

MEDIAL MOBILE-BEARING UNICOMPARTMENTAL KNEE ARTHROPLASTY IN YOUNG PATIENTS AGED ≤ 50 YEARS

Abstract

Introduction

Contemporary research has shown medial mobile-bearing unicompartmental knee arthroplasty to be an effective treatment in patients younger than 60 years of age; however only one study using a fixed-bearing design has investigated outcomes in patients 50 years or younger. The purpose of this study was to determine the clinical outcomes and survivorship of medial mobile-bearing unicompartmental arthroplasty in this younger patient population.

Methods

A retrospective review of patients undergoing primary unicompartmental knee arthroplasty using the Oxford partial knee from 2003 to 2014 in a single practice database was performed. Patients were included in the study if they were 50 years of age or younger with a primary diagnosis of anteromedial osteoarthritis and minimum clinical follow-up of two years. Patient clinical outcomes, function and need for revision surgery were assessed.

Results

The study included 340 knees. Average patient age was 46.5 years, and the mean follow-up was 6.1 years. Patients demonstrated significant improvements ($p < 0.05$) in ROM [114.5 v 116.9], UCLA activity score [4.4 vs. 5.6], Knee Society Clinical [37.3 vs 86.5] and functional scores [58.8 v 79.8]. Overall 22 patients required reoperation and the predicted survival rate was 96% at 6-years and 86% at 10-years. Aseptic loosening occurred in seven patients at an average of 5.6 years post-operatively, while four patients required conversion to total knee arthroplasty due to arthritic progression at a mean time of 6.6 years. There were no revision procedures required due to polyethylene liner wear or breakage.

Conclusion

Medial mobile-bearing unicompartmental arthroplasty should be considered an effective surgical treatment in patients younger than 50 years of age suffering from anteromedial osteoarthritis of the knee.

Introduction

The “Oxford Knee” was first introduced by Goodfellow and O’Connor in England in 1974 specifically for treatment of anteromedial osteoarthritis of the knee (Goodfellow, O’Connor, Dodd, & Murray, 2006) (Goodfellow, Kershaw, Benson, & O’Connor, 1988). It was a descendent of early unicondylar arthroplasty procedures, but it first introduced the concept of a fully congruent mobile articulating surface. Historically survivorship has demonstrated to range between 84% to 100% at 10-year follow-up in various studies with one study exhibiting 91% implant survivorship at 20-year follow-up (Murray, Goodfellow, & O’Connor, 1998) (Rajasekhar, Das, & Smith, 2004) (Price & Svard, A second decade lifetable survival analysis of the Oxford unicompartmental knee arthroplast, 2011).

Despite these generally successful outcomes, there has remained constant debate centering on patient indications for the procedure. Beginning in 1989, the classic article by Kozinn and Scott detailed contraindications to uniarthroplasty procedures including both disease-specific as well as patient-specific criteria which were based on outcomes from a case series of 100 patients (Kozinn & Scott, 1989). They stated that patients exceeding an age of 60, weight of 180 pounds, or those extremely physically active heavy laborers were contraindicated for the procedure given an increased risk for mechanical loosening based on their anecdotal evidence. And interestingly this philosophy has remained prevalent, as a study of members of the American Academy of hip and knee surgeons in 2006 cited age as the most important factor when deciding on treatment of patients with medial compartment arthritis, an intact ACL, and mild patellofemoral disease (Barnes, Mesko, & Teeny, 2006).

Multiple investigations have aimed to discredit this thought process when determining the appropriate indication for a uniarthroplasty procedure. Pandit and colleagues showed that the Oxford phase 3 implant revision rate and cumulative 10-year survival rates were relatively similar for patients of age less than 60-years old, of weight greater than 180-pounds, and those very active patients as compared to the ideal patients satisfying the Kozin and Scott criteria (Pandit, Jenkins, & Gill, 2011). The average age of the cohort less than 60-years old in this study was 55-years of age with only a few included patients less than 50-years of age. Similarly, in a study from Heidelberg Germany examining return to activity in young patients following Oxford uniarthroplasty, 93% of patients returned to regular activity and the revision rate was merely 2.5% at an average age of 55-years in the study cohort (Walker & Gotterbarm, 2015).

Even with these encouraging results in relatively young patients, the optimal treatment of medial compartment arthritic disease in patients aged less than 50-years remains uncertain. High tibial osteotomy was previously the primary means of surgical management in this patient population, although more recent study of long-term outcomes of this procedure is less promising (Farfalli, Farfalli, & Aponte-Tinao, 2012). As such, utilization of this procedure has decreased. However, uniarthroplasty results in these younger patients has scarcely been reported. The only work studying uniarthroplasty in patients under 50 years of age was comprised of a cohort of 35 patients from France (Parratte, Argenson, & Pearce, 2009). The 10-year implant survival reported in 2009 was 80.6% in this cohort, but patients were treated with a fixed-bearing implant and the operation was performed through a standard medial parapatellar approach with patellar eversion.

Therefore, the purpose of this research was to scrutinize uniarthroplasty outcomes in patients under 50-years of age using a medial mobile bearing implant through a minimally invasive approach. We sought to determine whether unicompartmental arthroplasty would provide a viable solution for treatment of medial compartment disease in this patient population, particularly focusing on patients' return to function and whether implant survival rate was comparable to the previously reported data.

Methods

Patients undergoing primary medial unicompartmental knee arthroplasty from 2005 to 2015 within a single practice database were retrospectively reviewed. Surgery was performed by one of four fellowship-trained joint arthroplasty surgeons. Patients were included in the study analysis if they were of age less than or equal to 50 years at the time of surgery. Those that had not completed a minimum of two-year clinical follow-up were excluded from the participants. Furthermore, patients were included if their indication for surgery was anteromedial osteoarthritis, whereas those patients with a diagnosis of avascular necrosis of the medial femoral condyle or tibia were excluded from analysis. All patients satisfied objective deformity criteria for anteromedial osteoarthritis of the knee including completion of a valgus stress radiograph to ensure appropriate correction of the deformity. Demographic data for each patient was collected and included in the final analysis.

The Oxford® partial knee replacement (Zimmer-Biomet; Warsaw, Indiana) was used for all cases in this study. This implant consists of a flat cobalt-chromium tibial tray with single keel and mobile polyethylene bearing which articulates with a spherical femoral component. An assortment of single-peg and twin-peg femoral components were used in this study depending on the date of surgery. The articulating surface of the polyethylene bearing is concave and the geometry perfectly matches the sphericity of the femoral component, while the undersurface of the polyethylene is flat. The surgical procedure was performed using minimally invasive instrumentation which allows the implantation without dislocation of the patella.

Post-operatively the patient underwent a standard 4-6-week course of physical therapy. Patients were evaluated clinically and radiographically at follow-up appointments at 6 weeks and one-year post-operatively, and on an annual basis thereafter unless problems arose.

Clinical outcomes were measured by the Knee society clinicals score, function score, and UCLA activity score at each follow-up appointment. Causes of implant failure and need for revision surgery were also examined.

The goal of the analysis was to determine the change in clinical function following the surgical procedure, and to establish the rate of revision surgery in this population. Pre-operative clinical scores were compared to the post-operative scores at the most recent clinical follow-up timepoint. Student's two-tailed t-test was used to compare the pre-operative to post-operative clinical scores with a standard error set at 5%. Survival rate was calculated from a life-table using revision for any cause as the endpoint.

Results

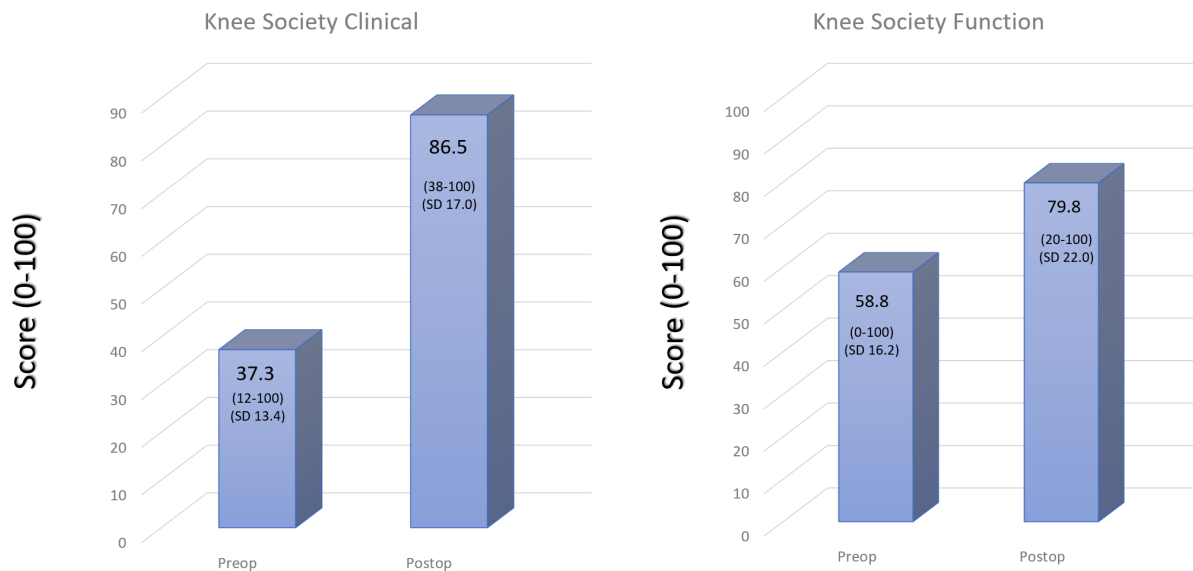
A total of 425 primary medial unicompartmental knee arthroplasty procedures were performed in patients younger than 50 years of age during the study period with 340 knees meeting the inclusion criteria of anteromedial osteoarthritis and two-year minimum clinical follow-up. The mean patient follow-up was 6.1 years (range 2 to 13). Average patient age was 46.5 years (range 29 to 50 years). Complete demographic data is presented in table 1.

TABLE 1: DEMOGRAPHIC DATA FOR STUDY POPULATION

279 patients (340 knees)	
Males : Females	41% : 59%
Age (years)	46.5 (29-50)
Height (inches)	67.2 (59-79)
Weight (pounds)	226.2 (115-420)
BMI (kg/m ²)	35.2 (18-62)
Insert height (mm)	3.6 (3-7)
Phase III : Twin-Peg	37% : 631%
Operative time (min)	59.9 (24-182)
Tourniquet time (min)	38.4 (13-93)
Intraop blood loss (cc)	53.9 (20-300)
Length of stay (days)	1.0 (0-4)

Clinical parameters and function improved post-operatively following medial mobile-bearing unicompartmental arthroplasty. Improvement in ROM was small but significant with a pre-operative mean of 114.5 [standard deviation 12.4] and post-operative mean of 116.9 [standard deviation of 11.2] [$p=0.02$]; however, the overall objective clinical parameters showed significant improvement of nearly 50 points in the Knee Society clinical score with a pre-operative mean of 37.3 [standard deviation 13.4] and post-operative mean of 86.5 [standard deviation 17] [$p<0.001$]. Patients also reported significant improvement in functionality following surgery that measured nearly 20 points in the Knee Society function score with a pre-operative mean of 58.8 [standard deviation 16.2] and a post-operative mean of 79.8 [standard deviation of 22] [$p<0.001$]. Knee society clinical and function scores are presented in Figure 1. Patient activity level also significantly increased as measured by the UCLA activity score [$p<0.001$]. Pre-operatively the mean score of 4.4 [standard deviation 1.5] categorized patients as being able to perform mild activity with limitations in activities around the house, whereas post-operatively the mean score improved to 5.7 [standard deviation 1.8] which correlates with the ability to perform moderate physical activity such as swimming in addition to having no limitations with daily housework.

FIGURE 1: KNEE SOCIETY CLINICAL AND FUNCTION SCORE



A total of 22 revision surgeries were performed during the period of the study as presented in Table 2. The most common cause for revision surgery was aseptic loosening in 7 patients with an average age of 46.1 years [standard deviation 2.5 years] occurring at an average of 5.6 years post-operatively [standard deviation 1.6 years]. Four patients with a mean age of 47 years [standard deviation 4 years] required conversion to total knee arthroplasty due to arthritic progression at a mean time of 6.6 years following the primary procedure [standard deviation 3.9 years]. There were no revision procedures required due to polyethylene liner wear or breakage in the study. Of interest, those patients revised at other institutions and those revised for unexplained pain were all re-operated on within 3 years of the primary surgery. The cumulative survival rate, using all cause revision surgery as the endpoint, was 96% at 6 years and 86% at 10-years as presented in table 3.

TABLE 2: FAILED UNICOMPARTMENTAL ARTHROPLASTY CASES

Age		Time	Reason for revision
43	F	0.8	Revised Elsewhere
46	F	1.7	Revised Elsewhere
48	F	3.4	Revised Elsewhere
41	F	1.3	Arthritic Progression
49	M	6.2	Arthritic Progression
49	F	9.5	Arthritic Progression
49	F	9.5	Arthritic Progression
42	M	3.2	Aseptic Loosening

50	F	6.2	Aseptic Loosening
46	M	4.4	Aseptic Loosening
46	M	4.9	Aseptic Loosening
46	M	6.2	Aseptic Loosening
45	F	6.4	Aseptic Loosening
48	F	8.2	Aseptic Loosening
42	M	0.2	Fall with Instability, Poly
47	M	2.4	Infection, Poly
47	M	1.1	Pain
43	F	1.6	Pain
49	M	2.4	Pain
48	M	0.6	Tibia Stress Fracture

TABLE 3: LIFE-TABLE ANALYSIS USING REVISION FOR ANY REASON AS ENDPOINT

Interval End Time	Number Entering Interval	Number Withdrawing during Interval	Number Exposed to Risk	Number of Terminal Events	Proportion Terminating	Proportion Surviving	Cumulative Proportion Surviving at End of Interval	Std. Error
1	340	0	340	1	0	1	1	0
2	339	12	333	2	0.01	0.99	0.99	0.01
3	325	42	304	4	0.01	0.99	0.98	0.01
4	279	38	260	3	0.01	0.99	0.97	0.01
5	238	36	220	1	0	1	0.96	0.01
6	201	46	178	1	0.01	0.99	0.96	0.01
7	154	37	135.5	2	0.01	0.99	0.94	0.02
8	115	19	105.5	3	0.03	0.97	0.92	0.02
9	93	22	82	2	0.02	0.98	0.89	0.03
10	69	26	56	2	0.04	0.96	0.86	0.03
11	41	21	30.5	0	0	1	0.86	0.03
12	20	10	15	1	0.07	0.93	0.8	0.06
13	9	9	4.5	0	0	1	0.8	0.06

Discussion

In our study of patients under 50 years of age with anteromedial osteoarthritis, treatment with medial mobile-bearing unicompartmental arthroplasty was shown to provide improvement in patient function and clinical parameters. Patient survival rate free of revision surgery was estimated to be 96% at 6 years and 86% at 10-years post-operatively.

Indications for utilization of unicompartmental arthroplasty have evolved over time with continued debate over the ideal patient candidate. In 1989 Kozinn and Scott were amongst the first to develop disease-specific and patient-specific criteria for application of unicompartmental arthroplasty (Kozinn & Scott, 1989). They believed that patients older than 60 years, of weight greater than 180 pounds, and those extremely physically active patients or heavy laborers were relatively contraindicated for the procedure. These principles stemmed from an unpublished study of 100 consecutive unicompartmental arthroplasty procedures performed by the author with 10-year follow-up in which nine of the thirteen failures from mechanical loosening occurred in patients meeting one of these aforementioned descriptions. Other authors have echoed this sentiment when indicating patients for the procedure (Thornhill, 1986). This ideology has remained prevalent as shown in a study of members of the American Academy of Hip and Knee Surgeons just over 10 years ago (Barnes, Mesko, & Teeny, 2006). In this poll, less than 50% of surgeons felt that unicompartmental arthroplasty would be indicated for treatment of a 60-year old moderately active patient with isolated medial compartment disease, an intact ACL, mild patellofemoral disease, and less than 7-degrees of varus angulation.

These historical contraindications have been challenged in recent studies using a medial mobile-bearing unicompartmental arthroplasty implant. The Oxford surgeons compared outcomes between those patients that met Kozinn and Scott indications verses those that did not in a prospective cohort of 1000 Oxford partial knee replacements (Pandit, Jenkins, & Gill, 2011). Cumulative 15-year survival rate was similar between those highly active male patients greater than 60-years old with weight greater than 180 pounds as compared to those patients without any of these contraindications [92.7% vs 89.9%]. Furthermore, clinical outcomes were similar or better in the Kozinn and Scott contraindicated patients (Hamilton, Pandit, & Jenkins, Evidence-Based Indications for Mobile-Bearing Unicompartmental Knee Arthroplasty in a consecutive Cohort of Thousand Knees, 2017).

Age has been a specific focus in these studies examining patient indications for unicompartmental arthroplasty. In this aforementioned Oxford knee study, when investigating solely the patient age, those patients less than 60-years old demonstrated no statistical difference in 15-year revision-free survival rate compared to those patients older than 60-years of age [94.8% vs 91.3%]; however they exhibited significantly greater improvement in the Knee Society Functional score, Oxford knee score, and Tegner activity score following the surgical procedure (Price, Dodd, Svard, & Murray, 2005). Similarly, in a study of 118 knees in patients less than 60-years of age treated with an Oxford phase 3 implant, 93% were able to return to regular physical activity with only five patients requiring revision procedures (Walker & Gotterbarm, 2015). Thus, it is believed that disease specific criteria of anteromedial osteoarthritis are more important in the determination of a unicompartmental arthroplasty candidate instead of patient age (Hamilton, Pandit, & Lombardi, Radiological Decision Aid to determine suitability for medial unicompartmental knee arthroplasty, 2016).

Despite these results in a relatively younger patient population, the treatment of medial compartment disease in patients under 50 years of age has remained uncertain. High tibial osteotomy had served as the primary means of treatment in these younger patients as recommended by Kozinn and Scott (Aglietti, Rinonapoli, & Stringa, 1983). And in the previously mentioned AAHKS member survey, over 50% of respondents stated they would choose high tibial osteotomy for treatment of a 45-year old patient in the same case scenario as opposed to less than 30% who would choose unicompartmental arthroplasty. However there has been waning enthusiasm for the use of high tibial osteotomy in this population, largely due to the increased difficulty in converting these osteotomized knees to total knee replacements (Jackson, Sarangi, & Newman, 1994). In a study by Cross et al comparing conversion of unicompartmental arthroplasty and high tibial osteotomy to total knee replacement, the complication and reoperation rates of those patients with high tibial osteotomy was more than twice as large as those patients with unicompartmental arthroplasty [21% vs 8%; 17% vs 8%] (Cross, Yi, & Moric, 2014).

There is only one previous study examining the outcomes of medial unicompartmental arthroplasty in patients under the age of 50. In this study performed in France of 35 consecutive knees with an average age of 46-years, a standard medial parapatellar approach with patellar dislocation was performed in 80% of cases while all patients received a fixed-bearing unicompartmental implant [Miller-Galante; Zimmer, Warsaw, Indiana] (Parratte, Argenson, & Pearce, 2009). Patients demonstrated significant improvement in Knee Society Clinical and Function scores, and 29 of 31 patients were able to return to previous activities at a mean follow-up of 9.7 years. However, at this mean follow-up timepoint, the survival rate free of revision surgery was 80.6% due to six revision procedures of which four were due to significant polyethylene bearing wear. In comparison, our series predicted survival at 10-years is 86% with no failures associated with polyethylene bearing. The most common reason for revision surgery was aseptic loosening of either the femoral or tibial component, which was the cause in 7 of the 22 failures. In this age group the 10-year survival is lower than has previously published for the Oxford partial knee in older patient groups (Pandit, Jenkins, & Gill, 2011) (Price, Dodd, Svard, & Murray, 2005) (Rajasekhar, Das, & Smith, 2004) (Keys, Ul-Abiddin, & Toh, 2004). This likely reflects the young age of the patients and is similar to the trends seen in registry data with higher revision rates in young patients (Jeschke, Gehrke, & Gunster, 2016).

However the mobile-bearing design with a congruent articulation reducing contact stress is likely to be an advantage to the younger patient (Goodfellow, O'Connor, Dodd, & Murray, 2006). This was born out in our study in which there were no revision surgeries due to polyethylene fracture or wear. Conversely, the fixed-bearing design is likely subject to higher areas of stress concentration as shown by the need for polyethylene bearing revision in the study by Parate et al. Mobile-bearing polyethylene is subject to the risk of dislocation yet this was not an encountered problem within our study.

An interesting finding in this study which has been observed within larger registry studies is the tendency toward early conversion of unicompartmental arthroplasty in cases of unexplained pain. Despite the proven success of unicompartmental arthroplasty in independent studies, there have been multiple registry studies demonstrating a slightly lower survivorship of unicompartmental arthroplasty compared to total knee arthroplasty (Koskinen, Eskelinen, & Paavolainen, 2008) (Amin, Patton, & Cook, 2006). This difference is believed to be due to differences in indications, implants, and technical aspects of the procedure such as overcorrection of the deformity which cannot be controlled for in a large registry collection. Likewise, there is also a difference in threshold for converting a unicompartmental arthroplasty to a total knee arthroplasty. Conversion from unicompartmental arthroplasty to total knee

arthroplasty is technically easier than revision total knee arthroplasty, and patients demonstrate superior clinical outcomes and lower complications following conversion; therefore surgeons likely are biased when determining the threshold for performing a conversion procedure as opposed to revision total knee arthroplasty (Liddle, Pandit, & Judge, Patient-reported outcomes after total and unicompartmental knee arthroplasty: a study of 14,076 matched patients from the National Joint Registry for England and Wales., 2015) (Liddle, Judge, & Pandit, 2014). This was apparent in our study as there were 3 patients revised to total knee arthroplasty for unexplained pain and another 3 revised to total knee arthroplasty by surgeons not affiliated with the study, and the average time to conversion was just under two years from the index procedure.

The structure of our study is not without limitations beginning with the retrospective design. A control group was not included in the analysis for comparison and instead the outcomes in our young patient population was compared to other previous studies. Additionally, there were four surgeons included in the study which predisposes to slight differences in pre-operative decision-making, technical experience, and indications for revision surgery.

Conclusion

Age has historically remained a contraindication for unicompartmental arthroplasty since the breakthrough article of Kozinn & Scott in 1989. Recent examination of the oxford medial mobile-bearing partial knee has demonstrated successful results in patients younger than 60 years of age; however only one study using a fixed-bearing design has investigated unicompartmental arthroplasty outcomes in patients 50 years or younger. The presented study demonstrates significant improvement in patient symptoms and function following medial mobile-bearing unicompartmental arthroplasty in subjects younger than 50 years of age with a diagnosis of anteromedial arthritis. At a mean follow-up of 6 years, survival free of revision surgery was 94%, while the survival rate at 10 years was 86%, which is better than that previously reported in a study using a fixed-bearing uniarthroplasty implant. Medial mobile-bearing unicompartmental arthroplasty should be considered an effective surgical treatment in young patients suffering from anteromedial osteoarthritis of the knee.

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