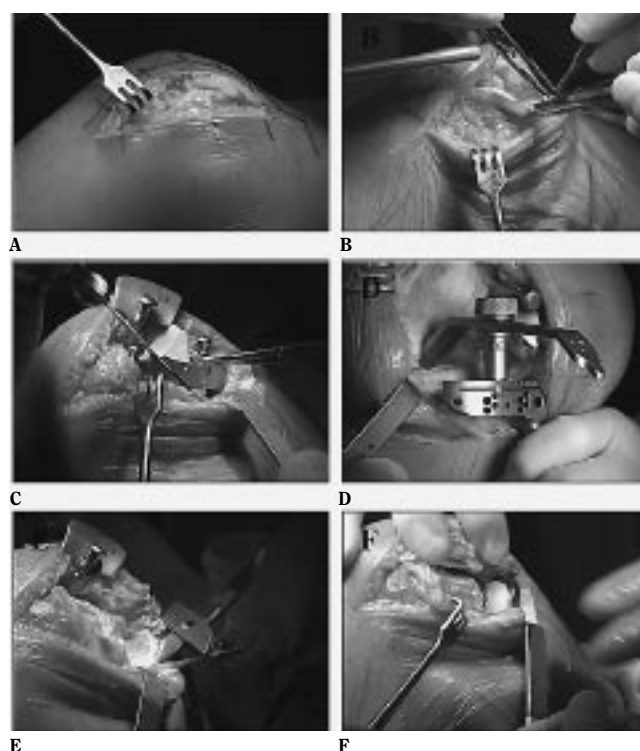


Figure 1. Minimally Invasive Unicompartmental Knee Arthroplasty: (A) Three inch long skin incision is made starting from the superior pole of the patella and extending distally to the tibial tubercle (1 cm medial to the medial pole of the patella). (B) A medial arthrotomy is made in line with skin incision. (C) Femoral sizing guide attached and the chamfer cuts performed along with drilling of the lug holes for the femoral component. (D) The external tibial alignment guide-taking approximately 2mm of bone from medial tibial plateau. (E) The transverse tibial cut is performed with a reciprocating saw. (F) Final implants

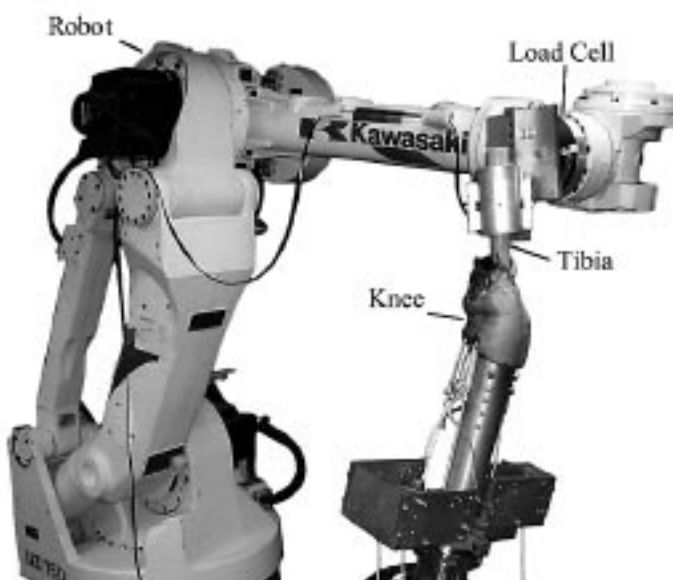


Figure 2. Robotic Testing System: Six degree-of-freedom (DOF) universal load cell (JR3 Model 160M50S, JR3 Inc., Woodland, CA) attached to the end effector of a 6DOF robot arm (Kawasaki UZ150, Kawasaki Heavy Industry, Japan). The system has a load capacity of 1470 N. Courtesy Dr. Guoan Li

Using strict patient selection criteria, this procedure has demonstrated excellent long-term results, comparable to those of total knee arthroplasty.^{3,5} In the current health-care market, unicompartmental knee arthroplasty may have mul-

iple advantages over total knee arthroplasty based on lower implant cost²¹, shorter hospital stay²⁰, more rapid recovery^{20,22}, decreased transfusion requirement^{19,23}, and improved patient satisfaction²⁴.

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