Symptomatic Flexion Instability in Posterior Stabilized Primary Total Knee Arthroplasty

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abstract

Flexion instability in posterior-stabilized total knee arthroplasty is a relatively uncommon but distinct problem that is often underdiagnosed and may require surgical management. This retrospective study evaluated the authors’ management strategy and assessed the results of revision surgery. The authors identified 19 knees that underwent revision for isolated flexion instability after primary posterior-stabilized total knee arthroplasty. All patients had typical symptoms and signs of flexion instability, which include diffuse pain, especially when negotiating stairs, a sense of instability without giving way, recurrent joint effusions, and diffuse periarticular tenderness. Knee Society scores were used to assess pain and function. Complete revision was performed in 11 knees, femoral revision with a thicker insert was performed in 1 knee, and isolated tibial polyethylene insert exchange was performed in 7 knees. Postoperatively, all patients reported improvement in instability symptoms and signs associated with improvement in mean Knee Society scores. Revision surgery with careful gap balancing is successful in the management of isolated flexion instability in posterior-stabilized total knee arthroplasty. Isolated tibial polyethylene insert exchange may have a role in selected patients where component malalignment and malrotation is ruled out and a thicker and/or semiconstrained insert can be used, while limiting the resultant flexion contracture to less than 5°.
Instability after total knee arthroplasty (TKA) is an important cause of early revision. Instability can present as frank dislocation or, more commonly, with subtle clinical symptoms and signs. Few reports have attempted to standardize the diagnosis and management protocol in such cases. Instability after TKA is classified as extension instability, flexion instability, global instability, or patellofemoral instability. Flexion instability complicates fewer than 1% of primary TKAs. Most literature has focused on flexion instability in cruciate-retaining TKA. Some reports have described flexion instability in posterior-stabilized TKA presenting as frank dislocation. Few reports have attempted to standardize the diagnosis of isolated flexion instability, which was to identify a patient cohort with a high incidence of flexion instability without giving way, recurrent joint effusions, and diffuse periarticular tenderness. Few reports have described the surgical management of isolated flexion instability without dislocation after primary posterior-stabilized TKA.

Certain aspects of the surgical technique may predispose patients to flexion instability in posterior-stabilized TKA. These include poor restoration of posterior condylar offset as a result of over-resection of the posterior condyles because of either undersizing or anteriorizing of the femoral component, malrotation of the femoral component that could lead to asymmetrical flexion gaps, and an increase in the posterior tibial slope. Surgical options include elevation of the joint line with distal femoral resection and use of a thicker polyethylene insert and increasing the posterior condylar offset by upsizing and posteriorizing the femoral component. Isolated tibial polyethylene insert exchange is of limited utility in the management of flexion instability.

The goal of this retrospective study was to identify a patient cohort with a diagnosis of isolated flexion instability, to better understand the clinical presentation and to evaluate the type of surgical intervention needed, and to assess the success of revision surgery.

**MATERIALS AND METHODS**

Institutional review board approval was obtained. Databases of 2 arthroplasty surgeons (J.A.R., G.R.S.) who performed 328 revision TKA procedures from January 2006 through June 2010 at 1 institution were used for this retrospective review. Of 328 revision TKA procedures, 60 were revised for instability, and of these, 19 knees in 19 patients had isolated flexion instability in the setting of well-fixed and aligned primary posterior-stabilized TKA. Fixation was considered satisfactory if there was no evidence of component migration, subsidence, change of alignment, or progressive radiolucency on radiographs. Coronal plane alignment was considered acceptable if it was within ±3° of the neutral mechanical axis. Sagittal alignment was considered acceptable if it was within ±3° of neutral for the femoral component. It was not possible to measure posterior condylar offset and tibial component sagittal alignment (posterior slope) accurately because there were no standardized lateral radiographs or full-length tibial radiographs.

Diagnosis of isolated flexion instability was made by 1 of the 2 senior authors (J.A.R., G.R.S.) in the clinic, based on clinical presentation, and was confirmed intraoperatively. The typical clinical presentation of flexion instability was described earlier and includes diffuse knee pain, difficulty in negotiating stairs, and recurrent effusions. Clinical signs included recurrent effusions, periarticular tenderness (pes, patellar tendon, and quadriceps tendon insertions) because of excessive aberrant movement, anterior translation of more than 5 mm on assessment by the anterior drawer test, and femoral condylar liftoff at 90° of knee flexion. Additionally, with the patient sitting at the edge of the examination table, the clinician assessed the affected knee for distractibility in 90° flexion by linear downward traction. The appearance of a sulcus at the tibiofemoral joint line suggested excessive tibiofemoral distractibility because of flexion gap laxity. The authors identified this as a positive sulcus sign, similar to the sulcus sign in shoulder laxity (Figure 1).

![Figure 1: Preoperative demonstration of the sulcus sign (arrow) and radiographic correlation with the C-arm before distraction (A) and after distraction (B).](image-url)
All patients had negative results on preoperative workup for periprosthetic infection as evaluated by erythrocyte sedimentation rate, C-reactive protein, and joint aspiration findings. None of these patients noticed improvement with conservative treatment with physical therapy and/or bracing. Eleven men and 8 women with a mean age of 63 years (range, 43-80 years) formed the study cohort. Mean body mass index was 30.4 kg/m² (range, 25-43 kg/m²). The original diagnosis was degenerative osteoarthritis in 18 patients and posttraumatic arthritis in 1 patient at the time of primary TKA. After revision TKA, patients were advised to follow up at 6 weeks, 3 months, 12 months, and annually thereafter. Knee Society scores were generated based on these assessments. The most recent follow-up of each patient was used for the current study. Radiographic evaluation included standing anteroposterior, lateral, and Merchant views taken preoperatively and at subsequent follow-up visits. Special stress views to show joint space distraction or excessive anterior translation with the knee in 90° flexion (Figure 2) were used to aid in diagnosis whenever required.

Surgical Algorithm

The diagnosis of isolated flexion instability was confirmed in the operating room by assessing flexion gap laxity after induction of anesthesia as well as intraoperatively. A medial parapatellar approach was used for exposure. In knees with well-sized components where no radiographic cause of flexion instability could be identified, stability was assessed first by changing to a thicker polyethylene insert. The aim was to eliminate condylar liftoff and limit anterior translation of the tibia to less than 5 mm with the extensor mechanism reduced. This maneuver eliminated flexion laxity but produced a flexion contracture. When the flexion contracture was less than 5°, it was addressed with posterior capsular release on the femoral and tibial sides. If the flexion contracture was greater than 5°, revision of the femoral component or both components was undertaken to re-establish equality of the flexion and extension gaps. Table 1 summarizes criteria considered for choosing isolated tibial polyethylene insert exchange as the revision procedure.

In cases in which preoperative radiographic causes of flexion instability could be identified, complete revision was performed directly. In these cases, a modular revision system was used to allow use of augments and stemmed components with unlinked constrained inserts. Excessive flexion gap was stuffed by selecting the largest possible femoral component, posterior augments, and an anteriorly offset stem in some cases. Appropriate femoral rotation was set based on the epicondylar axis or by setting it parallel to the tibial platform with the knee distracted in 90° flexion. This helped to eliminate coronal plane flexion instability and therefore condylar liftoff.

Statistical Analyses

Statistical analyses were performed with SPSS software (version 16 for Windows; SPSS Inc, Chicago, Illinois), with improvement in instability symptoms and Knee Society scores as outcome measures. A paired t test was used to de-

Table 1

<table>
<thead>
<tr>
<th>Criteria for Isolated Tibial Polyethylene Insert Exchange</th>
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<tr>
<td>Well-aligned components (coronal and sagittal planes)</td>
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<tr>
<td>Component rotational position confirmed</td>
</tr>
<tr>
<td>Trial tibial polyethylene insert to eliminate instability with extensor mechanism reduced</td>
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<tr>
<td>Anterior translation &lt;5 mm with knee at 90° flexion</td>
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<tr>
<td>&lt;3 mm condylar liftoff with varus-valgus stress at 90° flexion</td>
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<tr>
<td>&lt;5° flexion contracture</td>
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<td>Use of tibial polyethylene insert constraint if available</td>
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</table>
termine whether there was a significant improvement in postoperative Knee Society scores and range of motion (ROM) compared with preoperative values. Statistical tests were also used to determine whether there were differences between the complete revision group and the isolated tibial polyethylene insert exchange group in outcome variables (ROM and Knee Society scores). The means of continuous data were compared with the t test (parametric) and the Mann-Whitney U test (nonparametric). Categoric data were compared with the chi-square and Fisher’s exact tests. \( P < .05 \) was set as the level of statistical significance.

**RESULTS**

Of all revisions performed, 18% were for instability (60 of 328). Of all revisions performed for instability, 32% were for isolated flexion instability in a posterior-stabilized TKA (19 of 328) at the authors’ institution, which has a diverse referral base. The cumulative incidence of isolated flexion instability after posterior-stabilized TKA was 6% (19 of 328) at the authors’ institution, which has a diverse referral base. The mean clinical and radiographic follow-up was 35 months (range, 29-65 months; median, 31 months), with a minimum follow-up of 29 months. The time of appearance of symptoms after primary TKA varied from 3 to 18 months (mean, 5 months). Patients underwent revision surgery an average of 13 months after primary TKA (range, 6-20 months). Before revision surgery, all knees had a substantial anterior drawer sign (>5 mm) and a positive sulcus sign (evidence of tibiofemoral distractibility in 90° flexion). Eight of 19 knees (42%) had condylar liftoff in 90° flexion. These signs were absent after revision surgery.

Preoperatively, 7 of 19 knees (27%) showed juxta-articular erosions beneath the medial tibial base plate, with no effect on implant fixation (Figure 3). Revision of both the femoral and tibial components was performed in 11 of 19 knees (58%). One knee (5%) underwent revision of only the femoral component and insertion of a tibial polyethylene insert that was 4 mm thicker than the insert used in primary TKA. Details of the implant are summarized in Table 2. Seven of 19 knees (37%) were managed by isolated tibial polyethylene insert exchange. In 5 of these 7 knees, an unlinked constrained polyethylene insert was used. A standard posterior-stabilized insert was used in the remaining 2 knees because the existing implant would not allow use of a constrained insert. The average increase in tibial polyethylene insert thickness to achieve stability was 2.86 mm (range, 2-4 mm) in the isolated tibial polyethylene insert exchange group (Table 3). The complete revision group included 5 men and 7 women, with a mean age of 61 years.

![Figure 3: Juxta-articular tibial erosion (arrow) with well-fixed components.](image)

<table>
<thead>
<tr>
<th>Index Implant Design Manufacturer (All Posterior-stabilized Total Knee Arthroplasty)</th>
<th>Complete Revision, No.</th>
<th>Isolated Tibial Polyethylene Insert Exchange, No.</th>
<th>Revised Knees, Total No.</th>
<th>Complete Revision Implant Type and No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exactech (Gainesville, Florida)</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1 Zimmer LCCK&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>DePuy (Warsaw, Indiana)</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>2 Zimmer LCCK</td>
</tr>
<tr>
<td>Biomet (Warsaw, Indiana)</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>1 DePuy TC3&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Smith &amp; Nephew (Memphis, Tennessee)</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>1 Smith &amp; Nephew Legion 1 DePuy TC3</td>
</tr>
<tr>
<td>Stryker (Mahwah, New Jersey)</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Zimmer (Warsaw, Indiana)</td>
<td>4</td>
<td>2</td>
<td>6</td>
<td>3 Zimmer LCCK 1 DePuy TC3</td>
</tr>
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<sup>a</sup> NexGen, Legacy Constrained Condylar Knee, Zimmer.  
<sup>b</sup> P.F.C., Sigma TC3, DePuy.
(range, 50-69 years) and mean body mass index of 31 kg/m² (range, 24-43 kg/m²). There were 6 men and 1 woman in the isolated tibial polyethylene insert exchange group, with a mean age of 63.8 years (range, 43-80 years) and mean body mass index of 30 kg/m² (range, 23-31 kg/m²).

To allow comparison of treatment modalities, 12 knees (including 1 knee with only femoral component revision) were included in 1 group (complete revision group) and the remaining 7 knees formed the second group (isolated tibial polyethylene insert exchange group). Revision surgery with careful gap balancing resulted in improvement in symptoms and signs of instability in all patients at last follow-up. The average prerevision and postrevision Knee Society scores and ROM for the entire cohort are shown in Table 4 and separately for the 2 groups in Table 5. There were no significant differences between the 2 groups in postrevision Knee Society scores and ROM. There were no reoperations in the complete revision group. One patient in the isolated tibial polyethylene insert exchange group underwent another isolated tibial polyethylene insert exchange with a custom-made constrained insert (2 mm thicker than the previous insert) because of recurrent symptoms of instability, which subsequently resolved. Thus, overall results showed a success rate of 95% for the first revision surgery, irrespective of the treatment modality.

**DISCUSSION**

With improvement in polyethylene quality, revision TKA for instability secondary to polyethylene wear has decreased. However, the proportion of cases of instability secondary to poor gap balancing techniques and implant malposition has increased, thus contributing up to 20% of all revisions in the literature. The overall prevalence of instability in the current study was comparable, at 18%. Flexion instability in primary posterior-stabilized TKA accounts for a relatively small subset of all cases of instability after TKA. Understandably, it is less recognized and probably underdiagnosed. Obtaining a careful history as well as clinical assessment is of paramount importance. The finding of a positive anterior drawer sign and a sulcus sign, with or without condylar liftoff, during examination of a well-functioning, asymptomatic TKA does not qualify for a diagnosis of flexion instability, as emphasized in previous literature. Although very disabling to the patient, subtle flexion instability may present with relatively well-aligned, well-sized components, with or without identifiable radiologic findings, as noted earlier. The decision to offer complete revision is difficult and equally frustrating for the patient and the surgeon. The
current study focused on a cohort of patients with isolated flexion instability after posterior-stabilized TKA. Gap balancing and constrained articulation achieved during revision surgery resulted in resolution of symptoms and signs, with improvement in Knee Society scores and acceptable ROM in most of these patients, as reported in the current study and previous literature.5 To the authors’ knowledge, this is the largest cohort involving primary posterior-stabilized TKA reported so far.

In the current study, patients who underwent isolated tibial polyethylene insert exchange had marked clinical improvement, with Knee Society scores comparable to those of knees undergoing complete revision. This finding is contrary to previous literature.3,17-19 This may have occurred for the following reasons. First, a constrained polyethylene insert was used in this cohort whenever the primary TKA system allowed (5 of 7 cases). This suggests that flexion instability is not merely an issue of aberrant motion in distraction and anterior translation, but that it also has a rotational/coronal aspect, which when neutralized, may improve the clinical outcome. However, according to the criteria for isolated tibial polyethylene insert exchange (Table 1), 1 of 3 knees in which a posterior-stabilized insert was used needed re-revision with a constrained insert. Conversely, all 4 isolated tibial polyethylene insert exchanges involving a constrained insert were successful. Second, previously reported literature on the isolated tibial polyethylene insert exchange included a mixed population of patients with coronal plane instability and global instability, which might confound the results. Finally, poor outcomes in the isolated tibial polyethylene insert exchange group have also been attributed to overstuffing of the extension space with persistent flexion contracture.3 This was not observed in the current study because a flexion contracture greater than 5° dictated the need for complete revision. The authors believe that dissection carried out during the surgery, with removal of scar tissue, and hypertrophic synovium and release of the posterior capsule, may have increased the extension space without significantly affecting the flexion space. Hence, the surgeon could balance flexion-extension gaps with a thicker tibial polyethylene insert in these select cases, as has been described before.20 Also, isolated tibial polyethylene insert exchange is associated with less morbidity than complete revision TKA. However, the re-revision rate (1 of 7, or 14%) was higher in the isolated tibial polyethylene insert exchange group, making this procedure less predictable than complete revision, as reported earlier.3

Most knees (63%) in the current study needed complete or at least femoral revision. This helped in achieving proper restoration of the joint line, accurate flexion-extension gap balancing, and the use of constrained implants. Posterior femoral augments were required in most cases, highlighting the importance of restoration of posterior condylar offset in TKA. It also allowed correction of minor, indiscernible malalignment in individual components that may lead to asymmetric flexion instability.15 Hence, the authors exercised a low threshold to perform complete revision and recommend isolated tibial polyethylene insert exchange only as an option in selected cases and not as the standard of care in flexion instability in primary posterior-stabilized TKA.

The association of flexion instability with juxta-articular erosions (27% of knees) noted in the current study has not been previously reported. The authors believe that recurrent hemorrhrosis, effusion, and synovitis in these knees as a result of aberrant motion led to this erosive radiolucency.

The limitations of the current study include its retrospective nature, lack of a control group, and limited numbers of participants. The study may be underpowered to determine any significant difference in Knee Society scores and ROM between the 2 treatment groups. Radiographic analysis was qualitative; therefore, the authors could not quantify posterior condylar offset because not all

### Table 5

<table>
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<tr>
<th>Evaluation Time/Revision Type</th>
<th>Mean Flexion Deformity, ° (SD)</th>
<th>Mean Maximum Flexion, ° (SD)</th>
<th>Mean Knee Society Score Clinical (SD)</th>
<th>Mean Knee Society Score Functional (SD)</th>
</tr>
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<tbody>
<tr>
<td>Prerevision</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete revision</td>
<td>1.3 (2.8)</td>
<td>122 (7.8)</td>
<td>50.9 (6.3)</td>
<td>47 (11.8)</td>
</tr>
<tr>
<td>Isolated tibial polyethylene insert exchange</td>
<td>0.7 (1.8)</td>
<td>107.1 (12.5)</td>
<td>54.8 (9.1)</td>
<td>56.4 (9.4)</td>
</tr>
<tr>
<td>Postrevision</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete revision</td>
<td>0</td>
<td>120 (7.8)</td>
<td>77.8 (11.8)</td>
<td>77 (10.8)</td>
</tr>
<tr>
<td>Isolated tibial polyethylene insert exchange</td>
<td>0</td>
<td>110.7 (11.3)</td>
<td>85.0 (3.9)</td>
<td>81.4 (8.9)</td>
</tr>
</tbody>
</table>

Abbreviation: SD, standard deviation.
radiographs had true lateral projection. Additionally, the authors did not have a standard method of evaluating preoperative femoral component rotation. Computed tomography scans were not performed routinely to evaluate component rotation, and the authors subjectively assessed it intraoperatively, based on bony landmarks.

CONCLUSION

Management of isolated flexion instability after primary posterior-stabilized TKA starts with thorough preoperative assessment to rule out other causes of pain, clinical examination to assess flexion laxity, and radiographic assessment to determine reduced posterior condylar offset, excessive posteroir tibial slope, and malrotation of the femoral component, leading to asymmetric flexion instability. When 1 or more identifiable radiographic findings are present, femoral and tibial component revision should be considered. In select cases, when no apparent radiographic cause can be determined, an isolated tibial polyethylene insert exchange (preferably with a constrained insert), along with posterior capsular release, may be attempted to determine whether it selectively eliminates excessive flexion laxity without overstuffing the extension gap. However, a low threshold should be maintained to convert the procedure to femoral and tibial revision. Revision TKA with unlinked constrained implants is usually successful for the management of isolated flexion instability after primary posterior-stabilized TKA.

REFERENCES