Revision of a Medial UKA to a Kinematic Aligned TKA: Comparison of Operative Complexity, Postoperative Alignment, and Outcome Scores to a Primary TKA

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Abstract

Revision of a medial unicompartmental knee arthroplasty (UKA) to a mechanically aligned total knee arthroplasty (MA TKA) is inferior to a primary TKA; however, revision with kinematic alignment (KA) has not been well studied. The present study determined whether patients revised with KA had a higher use of revision components, different postoperative alignment, and different clinical outcome scores from patients with a primary KA TKA. From 2006 to 2017, all patients suitable for a revision of a failed medial UKA to a TKA and a primary TKA were treated with KA. Reasons for the revision performed in ten females and six males at a mean age 67 ± 8 years included progression of osteoarthritis in the lateral hemi-joint (n = 6), aseptic loosening (n = 4), unremitting medial pain without loosening (n = 4), and insert wear (n = 2). Patients with a revision were matched 1:3 with a control cohort treated with a primary KA TKA. Revisions were performed with primary components without augments, stem extensions, or bone grafts. Seven postoperative alignment parameters of the limb and components were comparable to the control cohort (p > 0.05). At a mean follow-up of 5 years (1–10), implant survival was 100%, and the revision/primary group clinical outcome scores were 39/43 points for the Oxford Knee Score (OKS), 2.2/1.0 cm for the Visual Analog Pain Score, and 12/7 points for the Western Ontario and McMaster Universities Osteoarthritis Index score. When compared with primary KATKA, surgeons that revise a failed medial UKA to a TKA with use of KA can expect similar operative complexity, comparable postoperative alignments, and a mean OKS of 39 points, which is higher than the mean 27 to 30 point range reported for revision of a failed UKA to a TKA with the use of MA.

Keywords

► knee arthroplasty
► unicompartmental knee arthroplasty
► kinematic alignment
► Oxford Knee Score
► WOMAC

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Unicompartmental knee arthroplasty (UKA) has undergone a renaissance over the past two decades for the treatment of medial knee osteoarthritis. Short-term advantages of medial UKA include decreased blood loss, shorter operative times, lower complication rates, and faster postoperative rehabilitation compared with total knee arthroplasty (TKA). However, the annual revision rate of medial UKA is twofold than that of TKA.¹

Reasons for revision of a medial UKA to a mechanically aligned (MA) TKA include osteoarthritis progression in the lateral hemi-joint and/or patellofemoral compartment, aseptic loosening, and medial knee pain.² ³ Studies have reported mean Oxford Knee Scores (OKS) ranging from 27 to 30 points after revision of a failed UKA to a TKA with MA, which is a lower range than those of a primary MA TKA and more comparable to a revision TKA.² ⁶

Kinematically aligned (KA) has emerged as a viable alternative to MA TKA as four meta-analyses, three randomized trials, and a national multicenter study showed that patients treated with KA TKA reported significantly better pain relief, function, flexion, and a more normal feeling knee than patients treated with MA TKA,² ⁷–¹⁵ whereas two randomized trials showed similar clinical outcomes.¹⁶ ¹⁷ The goal of KA is to co-align the axes and joint lines of the components with the three “kinematic” axes and joint lines of the prearthritic or native knee without placing limits on the preoperative deformity and postoperative correction and without ligament release. KA can be performed with calipered measurements of bone resections or patient-specific instrumentation (PSI; ediator Fig. 1).¹⁸–²² The operative complexity, implant requirements, postoperative alignment, and clinical outcome scores of patients with a failed medial UKA revised to TKA with the KA that does not place limits on the operative deformity and that restores the native joint lines with the use of caliper measurements and bone resection without restricting postoperative correction and without ligament release would be of interest to arthroplasty surgeons.

The present case–control study evaluated the use of KA instead of MA to revise patients with a failed medial UKA to a TKA and determined whether patients revised with KA had a higher use of revision components, different postoperative alignment, and different clinical outcome scores from patients with a primary KA TKA.

Patients and Methods

An Institutional Review Board (1243527–1) approved a retrospective review of a single surgeon’s prospectively collected database containing all patients treated with a revision UKA and a primary TKA between January 2006 and December 2017. During this period, all patients suitable for a revision of a failed medial UKA to a TKA (10 females, 6 males, mean age 67 ± 8 years), and all patients suitable for a primary TKA (4636 knees) were treated with KA. A control group was randomly selected by matching revision patients 1:3 to patients with a primary KA TKA based on date of surgery (±3 months), age (±10 years), sex, knee deformity (varus or valgus), and implant brand (– Table 1). The brands of the failed medial UKA were a cemented Repici UKA (Zimmer Biomet, Warsaw, IN) in 14 patients and a cemented Mako UKA (Stryker, Mahwah, NJ) in two patients (– Table 2). The medial UKA remained in situ a mean of 9 ± 5 years before revision (– Fig. 2). Reasons for revision included osteoarthritis progression in the lateral hemi-joint (n = 6), aseptic loosening of the tibial component (n = 4), unremitting medial pain without loosening (n = 4), and insert wear (n = 2).

The goal of KA is to co-align the axes and joint lines of the components with the three “kinematic” axes and joint lines of the prearthritic or native knee without placing limits on the preoperative deformity and postoperative correction and without ligament release.¹⁸–²² Detailed descriptions of the rationale and use of either PSI or caliper measurements to KA the femoral and tibial components are available.⁹,²²–²⁵ Between 2006 and 2009, PSI was commercially available, which was used to revise five failed medial UKA to a TKA with KA (OtisMed, Stryker, Mahwah, NJ). Between 2009 and 2017, PSI was not commercially available and the calipered technique that uses 10 measurements of bone resections and positions and manual instruments was used to revise eleven failed medial UKA to a TKA with KA.²⁶ Briefly, the femoral and tibial components are introduced in such a way that the unique angle and level of the distal and posterior femoral joint lines and the tibial joint line of each patient are restored to the native alignment by compensating for loss of cartilage on the femur, cartilage, and bone on the tibia, and the kerf of the saw blade as determined by either preoperative three-dimensional planning for the PSI technique or intraoperative measurement and adjustment of the thickness of the bone resections for the caliper technique. For the caliper technique, the distal femoral referencing guide was set coincident to the most distal point of the lateral femoral condyle and medial UKA femoral component with the assumption that the setting of the UKA femoral component was coincident to the native medial distal joint lines since none of the unicompartmental femoral components were loose and medial femoral bone was not lost. The distal femoral resection guide was pinned to the femur, the medial unicompartmental femoral component was removed, and the distal femur was resected. A caliper measured the posterior medial gap created by the removal of the femoral component, bone, and cement. A 0 degree posterior femoral referencing guide was set coincident to the posterior lateral femoral condyle. Drilling a pin through the lateral hole secured the guide. The medial foot of the posterior referencing guide was rotated away from the posterior femoral condyle the thickness of the posterior medial gap. Insertion of a spacer as a shim is an alternative technique. Drilling a pin through the medial hole secured the guide.

The posterior medial foot of the guide was rotated the combined thickness of the of the posterior condyle of the unicompartmental femoral component, and the bone removed with the implant away from the posterior medial surface of the femoral condyle and a pin was drilled through the medial hole into the distal femur. An alternative is to insert a spacer with a thickness corresponding to an estimate of the loss of bone and cartilage as a shim between the posterior bone surface and the foot of the posterior referencing guide. These two drill holes set the anterior–posterior and internal–external rotation of the four-in-one anterior and chamfer block. When the thickness of
the distal and posterior bone resections equals the thickness of the distal and posterior femoral condyles of the femoral component after compensation for cartilage wear and kerf, the rotational axes in the component are closely co-aligned to the kinematic axes of the knee.\(^{28}\) The tibial component was set relative to the varus–valgus angle of the native tibial joint line by using either the PSI or an extramedullary guide that set the tibial resection just distal to the medial tibial component at the perceived varus–valgus angle and slope of the native tibia.

With the knee in full extension, spacer blocks were inserted in increasing thickness to tighten at least one compartment. A varus–valgus laxity test assessed the millimeters of medial or lateral opening. When one compartment was tighter than the other, a 1 or 2 degree varus or valgus recut guide cut removed bone from the tibia in the tight compartment until the varus–valgus laxity was negligible with a thicker spacer block, which replicates the laxity of the native knee in full extension.\(^{26,29}\)

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**Fig. 1** Current worksheet for intraoperatively recording serial verification checks based on caliper measurements of bone resections and positions for a femoral component with a 9 mm thick distal femoral condyle and 8 mm thick posterior femoral condyles. The order of the bone cuts progress from distal femoral, posterior femoral, anterior femoral, chamfer femoral, and tibial resection. The thickness of the distal and posterior femoral resections is adjusted so they equal the thickness of the implant within 0 ± 0.5 mm after compensating for a ~1 mm kerf from the saw cut and 2 mm of cartilage wear when present.
posterior cruciate ligament retaining femoral and tibial components without stem extensions, augments, or bone grafts and all polyethylene patellar components were used (► Table 2).

In all patients, nonweight bearing two-dimensional anterior–posterior and lateral computer tomographic scanograms of the limb were obtained on the day of discharge using a previously described technique. The scanograms mean radiation dosage is 0.5 mSv lower than a conventional long-leg radiograph. Repeating the anterior–posterior scanogram until the flange was between the posterior condyles of the femoral component, and repeating the lateral scanogram until the femoral condyles were superimposed limited the projection.

Table 1 Average preoperative characteristics of patients with a revision UKA to KA TKA and control patients with a primary KA TKA

<table>
<thead>
<tr>
<th>Preoperative characteristics</th>
<th>Revision UKA to KA TKA</th>
<th>Control Primary KA TKA</th>
<th>Significance (NS = nonsignificant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>67 ± 8</td>
<td>67 ± 5</td>
<td>NS (p = 0.774)</td>
</tr>
<tr>
<td>Sex (male) (n (%))</td>
<td>6 (38%)</td>
<td>18 (38%)</td>
<td>NS (p = 1.000)</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>30 ± 4</td>
<td>30 ± 6</td>
<td>NS (p = 0.568)</td>
</tr>
<tr>
<td>Motion and deformity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extension (degree)</td>
<td>10 ± 9</td>
<td>9 ± 8</td>
<td>NS (p = 0.747)</td>
</tr>
<tr>
<td>Flexion (degree)</td>
<td>110 ± 12</td>
<td>115 ± 9</td>
<td>NS (p = 0.183)</td>
</tr>
<tr>
<td>Valgus (+)/varus (-) deformity (degree)</td>
<td>2 ± 13</td>
<td>-2 ± 10</td>
<td>NS (p = 0.517)</td>
</tr>
<tr>
<td>Clinical outcome scores</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxford Knee Score (48 best, 0 worst)</td>
<td>18 ± 7</td>
<td>22 ± 9</td>
<td>NS (p = 0.132)</td>
</tr>
<tr>
<td>Knee Society Score (100 best, 0 worst)</td>
<td>37 ± 15</td>
<td>36 ± 17</td>
<td>NS (p = 0.328)</td>
</tr>
</tbody>
</table>

Abbreviations: KA TKA, kinematic alignment total knee arthroplasty; UKA, unicompartmental knee arthroplasty.

Table 2 Demographic characteristics for patients with a failed medial UKA revised to a KA TKA, UKA implant type, reason for revision, months between UKA and revision to TKA, surgical technique, and implant brand used for revision TKA

<table>
<thead>
<tr>
<th>Subject</th>
<th>Age</th>
<th>Sex</th>
<th>BMI</th>
<th>UKA implant</th>
<th>Reason for revision</th>
<th>Months between UKA and revision TKA</th>
<th>Kinematic alignment surgical technique</th>
<th>Revision TKA implant brand</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>67</td>
<td>F</td>
<td>32</td>
<td>Repicci</td>
<td>Polyethylene wear</td>
<td>96</td>
<td>Calipered</td>
<td>Triathlon CR</td>
</tr>
<tr>
<td>2</td>
<td>64</td>
<td>M</td>
<td>30</td>
<td>Repicci</td>
<td>Aseptic loosening</td>
<td>170</td>
<td>Calipered</td>
<td>Persona CR</td>
</tr>
<tr>
<td>3</td>
<td>61</td>
<td>M</td>
<td>31</td>
<td>Repicci</td>
<td>Polyethylene wear</td>
<td>132</td>
<td>Calipered</td>
<td>Persona CR</td>
</tr>
<tr>
<td>4</td>
<td>67</td>
<td>F</td>
<td>29</td>
<td>Repicci</td>
<td>Aseptic loosening</td>
<td>156</td>
<td>Calipered</td>
<td>Persona CR</td>
</tr>
<tr>
<td>5</td>
<td>71</td>
<td>F</td>
<td>26</td>
<td>Repicci</td>
<td>Osteoarthritis progression lateral hemi-joint</td>
<td>180</td>
<td>Calipered</td>
<td>Persona CR</td>
</tr>
<tr>
<td>6</td>
<td>60</td>
<td>F</td>
<td>27</td>
<td>Repicci</td>
<td>Aseptic loosening</td>
<td>25</td>
<td>PSI OtisKnee</td>
<td>Vanguard CR</td>
</tr>
<tr>
<td>7</td>
<td>70</td>
<td>F</td>
<td>41</td>
<td>Repicci</td>
<td>Osteoarthritis progression lateral hemi-joint</td>
<td>204</td>
<td>Calipered</td>
<td>Persona CR</td>
</tr>
<tr>
<td>8</td>
<td>51</td>
<td>F</td>
<td>33</td>
<td>Repicci</td>
<td>Medial pain, no loosening</td>
<td>52</td>
<td>PSI OtisKnee</td>
<td>Vanguard CR</td>
</tr>
<tr>
<td>9</td>
<td>69</td>
<td>F</td>
<td>28</td>
<td>Repicci</td>
<td>Medial pain, no loosening</td>
<td>88</td>
<td>PSI OtisKnee</td>
<td>Vanguard CR</td>
</tr>
<tr>
<td>10</td>
<td>69</td>
<td>M</td>
<td>32</td>
<td>Repicci</td>
<td>Aseptic loosening</td>
<td>149</td>
<td>Calipered</td>
<td>Persona CR</td>
</tr>
<tr>
<td>11</td>
<td>59</td>
<td>M</td>
<td>34</td>
<td>Repicci</td>
<td>Osteoarthritis progression lateral hemi-joint</td>
<td>144</td>
<td>Calipered</td>
<td>Persona CR</td>
</tr>
<tr>
<td>12</td>
<td>69</td>
<td>F</td>
<td>25</td>
<td>Repicci</td>
<td>Osteoarthritis progression lateral hemi-joint</td>
<td>131</td>
<td>Calipered</td>
<td>Sigma CR</td>
</tr>
<tr>
<td>13</td>
<td>62</td>
<td>M</td>
<td>32</td>
<td>MAKO</td>
<td>Medial pain, no loosening</td>
<td>24</td>
<td>Calipered</td>
<td>Sigma CR</td>
</tr>
<tr>
<td>14</td>
<td>87</td>
<td>M</td>
<td>28</td>
<td>MAKO</td>
<td>Osteoarthritis progression lateral hemi-joint</td>
<td>14</td>
<td>Calipered</td>
<td>Vanguard CR</td>
</tr>
<tr>
<td>15</td>
<td>69</td>
<td>F</td>
<td>36</td>
<td>Repicci</td>
<td>Medial pain, no loosening</td>
<td>72</td>
<td>PSI OtisKnee</td>
<td>Vanguard CR</td>
</tr>
<tr>
<td>16</td>
<td>66</td>
<td>F</td>
<td>23</td>
<td>Repicci</td>
<td>Osteoarthritis progression lateral hemi-joint</td>
<td>71</td>
<td>PSI OtisKnee</td>
<td>Triathlon CR</td>
</tr>
</tbody>
</table>

Abbreviations: KA TKA, kinematic alignment total knee arthroplasty; UKA, unicompartmental knee arthroplasty. Triathlon CR (Stryker Inc.), Vanguard CR and Persona CR (ZimmerBiomet, Inc.), Sigma CR (Depuy, Inc.).
error from malrotation to approximately ± 1 degree. In 2010, the addition of axial tomograms about the knee enabled measurement of internal–external rotation of the tibial component on the femoral component in the extended knee in 12 of 16 revision patients and 35 of 48 of control patients.

Between January and April 2018, a clinical assessment of implant survival and function was performed. Observers blinded to the patient’s treatment, contacted patients independently of the treating surgeon by either phone, email, or postal service. Whether the patient had further surgery on the arthroplasty knee for any reason was recorded and the operative note was obtained. Patients completed OKS (48 best, 0 worst), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) (0 best, 96 worst), and Visual Analog Scale for pain (0 best, 10 worst) (►Table 2).

One author, blinded to the treatment of the patient, made seven postoperative radiographic measurements including hip–knee–ankle angle of the limb, varus–valgus angle of the femoral component to the mechanical axis and the anatomic axis of the femur, varus–valgus angle of the tibial component to the mechanical axis and the anatomic axis of the tibia, flexion–extension of the femoral to the anatomic axis of the femur, and internal–external rotation of the tibial component on the femoral component using previously described techniques with use of image-analysis software (Horos Imaging Software. http://www.horosproject.org) (►Fig. 3). The interclass coefficients for these measurements of 0.86 to 0.87 indicate good reproducibility and the reported intraobserver and interobserver measurement errors are <1 degree for all of the analyzed angles.

Statistical Analysis
Data were recorded and analyzed using statistical software (JMP Pro 14.0, www.jmp.com, SAS, Cary, NC). Continuous variables were reported as mean ± standard deviations or median (range), and discrete variables were reported as number (percentage). Wilcoxon rank-sum test for continuous and discrete variables, or a Fisher’s exact test for categorical variables determined whether clinical outcomes, and measurements of alignment were different between patients with a revision of a UKA to a KA TKA and control patients with a primary KA TKA.

Results
Patients with a medial UKA revised to a KA TKA and control patients with a primary KA TKA had comparable preoperative characteristics of age, sex, body mass index, knee extension and flexion, varus–valgus deformity, OKS, and Knee Society Score (p = 0.183–1.000) (►Table 1). At a mean follow-up of 5 years (range: 1–10 years), implant survival was 100% with no knees requiring an additional knee operation. No patients were lost at follow-up. Primary posterior cruciate-retaining primary components without augments, stem extensions, or bone grafts were used in both treatment groups. The implant brands of the TKA for each revision are listed in ►Table 2.

In terms of postoperative alignment, the mean measurements of the seven coronal, sagittal, and axial component alignments were not different between the revision and control patients, respectively (p = 0.156–0.932) (►Table 3).

In terms of clinical outcome scores, the mean OKS were 39 and 43 points (p = 0.078), the Visual Analog Pain Scores were 22 and 12 mm (p = 0.069), and the WOMAC scores were 12 and 7 points (p = 0.422), for the revision and control patients, respectively (►Figs. 4–6). The clinical outcome scores reported by revision patients trended 5 to 10% lower than those reported by control patients.

Fig. 2 Composite shows anterior–posterior and lateral radiographs prior to revision to a kinematic alignment total knee arthroplasty of a patient with subsidence and loosening of a Repicci all polyethylene tibial component with cyst formation from insert wear at 11 years (left two images), and a patient with a painful medial tibia with a well-fixed Mako metal backed tibial component at 2 years (right two images).
Fig. 3 Composite shows the landmarks used for performing seven measurements of limb and component alignment on anteroposterior and lateral computed tomography (CT) scanograms and axial CT images that include (A) coronal hip–knee–ankle angle, (B) V-V angle of the femoral component to the mechanical axis of the femur, (C) V-V angle of the tibial component to the mechanical axis of the tibia, (D) V-V angle of the femoral component to the anatomic axis of the femur, (E) V-V angle of the tibial component to the anatomic axis of the tibia, (F) F-E angle of the femoral component to the anatomic axis of the femur, and (G) internal–external rotation of the tibial component on femoral component.

Table 3 Average alignment measurements of patients with a revision UKA to KA TKA and control patients with a primary KA TKA

<table>
<thead>
<tr>
<th>Postoperative alignment measurements</th>
<th>Revision UKA to KA TKA (in degrees; n = 16)</th>
<th>Control primary KA TKA (in degrees; n = 48)</th>
<th>Significance (NS = nonsignificant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip–knee–ankle angle of limb (+ valgus)</td>
<td>0 ± 5</td>
<td>0 ± 3</td>
<td>NS (p = 0.515)</td>
</tr>
<tr>
<td>V-V of femoral component to mechanical axis of femur (+ valgus)</td>
<td>2 ± 2</td>
<td>3 ± 2</td>
<td>NS (p = 0.158)</td>
</tr>
<tr>
<td>V-V of tibial component to mechanical axis of tibia (+ valgus)</td>
<td>−2 ± 3</td>
<td>−2 ± 2</td>
<td>NS (p = 0.822)</td>
</tr>
<tr>
<td>V-V of femoral component to anatomic axis of femur (+ valgus)</td>
<td>8 ± 3</td>
<td>9 ± 3</td>
<td>NS (p = 0.160)</td>
</tr>
<tr>
<td>V-V of tibial component to anatomic axis of tibia (+ valgus)</td>
<td>−3 ± 2</td>
<td>−2 ± 2</td>
<td>NS (p = 0.420)</td>
</tr>
<tr>
<td>F-E of femoral component (+ flexion)</td>
<td>6 ± 4</td>
<td>5 ± 6</td>
<td>NS (p = 0.420)</td>
</tr>
<tr>
<td>Axial rotation of tibial component on femoral component (+ external/–internal)</td>
<td>−1 ± 4 (n = 12)</td>
<td>−1 ± 4 (n = 35)</td>
<td>NS (p = 0.184)</td>
</tr>
</tbody>
</table>

Abbreviations: KA TKA, kinematic alignment total knee arthroplasty; UKA, unicompartmental knee arthroplasty.
Discussion

The present case–control study evaluated the feasibility of the use of KA TKA to revise patients with a failed medial UKA by analyzing the operative complexity and use of revision components, postoperative limb and component alignments, and clinical outcome scores. The most important findings were that surgeons performing revision of a failed medial UKA to a TKA with KA can expect similar operative complexity and comparable postoperative alignments to a primary KA TKA, and a mean OKS of 39 points that is higher than the mean 27 to 30 point range reported for revision of a failed UKA to a TKA with the use of MA.

Three limitations should be discussed which might affect the generalization of the findings. First, the revision of a bone-conserving medial onlay polyethylene tibial component (i.e., Repici) in 14 of 16 patients could have underestimated the use of components designed for revision as the revision of metal-backed fixed-bearing tibial components can leave large bone defects requiring fill in with a metal augment or bone-graft (∼ Fig. 1). Second, the availability of 16 revision patients and 48 controls underpowered the study, which increased the risk of a falsely accepting the null hypothesis that the clinical outcome scores between treatment groups were not different (i.e., Type II error). The power for determining the mean difference in the OKS of four points between treatment groups was 35% assuming a sample size of 64 and an α of 0.05. Hence, the ~ 5 to 10% lower clinical outcome scores of the patients revised to a KA TKA might be significant, which requires investigation with a larger sample size. Third, these results represent a designer surgeon’s experience, which requires independent

Fig. 4 Box and whisker plots show the Oxford Knee Scores (OKS) (48 best, 0 worst) at final follow-up. The mean score of 39 ± 10 points for patients treated with a revision unicompartmental knee arthroplasty (UKA) to a kinematic alignment total knee arthroplasty (KA TKA) was comparable to the mean score of 43 ± 8 points for control patients with a primary KA TKA (p = 0.078). Patients revised from a Mako UKA are indicated with red markers.

Fig. 5 Box and whisker plots show the Visual Analog Pain Scale (VAS) (0 best, 100 worst) at final follow-up. The mean score of 22 ± 24 mm for patients treated with a revision unicompartmental knee arthroplasty (UKA) to a kinematic alignment total knee arthroplasty (KA TKA) was comparable to the mean score of 10 ± 18 mm for control patients with a primary KA TKA (p = 0.069). Patients revised from a Mako UKA are indicated with red markers.
confirmation as designer surgeons tend to report lower failure rates and higher function than nondesigner surgeons.  

One useful standard for determining the effectiveness of revising a failed medial UKA to a TKA with KA is the complexity of the revision operation. The revisions in the present study treated with KA TKA required only primary components, whereas revisions to MA TKA are reported to required augments, stemmed implants, and/or bone grafts in 34 to 67% of cases.  

A study of an anatomic tibial resection with the use of restricted KA and medial collateral ligament release showed similar findings to the present study (performed with caliper measurements and bone resection without restricting postoperative correction and without ligament release), as the anatomic group required less augments, stems, and constrained inserts than the mechanical group and thinner polyethylene bearings.  

Another standard for determining the effectiveness of revising a failed medial UKA to a TKA with KA is implant survivorship. Implant survivorship depends on restoring alignment to the correct target, which in KA TKA is the native alignments of the limb and joint lines, which theoretically co-aligns the rotational axis of the femoral, tibial, and patella components to the three kinematic axes of the knee. In the present study, the seven component alignments of the patients with a revision of a failed medial UKA to a KA TKA were comparable to those of a primary KA TKA at a mean follow-up of 5 years (range: 1–10 years) implant survival was 100% with no knees requiring an additional knee operation. The calipered technique, used in 11 of 16 of the revisions, restores the native left to right symmetry of the hip–knee–ankle angle, distal lateral femoral angle, and proximal medial tibial angle in nearly all patients with negligible risk of varus alignment of the tibial component with respect to the native tibial joint line. The benefits from performing KA TKA without a ligament release are (1) a high 10-year implant survivorship (yearly revision rate) of 98.4% for aseptic failure with negligible risk of varus failure of the tibial component, (2) restoration of intraoperative forces in the medial and lateral compartments comparable to the native knee without overload regardless of whether the alignment of the limb, knee, and tibial component are in range or in the varus or valgus outlier ranges according to MA criteria and (3) a reduction in the peak knee adduction moment during gait because restoring the native joint line orients the tibial component parallel to the ground during gait, which shortens the lever arm of the ground reaction force when compared with MA TKA. Hence, on the basis of postoperative alignment and the long-term implant survivorship, the failed medial UKA revised to a TKA with KA might be comparable to a primary KA TKA.

A third standard is clinical outcomes scores and the complexity. The mean OKS for the patients with a failed UKA revised to a KA TKA was 39 points, which is higher than the mean 27 to 30 point range reported for revision of a failed UKA to a TKA with the use of MA. One reason for the higher OKS with revision to a KA TKA is that four meta-analyses, three randomized trials, and a national multicenter study showed that patients treated with KA TKA reported significantly better pain relief, function, flexion, and a more normal feeling knee than patients treated with MA TKA. In summary, the use of KA to revise a failed medial UKA to a TKA is a reasonable option as the operative complexity and postoperative alignments are comparable to a primary KA TKA. The clinical outcome scores, though trending lower than a primary KA TKA, are comparable or greater than those reported for revision of a failed UKA to a TKA with the use of MA. 

Note
The study was approved by our ethical committee.

Conflict of Interest
None declared.
References


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