The frequency of unicompartmental knee arthroplasty (UKA) procedures has increased rapidly over the past decade. Some conflicting evidence exists concerning UKA revision. Some studies have found UKA revisions to be comparable with primary total knee arthroplasty, whereas others have found that UKA revisions require a higher need for tibial stems and augments and have more complications and worse results. This study seeks to determine the effect of a conservative tibial resection in UKA on the ease of revision and its outcomes in a consecutive patient cohort.

Thirty-five patients underwent 37 conversions of a medial UKA to a total knee arthroplasty. Clinical, functional, and radiological data were evaluated. At revision, a primary total knee arthroplasty implant was used in 24 (88.8%) patients who underwent a conservative tibial resection during their UKA compared with only 3 (30%) patients who underwent an aggressive tibial resection ($P<.001$). The odds ratio of needing an augment or stem was 26.8 (95% confidence interval, 3.71-194) when an aggressive resection was performed compared with a conservative resection during the UKA.

The results indicate that revision of a medial UKA can be comparable with a primary TKA when a conservative tibial resection is performed at the time of the primary UKA. It is possible to preoperatively predict which patients might need the use of augmentation and stems during UKA revision. This data should guide surgeons to strive for the most conservative UKA tibial resection possible in patients undergoing medial UKA.
The frequency of unicompartmental knee arthroplasty (UKA) procedures has increased in the past decade. The number of UKA procedures has more than tripled that of total knee replacement (TKA) procedures in the United States over the past 10 years. Although UKA is thought to be controversial procedure by some, proponents have argued that it has several primary advantages, including better preservation of normal knee kinematics, smaller blood volume loss, decreased perioperative morbidity, and faster patient recovery. Typically, range of motion (ROM) is greater and revision of UKA is usually less challenging than revision of TKA. In addition, because a UKA procedure is inherently more conservative, less bone is sacrificed.

One key reason to consider UKA procedures is the relative success of revision to a TKA should the UKA fail. Some conflicting evidence exists concerning UKA revision. Some studies have found UKA revisions to be comparable to primary TKA, whereas others have found UKA revisions to cause a higher incidence of complication and worse results.

This study seeks to determine the effect of a conservative tibial resection in a medial UKA regarding the ease of revision and its outcomes in a consecutive patient cohort. The authors retrospectively examined the outcomes after a failed UKA revision. They hypothesized that a primary knee implant might be used during revision surgery if a conservative tibial cut was performed during the original UKA.

**Materials and Methods**

Between January 1988 and December 2011, thirty-five patients (37 knees) underwent conversion from a medial UKA to a TKA. Twenty men and 15 women with an average age of 60.6 years (range 39-73 years) at the time of the UKA conversion surgery were included. All but 2 patients had their original UKA surgery and all but 1 revision surgery were performed by the senior author (R.D.S.). Clinical, functional, and radiological data were evaluated for all patients. The underlying indication for UKA conversion surgery was adjacent compartment osteoarthritis, femoral implant failure, tibial implant failure, and polyethylene insert wear or osteolysis.

For all patients, the procedure was performed in the supine position via a standard medial parapatellar approach.

**Data Collection**

All 35 patients (37 knees) from the original study cohort were evaluated. Of these, 15 patients died of causes unrelated to the TKA. Patients’ demographic data were collected from the their charts. Radiographic data were found for all patients. The Knee Society score was completed preoperatively and at the last follow-up visit.

Two authors (R.S., R.D.S.) performed the radiological assessment. Anteroposterior (AP) radiographs of the knee and operative reports were evaluated and the UKA tibial cut was measured and assessed. The tibial cut was considered conservative if the resection level from the medial tibial plateau extended laterally at a perpendicular angle to the tibial shaft and the resultant lateral resection was smaller than 12 mm (Figure 1A) and was considered aggressive if the resultant lateral tibial resection was larger than 12 mm (Figure 2A). The conversion to a TKA was considered primary if no augments, stems, or bone grafts were used and the composite tibial thickness was less than 15 mm during the UKA conversion (Figure 1B) and was considered complex if augments, stems, or bone grafts were used (Figure 2B).

**Data Analysis**

A multiple logistic regression analysis was performed to examine the association between the type of tibial resection and the use of augments, stems, or bone grafts. A P value less than .05 using a 2-sided t test was considered statistically significant. Fisher’s exact test was used for categorical variables, and the Wilcoxon Signed-Rank test was used for the continuous variables to compare complex and primary implant groups during the TKA revision and to compare the with and without surgery groups after TKA.

Figure 1: Anteroposterior radiograph showing a unicompartmental knee arthroplasty with a conservative tibial resection (A). Anteroposterior radiograph showing a revision total knee arthroplasty with a primary implant after conservative tibial resection (B).
Cumulative survival analysis for the revision TKA component was measured via a Kaplan-Meier curve, with surgery for any reason and revision for tibial component failure as the endpoints, with 95% confidence intervals (CI).

**Results**

For the 35 patients (37 knees), median clinical follow-up after UKA conversion to TKA (including the deceased) was 7.8 years (range, 1.2-22.8 years). Thirty-seven knees' operative reports and AP knee radiographs were evaluated to assess the UKA tibial cut. Twenty-seven knees had a conservative (smaller than 12 mm) tibial cut and 10 knees had an aggressive tibial cut (larger than 12 mm). Of the 37 knees that underwent conversion of from UKA to TKA, 27 (73%) received a primary TKA implant, and 10 (27%) received a complex (augment, stem or bone graft) TKA implant. At the time of UKA revision, a primary TKA implant was used in 24 (88.8%) of 27 knees that underwent a conservative tibial resection during their UKA and 3 (30%) of 10 knees underwent an aggressive tibial resection; this difference was shown to be statistically significant ($P<.001$). The odds ratio of needing an augment or stem during the conversion TKA was 26.8 (95% CI, 3.71-194) when an aggressive tibial resection was performed during the UKA surgery compared with a conservative resection during the time of the UKA. When adjusting for other confounding variables (ie, age, sex, ROM, time from UKA to revision), the odds ratio was almost doubled.

Average time from UKA to TKA conversion among all patients was 8.3 years (range, 1.2-22.8 years). For patients who underwent revision surgery with a complex implant (n=10), average time was 8.8 years (range, 1.2-22.8 years) between the UKA procedure and the TKA conversion surgery compared with an average of 8.1 years (range, 2.2-17.3 years) for the group of patients who received a primary implant during the TKA conversion (n=27). This difference was not statistically significant. Average knee ROM prior to UKA revision was 116.9° (range, 105°-140°) for patients who had a complex implant revision compared with 112.5° (range, 90°-140°) for patients who received a primary TKA; the difference was not statistically significant. Sex, age, and ROM prior to UKA procedure were not statistically significant predictors of the need for complex revision (Table 1).

When the associations between the different variables and the need for further surgery after the TKA conversion were examined, sex was found to be slightly associated ($P=.067$). Age at TKA conversion, length of follow up, ROM before TKA conversion, ROM at most recent follow-up, and type of tibial resection were not found to be statistically associated with need for further surgery after TKA conversion (Table 2). None of the variables examined was statistically associated with ROM after TKA conversion.

Revision of any component of the TKA conversion was documented in 3 (8.1%) knees, with an average time to revision of 5.6 years (range, 2.7-7.7 years); 2 revisions were due to femoral component loosening and 1 was due to tibial component failure. The tibial revision was due to component collapse 8 years after conversion into an unincorporated bone graft placed at the site of the revised UKA tibial component. A conventional primary tibial component had been used on top of the graft without any augment or extended tibial stem.

Using the Kaplan-Meier survivorship method, with revision surgery due to tibial component failure as an end point, the authors compared patients who had undergone conversion UKA with a primary TKA implant with patients who underwent a conversion UKA with a complex TKA implant; the 5-year survivorship, with revision surgery as the end point, was 100% and 100%, respectively, and the 10-year survivorship was 100% and 66.7% (95% CI, 5.4%-94.5%), respectively. Survivorship stayed unchanged until 17 years for primary TKA implant group (Figure 3). When patients who underwent a conservative tibial cut were compared with patients who underwent an aggressive tibial cut, the 5-year survivorship rate, with tibial revision surgery as the end point, was 100% in both groups and the 8-year survivorship rate was 83.3% (95% CI, 24.8-99.9%).
27.3%-97.5%) and 100%, respectively; the survival rate stayed unchanged until the last follow up.

A Knee Society score was collected from 17 patients with an average follow-up of 4 years (range, 0.08-11.7 years). No statistically significant association was observed between the different functional scores and the rate of revision TKA.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Yes (n=5)</th>
<th>No (n=32)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean±SD age at conversion from UKA to TKA, y</td>
<td>65±11.9</td>
<td>69.2±10.0</td>
<td>.428</td>
</tr>
<tr>
<td>Mean±SD time from conversion to recent follow-up, y</td>
<td>7.2±4.0</td>
<td>3.9±4.6</td>
<td>.088</td>
</tr>
<tr>
<td>Mean±SD ROM prior to conversion UKA, deg</td>
<td>117.0±14.8</td>
<td>120.2±11.8</td>
<td>.396</td>
</tr>
<tr>
<td>Mean±SD ROM at recent follow-up, deg</td>
<td>117.0±5.7</td>
<td>110.5±11.6</td>
<td>.271</td>
</tr>
<tr>
<td>Sex, No. (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>5 (22.7)</td>
<td>17 (77.3)</td>
<td>.067</td>
</tr>
<tr>
<td>Women</td>
<td>0</td>
<td>15 (100)</td>
<td></td>
</tr>
<tr>
<td>Tibia cut status, No. (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conservative</td>
<td>3 (12)</td>
<td>22 (88)</td>
<td>1.000</td>
</tr>
<tr>
<td>Aggressive</td>
<td>1 (10)</td>
<td>9 (90)</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2**

Association Between Patient Variables and Patients’ Need for Further Surgery Following Conversion UKA to TKA

**Table 1**

Demographic and Outcome Variables Associated With Implant Type Used at UKA Conversion to TKA

**Discussion**

Unicompartmental knee replacement is considered a less invasive approach for the treatment of unicompartmental knee arthritis when compared with total knee replacement surgery. This difference is attributed to the sparing of bone and soft tissue when performing an UKA compared with a TKA. Correct patient indication for UKA and attention to surgical technique are paramount to the procedure’s success.13

Past studies have provided evidence of the advantages of UKA relative to TKA. In a comparative study of patients who underwent TKA in one knee and UKA in the other, Laurencin et al6 found that a majority of patients preferred the UKA knee due to a feeling of a more normal knee function. In a randomized, prospective study of 102 knees treated with either UKA or TKA, Newman et al4 found that UKA patients experienced decreased perioperative morbidity, a higher proportion of excellent Bristol knee score outcomes, and a more rapid recovery to preoperative function.

Kozinn and Scott14 proposed a framework to define the indications and contraindications for UKA surgery. Indications include unicompartmental osteoarthritis or osteonecrosis in the medial or lateral compartments, age older than 60 years, weight less than 181 pounds, ROM arc greater than 90°, flexion contracture less than 5°, angular deformity less than 15°, and a relatively sedentary lifestyle. Contraindications include inflammatory arthritis, age younger than 60 years, highly active lifestyle, pain at rest, patellofemoral pain, and exposed bone in opposite compartment or patellofemoral joint. A review by Ritter et al15 found that approximately 6.1% of knees meet the anatomic requirements and only 4.3% also meet the clinical requirements for UKA surgery. Despite these relatively stringent criteria, some studies, including those by Pennington et al16 and Tabor et al,17 found favorable outcomes in patients who were...
younger than 60 years and who had body mass indices greater than 30 kg/m².

The literature discussing revision of failed UKA reports mostly good or excellent results but are considered by some as inferior to the outcome results of primary TKA. Barrett and Scott² reported good or excellent outcomes after UKA revision to TKA in 13 of 29 patients after 4.6 years follow-up. Among these revision procedures, approximately half required long-stem implants and bone graft or bone cement augmentation to treat osseous insufficiency. The authors suggested that the primary determinant of the difficulty of the revision was the surgical technique used in the original UKA. In fact, they concluded that UKA revision to TKA can be as successful as a primary TKA if minimal tibial bone was resected in the original UKA and implants were used without bone augmentation or stems in the revision. Levine et al⁷ noted similar results in 31 knees that underwent revision to TKA for a failed UKA; they reported similar outcomes among the study group and a similar primary TKA cohort.

The current authors believe that a minimal tibial cut during the primary UKA may allow the revising surgeon to avoid the need of tibial augmentation, even in the face of a well seated tibial base plate. Such situations may occur during femoral-sided failure or adjacent compartment arthritis. During tibial component explantation, surgeons must pay careful attention to the surgical technique to preserve as much bone as possible; minor contained defects can be managed with cement or bone graft.

The reported use of complex primary TKA implants at the time of revision UKA has been documented previously.⁶,⁷,¹¹,¹⁸-²¹ Early reports by Barrett et al¹¹ and Padgett et al¹⁸ reported that more than half of their cohorts needed a complex implant when revised to a TKA. More recent reports using modern UKA implants and techniques show similar results. Aleoto et al¹⁹ reported the use of cement and screws in the tibia in 18 knees, stems in 15, and augment in 8. McAuley et al²⁰ reported a series of 32 knees, of which 14 had stemmed tibial implants, 8 had wedge augments, and 10 required local autograft.

In the current study, the authors had similar results with complex revisions in the aggressive tibial resection group, with 70% of patients needing a complex TKA implant (ie, bone graft, stem, wedge, or augment); when compared with the conservative tibial resection group, the authors found that 96.6% of patients received a primary TKA implant. The current authors have also shown that patients who received a primary TKA implant had an improved tibial survivorship, with revision as an end point, compared with patients who received a complex TKA implant. The decision to use 12 mm as the breakpoint between aggressive and conservative tibial resection was made due to its corresponding resection level with primary TKA. Most surgeons use a minimum 10-mm guided cut of the lateral tibial plateau, but the current authors decided to use 12 mm to eliminate measurement variations and to ensure to include all primary resections.

The study had several limitations. First, the primary limitation is the study’s retrospective design. Second, because of the study’s limited cohort of patients, the authors suggest creating a multicenter study in the future to delineate surgical guidelines for younger UKA patients to facilitate future revision surgeries. Furthermore, the limited follow up of the cohort was due to 2 main contributors: the patients’ high mortality rate and the number of patients lost to follow up. Patients undergoing UKA are older historically, and as such by the time they undergo revision surgery the likelihood of possible follow up after the the revision surgery is limited. Due to the long time span from the original UKA, a loss of patients is expected.

The current results show that a revision UKA can be comparable with a primary TKA when a conservative tibial resection is performed during the primary UKA. It is possible to predict preoperatively which patients might need the use of augmentation and stems at the time of their UKA revision. This data should guide surgeons to strive for the most conservative UKA tibial resection possible in patients undergoing UKA.
REFERENCES


