A Single Surgeon, 10 Year Experience with the Oxford Partial Knee System: What a Difference Experience, Instruments, Implants, and Technique Can Make

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Abstract

Partial knee (unicompartmental) arthroplasty (PKA) for medial compartment disease of the knee has a long and well documented history of successful results over long periods of follow up. The Oxford Partial Knee Replacement has been available in the U.S. since 2004. After completing an FDA required instructional course, surgeons may use the device. Both the implant and the instruments have evolved since its introduction in 2004. This paper outlines the authors continuous cohort of 249 patients, 286 knees from 2004 to 2014 with minimum 2 year follow up, and reports the results while discussing the impact of experience, instruments and implants, and technique on the outcome of patients in this series. For the aggregate group of 286 knees, there were 17(5.9%) all-cause revisions to TKA, including 2(0.7%) dislocations, resulting in a (83%) survivorship at ten years. The survivorship at ten years for retained implants was 97% if non-implant related causes are not included. At one year, there were 89% excellent and good results, 5% fair, and 6% poor. At two years, there were 93% excellent and good, 1 % fair, and 5.5% poor. The causes for the poor results at one and two years were tibial sided failure or persistent pain. Three (12%) of patients with a poor result at one year had converted to good and excellent at two years. The use of the Oxford Mobile Bearing™ PKA has been shown to be a useful part of the surgeon's surgical armamentarium when dealing with anteromedial osteoarthritis or osteonecrosis of the knee. PKA has been shown to have a lower morbidity and mortality and is cost effective when compared to total knee arthroplasty. The author's experience, as demonstrated in this study, adds validity to the concept that understanding the pathoanatomy of anteromedial osteoarthritis and gaining surgical experience through increased surgical volume, adherence to well documented technique, and the use of a time proven implant, can be accomplished with a high degree of successful outcomes for patients with the appropriate indications.

Keywords: partial knee arthroplasty, PKA, Oxford Partial Knee Replacement

Level of Evidence: AAOS Therapeutic Level III

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Introduction

Partial knee (unicompartmental) arthroplasty (PKA) for medial compartment disease of the knee has a long and well documented history of successful results over long periods of follow up time in multiple publications and national joint registries [1,2,3,4]. More recent studies have also shown that compared to total knee arthroplasty, PKA carries a lower associated morbidity and mortality and is a more cost effective treatment [29,30,31,32]. White and Goodfellow published the concept and pathoanatomy involved in anteromedial osteoarthritis of the knee, which they believed was the primary indication for PKA [5]. The pathology of anteromedial OA of the knee consists of bone on bone cartilage loss in the anterior and mid medial compartment in association with an intact ACL, MCL, LCL, and functionally normal lateral compartment cartilage which can be demonstrated with a valgus stress radiograph [6].

Controversy still exists regarding indications and contraindications for PKA, particularly with respect to the widely adhered to published criteria set forth by Kozinn and Scott, [7]. Goodfellow began using the Oxford Mobile Bearing™ (OMB) PKA in the late 1980's for anteromedial osteoarthritis, and his early results were published by Murray et al. showing greater than 90% survivorship at 10 years. [8] Other, conflicting non-designing surgeon series, showed inferior results compared to the Oxford groups' series [9,10]. Because of these conflicting results, and to improve outcomes with the OMB device, the Oxford group developed an instructional course to better educate surgeons on the appropriate indications and surgical technique when using the OMB. The Oxford Mobile Bearing™ was released for use in the US in 2004. As a requisite of the release, the FDA required that all surgeons attend an instructional course prior to using the device. The author began using the OMB in 2004.

This study includes all patients (from an IRB approved data bank) operated on between 8/2004 and 9/2014, with a minimum two year follow up. The study period includes 249 patients with 286 knees, which will be analyzed as an aggregate group. A sub-group analysis includes two separate groups. Group I, 133 knees operated between 8/2004 and 9/2009, using the Phase III instruments, technique, and a single peg femur. Group II, 153 knees operated between 10/2009 and 9/2014, using Microplasty™ instruments, technique, and a two peg femur, changes for which the author participated as part of the OMB design team. A total of 10 knees performed using the Oxford Signature custom guides will be included in this group, because the surgical principles are based on the same Microplasty™ technique

as utilized for the other patients in Group II.

Materials and Methods

Of the 249 patients in this study, there are 128 females and 121 males. In 239 patients, the diagnosis was anteromedial osteoarthritis and in 10 patients the diagnosis was spontaneous osteonecrosis. The age range for the patients was from 38 to 88 years, with an average of 64.7 years. The right knee was operated in 152 knees and the left in 134 knees. Preoperative extension ranged from 0-12 degrees (average 1.7), and preoperative flexion ranged from 95-145 degrees (average 124). Preoperative KSS scores for pain ranged from 32-89 (average 53.7) and preoperative KSS function scores ranged from 25-90 (average 54.5). Fig. 3.

Preoperative evaluation for all patients included a standing AP radiograph, true lateral, sunrise view, and valgus stress view. Interpretation of these views for appropriate indication for PKA have been published and these indications were adhered to by the author in this series. [10]

The patients in Group I (8/2004-9/2009), consisting of 133 knees, were operated using the Phase III instruments and technique. The femoral component implanted in these patients was a single peg femur. Patients in Group II (10/2009-9/2014), consisting of 153 knees, were operated using newly developed Microplasty™ instrumentation and technique. The femoral component implanted in these patients was a redesigned 2 peg femur. All patients had spinal anesthesia, unless contraindicated. Surgeries were done using the Oxford leg holder, tourniquet control, minimally invasive surgical technique, and with pericapsular field blocks prior to closure. Early in the series, once daily Lovenox was used for DVT prophylaxis, but later switched to BID aspirin. Patients had 23-hour observation stays in the hospital.

Routine follow up was at one month, 3 months, and 1 year. Patients were then advised to follow up annually for 5 years, then a 10-year visit. As many patients who were doing well did not want to come in annually for the first five years, towards the middle of this series patients were advised to have a 10 year follow up visit after a successful 2-year visit, or return at any time if their knee was bothering them. Preoperative KSS scores were completed as well as KSS scores at annual follow up periods.

Radiographs were obtained preoperatively, including a valgus stress radiograph, then at the 4-week postoperative visit, and at the annual exams thereafter. Radiographs were read by the author and over read by a hospital based radiologist. Radiolucencies were classified as physiologic (less

than 1-2 mm and non-progressive) or pathologic (greater than 3 mm and progressive, with or without change in component position). No attempt was made to classify radiolucencies by zone, and implants were recorded as fixed or loose. Failure was defined as revision of the implants for any reason, including those for bearing dislocation and survivorship analysis was based on this definition. Return to the operating room for other causes were not listed as failures, but reoperations. Time to revision was displayed using Kaplan Meier curves. Log-rank test was conducted for comparing the survival curves between the cohorts of Group I and Group II. All tests were 2-sided and statistical significance level was set at 0.05. Statistical analyses were performed using SAS® Enterprise Guide 6.1 (SAS Institute, Cary, NC, USA).

Results

At one year follow up range of motion showed a range of extension from 0-25 degrees with an average of 0.3 degrees. The range of flexion was from 90-155 degrees with an average of 126.5 degrees. KSS pain scores improved with a range of 41-100 with an average of 93.4 and KSS function scores ranged from 40-100 with an average of 89.4. It is important to note that deductions for overall limb alignment were not done in the post op calculation, in that the principle of the surgery is to correct the limb to the pre-disease alignment, which may result in residual varus, and has been shown not to influence overall results [11]. The KSS scores are shown for the patient follow up periods listed as 1, 2, 5, and 10 years. (Fig. 3) At one year, there were 89% excellent and good results, 5% fair, and 6% poor. At two years, there were 93% excellent and good, 1 % fair, and 5.5% poor. The causes for the poor results at one and two years were tibial sided failure or persistent pain. Three (12%) of patients with a poor result at one year had converted to good and excellent at two years. Fourteen (5.6%) of the patients are deceased. Twenty-four (10%) are considered lost to follow up. Four (1.6%) were contacted and stated they did not want to return for a follow up visit, 2 are doing fine, 2 were having some degree of pain.

For the aggregate group of 286 knees, there were 17 (5.9%) all-cause revisions to TKA, including 2 (0.7%) dislocations, resulting in a (83%) survivorship at ten years. The survivorship at ten years for retained implants was 97% if non-implant related causes are not included. (Figs.1 and 2) Eight (2.8% of knees), which represented 47% of revisions were for tibial or femoral mechanical failure. There were 5 (1.7%) tibial sided failures at 15, 17, 24, 32 and 72 months' post index arthroplasty. There were 3 (1.0%)

Figure 1. Comparison of Group I and Group II survivorship 10 years

Figure 2. Comparison of Group I and Group II survivorship 5 years

Figure 3.

femoral component loosening at 3, 4, and 10 years. Eight (53%) of revisions were non-implant related: 3 (1.0%) lateral compartment progression, two within 1 year from surgery and 1 at 9 years. One patient developed rheumatoid arthritis at 5 years and the Oxford was revised to a TKA at 6 years. One patient (0.3%) had a periprosthetic femoral fracture at 3 years. One (0.3%) had a late hematogenous infection at 3 years which was managed with a two-stage revision TKA. In this aggregate group, there were 11 (3.8%) return to the OR for non-revision reasons: 2 (0.7%) dislocations; 1 (0.3%) I&D of a hematoma; 1 (0.3%) late sepsis; 1 (0.3%) superficial wound necrosis I&D with STSG; 2 (0.7%) manipulations under anesthesia; 4 (1.4%) arthroscopy for lateral meniscus tear, cement removal, documentation of a loose femoral component, and to document lateral progression, respectively. There were no cases of DVT, PE, MI, or death in the perioperative period.

In the Group II sub-analysis of 153 knees, there were 5 (3.2%) revision/re-operations. Two (1.3%) patients were revised to a TKA: one for a periprosthetic femur fracture and one for lateral compartment progression at 18 months. There were no revisions for implant loosening of either the femur or the tibia. There were 2 (1.3%) bearing dislocations in this group and 1 (0.75%) patient with superficial wound necrosis that required a STSG. These 3 patients were the only non-revision return to the OR in this group. There was a 97% all cause survivorship with revision to TKA as the endpoint for this subgroup at 5 years. For survivorship analysis, bearing dislocation was treated as a revision surgery, as both occurred in Group II. No implant related failures occurred in Group II. Although there was no statistical difference in all cause survivorship between Group I and Group II, all the implant related failures were in Group I. As stated, re-operations for dislocation, both occurring in Group II, were counted as failures, even though they did not result in revision to TKA.

Discussion

Partial knee arthroplasty for anteromedial osteoarthritis of the knee has been shown to be a cost-effective treatment with excellent outcome and durable long term results in multiple studies and reviews of national joint registry data. [1,2,3,4] The description of anteromedial arthritis by White and Goodfellow is the prime indication for the OMB, however spontaneous osteonecrosis is a good secondary indication with excellent outcomes [14,15]. Many surgeons feel that the criteria set forth by Kozinn and Scott are too restrictive, and a recent article more clearly elucidated the unnecessary contraindications for using the

OMB. [13]. This article more clearly defined how the status of the patellofemoral joint rarely has an adverse effect on patient outcome, unless there is significant lateral facet disease. A recent consensus statement has attempted to clarify current thought regarding the indications and contraindications for medial PKA [16]. Perhaps the debate regarding the appropriate use of PKA continues, however, in part due to the 2 to 3-fold higher failure rates as compared to TKA reported in several national joint registries [4,22]. Explaining this discrepancy is difficult, as national registries do not collect data as to whether the indications for the procedure or the surgical technique was appropriate for individual patients.

As part of the FDA approval process of the OMB in the US, all surgeons are required to attend an instructional course prior to using the device. The course stresses the importance of appropriate surgical indications and execution of the surgical steps necessary for a successful outcome. There have been several articles that address the effect of surgeon case volume as well as hospital volume on the outcomes in total joint arthroplasty. [17,18,19]. One study showed that surgeons who performed the OMB on 20 to 40 percent of knee replacement candidates, had significantly lower revision rates than those who performed less. [20,21] It stands to reason that surgical case volume is a surrogate for experience, particularly as it pertains to the individual surgeons' outcomes, as shown in the results from the National Joint Registry for England and Wales, which demonstrated higher revision rates in low volume surgeons. This data was also verified by a recent review of data for the UK NJR, which showed very low revision rates for surgeons who were performing PKA on 15 patients per year, and significantly higher rates in those who performed fewer than 5 per year. [4,22]

In the authors opinion, it is not well defined what the individual learning curve is for a given surgeon performing a given surgical procedure, and specifically when using the OMB. Intuitively, facilitating a surgeon becoming proficient at performing a particular surgical procedure can help to improve the outcome. Improvement through educational endeavors that facilitate the understanding of anatomic pathology, the indications for the procedure, and the proper execution of the surgical steps is undeniable. Having instruments used for the procedure that are intuitively practical, efficient to use, and reproducible is a necessary component of surgical success and long term outcome.

In the authors series, Group I patients were operated using Phase III instruments and the single peg femur. The Phase III technique involved making the vertical cut on the proximal tibia adjacent to the lateral edge of the medial femoral condyle. Patients with wide intercondylar notch-

es, particularly females, could end up with tibial resections too far medial thereby necessitating the use of a smaller tibial baseplate. Additionally, without a consistent stylus, the depth of the horizontal tibial cut could lead to over resection of bone. Small and Berend, in their work, using strain measurement techniques, showed the dramatic increase in tibial strain in the proximal medial tibia following PKA. [22,23] They were also able to demonstrate the adverse effect of excessive posterior or anterior slope on strain patterns, as well as the position and rotation of the vertical cut [24]. In Group I patients, the tibial sided failures were associated with tibial cuts that were either too medial or the horizontal cut was excessive (or both), leading to the use of a smaller base plate. The resultant increase in tibial stress is the probable cause for the subsidence and loosening observed in these cases.

In this series, four of the five tibial sided failures occurred early within the first three postoperative years. The cause of this early loosening is described above as it relates to the tibial bone cuts in the Phase I patients. Femoral loosening, although rare, 1.0% in this series, were all in Group I patients, using a single peg femoral component. These patients all had intact tibial components. With the development and implementation of the Microplasty™ instruments, the surgical execution has become easier and more reproducible, as elucidated in a paper by Hurst et al. [26] A significant change in the Microplasty™ technique was the positioning the vertical tibial cut adjacent to the tip of the medial tibial spine at the ACL footprint, instead of the lateral edge of the medial femoral condyle, thus maximizing the tibial baseplate size, increasing tibial plateau coverage, and reducing tibial stress, as elucidated by Small et al.

Of interest, is that none of the patients in Group II have had tibial sided loosening to date, nor have any had any worrisome radiographic radiolucencies or subsidence. On the femoral side, the Microplasty™ instruments have made femoral preparation simpler and more reproducible compared to Phase III [25]. In the authors opinion, however, that implementation of the two peg femur is responsible for the reduced femoral loosening to zero in the mid-term follow up of Group II patients. Additionally, in Group II, radiographic review has determined that no patients are felt to be at risk for loosening.

In the aggregate group, the all cause revision rate of 5.9% at 10 years is comparable to results found in other published series [2,26,27,28]. In this series, 2.4% of the revisions were for mechanical failure of either the tibial or the femoral component. More importantly, these implant related failures were all in Group I patients which were in the authors early experience with Phase III technique and the single peg femur. The leading cause of non-implant re-

lated failure, is lateral compartment progression, occurring in 3 (1.0%) patients, a number which is comparable with published results. [1] To the authors knowledge, there is no preoperative evaluation that can reliably identify those patients at risk for lateral compartment progression following medial PKA, however it is critical to note that the performance of the valgus stress radiograph is essential to documenting the status of the lateral compartment. In a recent publication, the valgus stress view demonstrated lateral compartment collapse in 3 of 78 patients, and thus a contraindication to PKA. [29].

It is important to state that in this series that although the 2 (0.7%) dislocations were considered failures for survivorship analysis, they are not revisions of the implants, as may be reported in some data sets and registries. The rationale for future reporting of bearing dislocation as a reoperation rather than a revision is that the solution for bearing dislocation involves a simple arthrotomy, retrieval of the dislocated bearing, and replacement with a new bearing. It does not involve the removal or exchange of fixed components, or revision to total knee arthroplasty. Therefore, if the rare bearing dislocation was to be considered a non-revision operation, survivorship would be improved 85% in this series.

In this series, the lack of significant perioperative complications, notably DVT, PE, MI, or death, is of significant interest. Lovenox was used initially for DVT prophylaxis and later changed to ASA, with no discernable difference except the return to OR for hematoma evacuation was in a patient on Lovenox prophylaxis. Several recent studies have shown the significant reduction in morbidity and mortality between PKA and TKA [30,31], and the results presented in this series would corroborate those findings. Additionally, in this series, there were no reoperations related to the patellofemoral joint, which reinforces the findings of the many published series cited in this paper.

Conclusions

The use of the Oxford Mobile Bearing™ PKA has been shown to be a useful part of the surgeon's surgical armamentarium when dealing with anteromedial osteoarthritis or osteonecrosis of the knee. PKA has been shown to have a lower morbidity and mortality and is cost effective when compared to total knee arthroplasty. The author's experience with the OMB, as demonstrated in this study, adds validity to the concept that understanding the pathoanatomy of anteromedial osteoarthritis and gaining surgical experience through increased surgical volume, adherence to well documented technique, and the use of a time proven im-

plant, can be accomplished with a high degree of successful outcomes for patients with the appropriate indications. Improved OMB surgical technique, instrumentation, and implant design have resulted in improved outcomes over time within the author's series, with a significant reduction in mechanical loosening of both the femoral and tibial components using later generation designs of the OMB. Lateral compartment disease progression, although infrequent, remains the leading non-implant related cause of long term failure. Future research efforts will need to be directed towards identifying those patients at risk, so they may be counseled preoperatively as to this small but significant risk. Additionally, future studies will be needed to compare other PKA designs and techniques regarding survivorship when comparing multiple surgeons from various locations who utilize PKA in the management of anterior medial OA of the knee and SONK.

Disclosure

One or more of the authors have disclosed information that may present potential for conflict of interest with this work. For full disclosures refer to last page of this journal.

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