Research Article

Elimination of Preoperative Flexion Contracture as a Contraindication for Unicompartmental Knee Arthroplasty

Abstract

Introduction: Unicompartmental knee arthroplasty (UKA) is an effective alternative to total knee arthroplasty (TKA) for the management of unicompartmental osteoarthritis. Historical contraindications limit patients’ eligibility for UKA. However, recent reports have suggested that some contraindications may not be absolute. This study evaluates preoperative flexion contracture with regard to UKA.

Methods: This study was a retrospective review of 53 patients with preoperative flexion contracture between 11° and 20° who underwent fixed-bearing UKA and a matched cohort of 53 patients who underwent cruciate-retaining TKA.

Results: Preoperatively, the average flexion contracture was 13.8° in the UKA group and 14.1° in the TKA group (P = 0.42). Mean preoperative motion was greater in the patients treated with UKA (106°) than in those treated with TKA (97°; P < 0.001). Postoperatively, patients who underwent UKA had greater motion than patients who underwent TKA had (121° versus 113°; P < 0.01). Residual flexion contracture was greater in the UKA group (4.1°) than in the TKA group (2.1°; P = 0.02). The two groups demonstrated similar improvements in Knee Society clinical scores (P = 0.32). However, patients treated with UKA demonstrated higher Knee Society functional scores, compared with patients treated with TKA (86 versus 75; P = 0.03).

Discussion: Although residual flexion contracture was worse after UKA, this group had greater clinical improvement, greater postoperative motion, and greater function scores, compared with the matched TKA group. Preoperative flexion contracture >5° may not be an absolute contraindication to UKA.

Conclusion: The contraindications to UKA regarding flexion contracture may not be as absolute as previously thought. Larger, prospective studies are needed to generalize these findings to a wider population.

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Dr. Goyal or an immediate family member serves as a paid consultant to Stryker and Zimmer Biomet. Dr. Engh or an immediate family member has received royalties from Innomed and Smith & Nephew; is a member of a speakers’ bureau or has made paid presentations on behalf of Smith & Nephew and Zimmer Biomet; serves as a paid consultant to Smith & Nephew and Zimmer Biomet; has stock or stock options held in Zimmer Biomet; and has received research or institutional support from DePuy Synthes, Inova Health System, and Smith & Nephew. None of the following authors or any immediate family member has received anything of value from or has stock or stock options held in a commercial company or institution related directly or indirectly to the subject of this article: Dr. Purcell, Dr. Cody, and Ms. Ammeen.

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The demand for knee arthroplasty is increasing. Recent interest in expediting patient discharge and minimizing bone loss has led to expansion of indications for unicompartmental knee arthroplasty (UKA).1,2 Historically, the indications for UKA have included isolated...
compartment disease, age >60 years, weight <82 kg, a functional anterior cruciate ligament, and a range of motion (ROM) arc >90° with <5° flexion contracture. Along with relief from pain, ROM is an important measure of success after knee arthroplasty and continues to be the subject of investigation. Previous literature has demonstrated that patients with moderate or severe preoperative flexion contracture will have improvement after total knee arthroplasty (TKA), with the preoperative arc of knee motion being the most predictive factor in obtaining adequate postoperative ROM.

The classic indication for UKA that limits flexion contracture to <5° excludes most patients with arthritic knees and, to our knowledge, has not been challenged in the current literature. Despite limited reports of expanding indications for UKA with respect to age, body weight, and anterior cruciate ligament integrity, many surgeons have begun to broaden their indications for UKA without evidence-based data regarding preoperative and postoperative motion. Historically, knee stiffness has been a contraindication to UKA because many surgeons think that stiffness is unlikely to improve and may result in less than satisfactory outcomes. However, in a study of patient-reported pain and function data, patients who underwent UKA were found to have fewer problems with activities that involved bending the knee, compared with patients who underwent TKA.

The ongoing interest in UKA calls for additional investigation of this procedure with regard to preoperative flexion contracture. The objective of the current study was to compare patients undergoing TKA and UKA with preoperative flexion contracture and determine whether residual postoperative flexion contracture has any substantial effect on functional outcome scores. We hypothesized that although patients may have differences in residual postoperative flexion contracture after TKA and UKA, this difference would not be clinically significant.

Methods

Data for all knee arthroplasty procedures performed at our institution are recorded in our institutional database. Approval was obtained from our Institutional Review Board to retrospectively obtain data that were collected for all patients with moderate preoperative flexion contracture who underwent either TKA or UKA between 1994 and 2011. All procedures were performed by the senior author (G.A.E.). The senior author’s indications to perform UKA were isolated medial compartment disease with a correctable varus deformity and maintenance of the lateral joint space. The lateral compartment was inspected intraoperatively, and UKA was performed if the lateral compartment had <10% of degenerative erosive changes. Inclusion criteria for this study included a preoperative fixed flexion contracture of between 11° and 20°, a preoperative diagnosis of osteoarthritis, a cruciate-retaining TKA or a fixed-bearing UKA, use of extrapoludillary techniques to measure distal femoral resection, and a minimum of 2-year follow-up. All knee ROM and flexion contracture measurements were determined with use of a goniometer. Preoperative knee ROM and flexion contracture were determined at the preoperative clinic appointment. The postoperative final knee ROM and flexion contracture were determined at 2 years. No patients were contacted for this retrospective analysis.

Patients in the UKA and TKA groups were matched in a 1:1 fashion for age, sex, body mass index, preoperative flexion contracture, and preoperative Knee Society clinical scores. Outcomes compared between the groups were the postoperative residual flexion contracture, arc of motion, postoperative Knee Society scores (clinical and function), and complications.

Statistical analysis was performed using SPSS software (IBM). Propensity scoring was used to match the UKA and TKA populations, as described previously. To evaluate the postoperative outcome differences between the matched populations, a paired Student t-test was used to examine parametric data, and a Wilcoxon signed-rank test was used to compare nonparametric data. For all analyses, P < 0.05 was deemed statistically significant.

Results

We matched 53 patients in each group that met the inclusion criteria. In terms of age, sex, body mass index, preoperative flexion contracture, preoperative Knee Society scores, and follow-up interval, we found no statistically significant differences between the patients who underwent UKA and the patients who underwent TKA (Table 1). The mean preoperative flexion contracture in patients who underwent TKA was 14.1° ± 2.2°, compared with 13.8° ± 2.1° in patients treated with UKA (P = 0.42). The mean preoperative Knee Society clinical score was 48 ± 13 for patients who underwent TKA and 47 ± 12 for patients who underwent UKA (P = 0.32). Similarly, the mean preoperative Knee Society functional score was 57 ± 19 for patients treated with TKA, compared with 56 ± 11 for patients treated with UKA (P = 0.94). The patients who underwent UKA had a greater preoperative arc of motion than the patients who underwent TKA did (106° ± 9.2° versus 97° ± 14.1°, P < 0.001).
After arthroplasty, the mean residual postoperative flexion contracture improved in the knees of both groups of patients (Table 2). This improvement was slightly better for patients treated with TKAs (11.9° ± 4.0°) than for patients treated with UKA (9.8° ± 4.5°; \( P = 0.02 \)). The residual flexion contracture between the groups was 2.1° ± 4.0° for patients who underwent TKA versus 4.1° ± 4.2° for those who underwent UKA (\( P = 0.02 \)). The overall postoperative arc of motion was greater in the UKA group (121° ± 9.9°) compared with the TKA group (113° ± 13.8°; \( P < 0.01 \)). However, the net improvement in motion was not significantly different between the groups (14.6° ± 10.2° in the UKA group versus 15.6° ± 14.2° in the

### Table 1

Demographics of the Matched Populations

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Unicompartmental Knee Arthroplasty Group</th>
<th>Total Knee Arthroplasty Group</th>
<th>( P ) Value&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of knees</td>
<td>53</td>
<td>53</td>
<td>—</td>
</tr>
<tr>
<td>Follow-up in months (mean ± SD)</td>
<td>34.7 ± 10.3</td>
<td>35.1 ± 8.2</td>
<td>0.62</td>
</tr>
<tr>
<td>No. of bilateral procedures</td>
<td>8 knees (4 patients)</td>
<td>0</td>
<td>—</td>
</tr>
<tr>
<td>Age in years (mean ± SD)</td>
<td>66 ± 9.2</td>
<td>67 ± 9.7</td>
<td>0.58</td>
</tr>
<tr>
<td>Patient sex (no. of knees)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>20</td>
<td>20</td>
<td>—</td>
</tr>
<tr>
<td>Women</td>
<td>33</td>
<td>33</td>
<td>—</td>
</tr>
<tr>
<td>Body mass index (mean ± SD)</td>
<td>28.9 ± 4.7</td>
<td>29.0 ± 5.5</td>
<td>0.99</td>
</tr>
</tbody>
</table>

<sup>a</sup> All patients had a diagnosis of osteoarthritis.

<sup>b</sup> The threshold for statistical significance was \( P < 0.05 \).

### Table 2

Flexion Contractures, Motion, and Scores by Matched Populations

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Unicompartmental Knee Arthroplasty Group</th>
<th>Total Knee Arthroplasty Group</th>
<th>( P ) Value&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of knees</td>
<td>53</td>
<td>53</td>
<td>—</td>
</tr>
<tr>
<td>Follow-up in months (mean ± SD)</td>
<td>34.7 ± 10.3</td>
<td>35.1 ± 8.2</td>
<td>0.62</td>
</tr>
<tr>
<td>Flexion contracture (mean ± SD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative</td>
<td>13.8° ± 2.1°</td>
<td>14.1° ± 2.2°</td>
<td>0.42</td>
</tr>
<tr>
<td>At follow-up</td>
<td>4.1° ± 4.2°</td>
<td>2.1° ± 4.0°</td>
<td>0.02</td>
</tr>
<tr>
<td>Change</td>
<td>9.8° ± 4.5°</td>
<td>11.9° ± 4.0°</td>
<td>0.02</td>
</tr>
<tr>
<td>Arc of motion (mean ± SD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative</td>
<td>106° ± 9.2°</td>
<td>97° ± 14.1°</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>At follow-up</td>
<td>121° ± 9.9°</td>
<td>113° ± 13.8°</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Change</td>
<td>14.6° ± 10.2°</td>
<td>15.6° ± 14.2°</td>
<td>0.51</td>
</tr>
<tr>
<td>Knee Society clinical score (mean ± SD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative</td>
<td>47 ± 12</td>
<td>48 ± 13</td>
<td>0.32</td>
</tr>
<tr>
<td>At follow-up</td>
<td>89 ± 14</td>
<td>93 ± 7</td>
<td>0.32</td>
</tr>
<tr>
<td>Change</td>
<td>42 ± 18</td>
<td>46 ± 14</td>
<td>0.55</td>
</tr>
<tr>
<td>Knee Society function score (mean ± SD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative</td>
<td>56 ± 11</td>
<td>57 ± 19</td>
<td>0.94</td>
</tr>
<tr>
<td>At follow-up</td>
<td>86 ± 17</td>
<td>75 ± 25</td>
<td>0.03</td>
</tr>
<tr>
<td>Change</td>
<td>30 ± 18</td>
<td>19 ± 28</td>
<td>0.02</td>
</tr>
</tbody>
</table>

<sup>a</sup> Bold indicates statistical significance at \( P < 0.05 \).
TKA group; \( P = 0.51 \). At the latest follow up, no significant differences were found in the mean Knee Society clinical scores between the groups (93 ± 7 for TKA group and 89 ± 14 for UKA group; \( P = 0.32 \)). The UKA group had a significantly higher mean postoperative Knee Society function score (86 ± 17) compared with the TKA group (75 ± 25; \( P = 0.03 \)).

A subgroup analysis of patients with a minimum 60-month follow up was performed and the results are presented in Table 3. In this subgroup, with mean follow-up of 106.0 and 120.8 months for UKA and TKA patients respectively, a statistically significant difference in residual flexion contracture persisted (\( P = 0.03 \)). However, no statistically significant difference was found in postoperative Knee Society clinical or function scores (\( P = 0.59 \) and \( P = 0.50 \), respectively; Table 3).

One patient in the UKA group required manipulation under anesthesia for the management of postoperative arthrofibrosis. No patients in the TKA group required manipulation under anesthesia. No other surgical interventions were performed in either group during the follow-up period.

### Discussion

In patients with moderate (11° to 20°) preoperative fixed flexion contractures, patients treated with UKA had a statistically significant worse residual flexion contracture, compared with a matched cohort of patients treated with TKA. Despite the greater residual flexion contracture in the UKA group, the clinical outcomes scores were similar between UKA and TKA groups, with higher Knee Society functional scores in the UKA group. These outcome similarities persisted at midterm follow-up (8 to 10 years), with no progression of the residual flexion contracture in the UKA group (Table 3).

The loss of knee motion secondary to arthritis is thought to be attributable to several pathognomonic changes that occur. Pain restricts movement of the joint, reducing the elasticity inherent in the tendons, ligaments, and muscle, ultimately leading to limited flexion and flexion contractures. Inflammation in the soft tissues that provide stability to the joint leads to variable amounts of arthrofibrosis in these structures. As the degenerative process becomes more advanced, osteophytes develop, further limiting knee motion and continuing the cascade.

Improvement in postoperative knee motion is widely reported, particularly in joints with severe loss of preoperative knee motion. Historically, in knees with restricted motion, TKA has been advocated because it was thought that UKA cannot address most of the changes that resulted in the knee contracture. Despite the abilities of both UKA and TKA to eliminate the pain associated with soft-tissue inflammation, TKA typically allows for the complete removal of osteophytes and posterior capsule release, resulting in theoretically better functional improvement because of the greater ability to improve flexion contractures. However, our data demonstrate that in patients who underwent UKA in the presence of moderate flexion contracture (11°...
to 20°), the clinical outcomes at both short-term and midterm follow-up were comparable to those of patients undergoing TKA with a similar degree of preoperative contracture.

The available literature provides a great deal of information on flexion contractures and motion restriction pertaining to TKA, but a paucity of similar information exists for UKA. The classic indications for UKA put forth by Kozinn and Scott† have led to improvements in outcomes after UKA. However, many surgeons have begun to broaden their indications, predominantly on the basis of age and body mass index.9,10 Because of the aforementioned hesitation to perform UKA in patients with larger degrees of flexion contracture, few studies have reported on these outcomes. Saito et al11 reviewed 109 UKA procedures stratified by preoperative flexion contracture and found a statistically significant negative correlation in postoperative Hospital for Special Surgery scores and degree of residual flexion contracture. A similar study reported on 803 patients who underwent UKA, 26 of whom had severe preoperative contracture (mean of 11°).12 Postoperatively, these patients had a residual contracture of 14°. The authors concluded that patients with residual flexion contracture >10° have poorer functional outcomes and quality-of-life scores, compared with patients with contracture <10°. Because of the poor outcomes associated with residual contracture in patients who underwent UKA, along with numerous studies demonstrating that preoperative motion is the greatest predictor of postoperative motion, many surgeons advocate for the use of TKA in patients with moderate to severe flexion contracture who otherwise meet the indications for UKA.13-15

Along with relief from pain, motion is an important measure of success after TKA. In the current analysis, patients who underwent UKA had a significantly greater arc of motion than did patients who underwent TKA at the most recent follow-up, and the patients treated with UKA also had a substantially greater preoperative arc of motion. Despite these differences in preoperative and postoperative motion, the net change, or improvement, in motion after arthroplasty was similar between the two groups (P = 0.51). This finding may bring into question many surgeons’ decision to perform TKA because of the presumed inability to achieve posterior soft-tissue release and ligamentous balance in UKA candidates with greater contracture. Despite this hesitation, the senior author would frequently perform limited medial and posterior capsular releases of the tightest fibers, at the level of the joint line, with electrocautery to intraoperatively correct the varus and fixed flexion deformity present in patients treated with TKA or UKA. In patients treated with TKA, a combination of additional distal femoral resection and posterior capsular release was used to improve contractures, whereas in patients treated with UKA, only posterior soft-tissue releases were performed to correct the deformity. This technique may partially explain the significant difference in residual postoperative contractures between the groups because posterior capsular release in patients who underwent UKA was largely limited to the medial side. Limited capsuloligamentous releases are a safe and effective method to restore normal sagittal and coronal alignment in both UKA and TKA patients with contracture.

In a recent large report of the Norwegian registry comparing functional outcomes of TKA and UKA, patients who underwent UKA reported fewer problems with activities that required bending of the knee.7 Because of the differences in preoperative arc of motion in the current study, with similar net improvements in motion, we think that a well-maintained preoperative arc of motion (>105°) may be protective in achieving similar or even better postoperative Knee Society scores in patients treated with UKA, compared with those treated with TKA who have similar preoperative flexion contracture, assuming that the surgeon is able to achieve adequate posteromedial capsular release.

This study has several limitations. The weaknesses inherent in any retrospective study hold true for this review. The information in our study was obtained from an institutional database, and no patients were contacted for further follow-up beyond the information that existed in the database. Second, we used a goniometer for all motion and flexion contracture measurements. This method has been shown to have intraobserver reliability issues.16 Despite this concern, all measurements were made by a single experienced surgeon using a standardized technique; therefore, general trends are likely to be consistent. The biggest limitation of this study stems from the fact that a single surgeon performed all arthroplasty procedures, and our findings may not be generalized to a greater population. For example, in the study by Chen et al,12 the cohort of patients with a mean preoperative flexion contracture of 11° had a mean postoperative contracture of 14°, whereas in our study, patients who underwent UKA had a residual contracture of 4.1°.

**Conclusion**

To our knowledge, this study is the first to directly compare the clinical outcome of a matched group of cruciate-retaining TKA and fixed-bearing UKA patients with moderate (11° to 20°) preoperative flexion contracture. Despite finding
a statistically significant difference of 2° in residual postoperative mean flexion contracture, we found similar postoperative Knee Society clinical scores and better Knee Society functional scores in the patients treated with UKA, compared with the patients treated with TKA. Our findings suggest that the decision to perform TKA based solely on the severity of the preoperative flexion contracture may provide only a theoretical advantage. We have demonstrated the ability to potentially expand the previously established indications for UKA based on preoperative flexion contracture. Although we cannot absolutely state that UKA can be successfully performed in any patient with moderate preoperative flexion contracture, this study demonstrates that historical contraindications regarding flexion contracture may not be as absolute as previously thought. Larger, prospective multicenter studies are needed to help extrapolate and generalize our findings across a larger population of patients and surgeons.

References

Evidence-based Medicine: Levels of evidence are described in the table of contents. In this article, references 7 and 12 are level III studies. References 1-3, 5, 6, 8-11, and 13-16 are level IV studies. Reference 4 is level V expert opinion.

References printed in bold type are those published within the past 5 years.