When Polyethylene Exchange Is Appropriate for Prosthetic Knee Instability

Abstract

Introduction: Prosthetic knee instability is a common cause of patient dissatisfaction and early failure after total knee arthroplasty (TKA). Strategies to manage such instability are dependent on the recognition of the presenting instability pattern because some require full revision, whereas others can be managed by polyethylene exchange (PE) only. This retrospective chart review classifies and reports on a series of patients where PE only was used to manage an unstable TKA.

Methods: Of 1606 revision TKA patients, 4% underwent an isolated PE for prosthetic knee instability. All cases were classified using the novel OrthoCarolina Prosthetic Knee Instability Classification System. This classification system was established to guide surgeons in the diagnosis and surgical management of periprosthetic knee instability. The final data set included 41 patients at an average follow-up of 43 months.

Results: Of the patients treated with poly exchange only for an appropriate indication (ie, coronal instability with competent ligaments or global instability), 63% felt their knee was stable, whereas 37% felt they remained unstable after revision. Additionally, only 59% had improvement in their pain, whereas 41% were dissatisfied with their pain relief after revision.

Discussion: Despite the use of this technique when indicated, the results of PE only with regard to pain and instability are unpredictable. Only approximately 50% of patients became stable and had adequate pain relief. Patients and surgeons alike should understand that this low morbidity option does not guarantee a good result regardless of whether it is used for an appropriate indication. Obtaining stability and pain relief in a patient with prosthetic knee instability remains a significant challenge. Therefore, the key to avoiding prosthetic knee instability is through prevention at the time of primary surgery. Prosthetic knee instability remains difficult to manage despite intuitive and appropriate indications for PE only.
Prosthetic knee instability is a common cause of patient dissatisfaction and early failure after total knee arthroplasty (TKA). Technical considerations account for most of these problems. The symptoms of prosthetic knee instability include catching, giving way, anterior knee pain, pes bursitis, and the inability to trust the knee in daily activities. Recurrent effusions are common with a predominance of red blood cells on aspiration. Whereas prosthetic knee instability is a common cause of patient dissatisfaction after knee replacement, strategies to manage such instability are dependent on the recognition of the presenting instability pattern. Some instability patterns require full revision, whereas others can be managed by polyethylene exchange (PE) only.

Whether PE only is ever appropriate in the treatment of such patients remains controversial. Babis et al. reviewed 27 cases of isolated poly exchange for periprosthetic knee instability and found 12 of these 27 cases to have persistent pain. They concluded that “isolated tibial insert exchange should be undertaken with caution.” Jensen et al. reported on 27 patients quoting 80% survival, whereas Brooks et al. and Konrads reported success rates of 71% and 72%, respectively.

Such mediocre results with isolated poly exchange were echoed by Baker et al. who reviewed 45 knees treated with isolated poly exchange for prosthetic instability. At an average follow-up of nearly 5 years, only 58% had successful clinical results. They concluded that “if selected appropriately, isolated liner exchange can significantly improve the function.” Intuitively, its use should be dictated by the type of instability pattern present; however, no instability classification system exists which would guide the appropriate use of PE only. Therefore, these less than optimal results may be related to the inappropriate use of this treatment alternative rather than the treatment alternative itself.

This study classifies a series of patients where PE only was used to manage an unstable TKA and reports on the results of this treatment alternative.

**Methods**

This study is a descriptive, cross-sectional study of a series of revision knee patients. After approval from an Institutional Review Board, two centers queried patient registries and practice management systems and identified 1606 patients who underwent revision TKA between 2004 and 2015. Of the 1606 revision TKA patients, 71 (4%) underwent an isolated PE for prosthetic knee instability. Surgical records and radiographs were reviewed to confirm that no other components were revised during the revision surgery. The degree of instability was not specifically documented in this retrospective study. However, the classification system used deals with this. By definition, the instability patterns are subjective by surgeon and patient alike. Any classification system used should take this into consideration, differentiating between subtle and gross forms of instability. The instability characteristics of all cases were retrospectively classified through review of surgical notes, using the novel OrthoCarolina Prosthetic Knee Instability Classification System. This classification system was established to guide surgeons in the diagnosis and surgical management of prosthetic knee instability (Figure 1).

Electronic medical records were reviewed to verify and record patient outcomes.
demographics (sex and age at the time of revision) and whether the patients underwent a second revision for failed management of peri-prosthetic instability. To evaluate long-term outcomes, patient medical records and institutional patient registries were reviewed to determine pain, feelings of knee instability, and subsequent revision procedures. If patients were not compliant with annual follow-up clinical visits, they were asked to volunteer participation in a phone survey. After verbal consent, patients were asked to answer questions regarding pain, feelings of knee instability, and subsequent revision surgery.

A total of 71 patients met the eligibility criteria. Of these 71 patients, 3 died without 2-year follow-up, 9 declined participation, 1 was unable to answer the questions, and 17 were lost to follow-up. The final data set included 41 patients at an average follow-up of 43 months (range, 24 to 134 months). Most patients were women (29, 72.5%), and 11 (27.5%) were male patients. The average age was 65 years (range, 47 to 88 years).

A variety of modular polyethylene inserts were used depending on the type of instability pattern present and the available inserts to match the existing implant (Table 1).

### Results

Most patients had a type 3 instability pattern (global instability; n = 29, 71%). The second most common instability pattern was a type 1a instability pattern (coronal instability with competent ligaments; n = 6, 15%). Three patients (7%) had a type 2 instability pattern—flexion-extension mismatch with flexion instability—two patients (5%) had a type 5 combined instability pattern and one patient (2%) had a type 1b instability pattern—coronal instability with incompetent ligaments.

Thirty-five of the 41 patients were revised for an appropriate indication—either coronal instability with competent ligaments or global instability.

Of the six patients revised with a type 1A instability pattern (coronal instability with competent ligaments), three (50%) remained unstable and one required re-revision. Of the remaining five patients, four had pain improvement after revision. The one patient with a type 1B instability pattern (coronal instability with incompetent ligaments) was not re-revised but declined to answer questions concerning pain and instability. Of the three patients with a type 2 instability pattern (flexion-extension mismatch), one was re-revised; the remaining two patients still felt unstable and one of those was not satisfied with their pain improvement.

Of the 29 patients revised with a type 3 instability pattern (global instability), 6 (21%) were re-revised and 4 declined to answer questions concerning pain and stability. Of the remaining 19 patients, 13 (68%) felt stable and 6 (32%) felt unstable. Only 11 patients of the 19 (58%) revised for global instability were satisfied with their pain relief, whereas 8 (42%) were dissatisfied. Therefore, of the 29 patients, 12 (41%) were either re-revised or remained unstable after PE only for global instability.

No patients had a type 4 instability pattern (posterior cruciate insufficiency) revised with an isolated poly exchange. Neither of the two patients with a type 5 instability pattern (combined instability pattern) was re-revised. One patient was satisfied with their pain and stability, whereas the other was dissatisfied.

Therefore, of 36 patients treated with poly exchange only for an appropriate indication (ie, coronal instability with competent ligaments or global instability), 9 refused to answer questions concerning pain and instability. Of the remaining 27 patients, 17 (63%) felt their knee was stable, whereas 10 (37%) felt they remained unstable after revision. Additionally, of the 27 patients treated with poly exchange only for an appropriate indication, 16 (59%) had improvement in their pain, whereas 11 (41%) were dissatisfied with their pain relief after revision.

### Discussion

Knee instability after TKA is one of the main reasons for dissatisfaction after primary TKA. In describing the reasons for early failure in the first 5 years after TKA, Fehring et al found that of 440 patients, 74 (27%) were revised for instability. Sharkey et al in a subsequent report evaluating early failures after primary TKA found that 21% were revised for instability.

Prosthetic knee instability was first described in a report from Fehring et al. At that time, a complete understanding of the various types of prosthetic knee instability was lacking. Most patients in that study had flexion-extension mismatch. Through our revision total knee experience, we have come to recognize multiple other types of instability patterns in isolation or in combination, which stimulated the development of a classification system for prosthetic knee instability.

Type 1A, coronal instability with competent ligaments, is a common instability pattern. In this situation, moderate coronal instability with a

### Table 1

| Type of Polyethylene Inserts Used | n  |
|----------------------------------|----|
| Posterior stabilized bearing      | 18 |
| Cruciate retaining               | 6  |
| Constrained condylar             | 10 |
| Anterior constrained             | 6  |
| Posterior stabilized mobile      | 1  |

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definite end point exists in only one direction, either varus or valgus, with stable ligaments in the opposite direction. This type of instability pattern is caused by reluctance to fully release the contracted side of either a varus or a valgus deformity at the time of primary surgery. Failure to perform enough of a release on the concave side of the deformity to “catch up” with the convex side leads to this instability pattern. Treatment is straightforward and involves the further release of the contracted issue on the tight side to catch up with the unstable ligaments on the opposite side. The polyethylene insert is then increased to provide prosthetic stability. On occasion, this solution can decrease the extension space and may require an additional posterior capsular release to prevent a flexion contracture. Type 1B instability pattern is fortunately uncommon and involves coronal instability without a definite end point. This usually occurs in only one direction, either varus or valgus, with stable ligaments on the opposite side. This type of instability is caused by unrecognized incompetence or iatrogenic injury at the time of primary surgery. On rare occasions, this type of instability pattern can be caused by a traumatic event. Management of this type of instability pattern usually requires conversion to a constrained condylar femoral implant and polyethylene. The reinforced post in this construct provides varus-valgus stability to compensate for the incompetent collateral ligaments. In extremely rare situations with complete loss of a collateral ligament or soft-tissue sleeve, a hinge may be necessary.

A type 2 instability pattern is probably the most common type of periprosthetic knee instability, that is, flexion-extension mismatch. This can lead to flexion instability where the knee is stable in extension and loose at 90° of flexion. Alternatively, the flexion-extension mismatch can lead to a flexion contracture where the extension gap is smaller than the flexion gap. In each of these presentations, the flexion gap is greater than the extension gap. This is caused by reluctance to either remove more distal femoral bone or strip the posterior capsule off the posterior femur at the time of primary surgery. Both these maneuvers can increase the extension gap to “catch up” with the flexion gap. Spacer blocks placed in full extension must match a spacer block placed at 90° of flexion to stabilize the knee. Two options exist to manage flexion instability; however, both involve removal of the femoral implant. A larger femoral implant can be used with posterior augments to tighten the flexion gap relative to the extension gap. More commonly, one can increase the extension gap through further distal femoral resection. Before performing bony resection, a soft-tissue release should be done by stripping the posterior capsule and soft tissue off the posterior distal femur. This decreases the amount of bone one must remove from the distal femur, minimizing joint line elevation. Similarly, the best way to manage flexion-extension mismatch that has led to a significant flexion contracture is to remove the femoral implant, strip the posterior capsule off the posterior aspect of the distal femur, or resect more distal femoral bone to increase the extension gap.

A type 3 instability pattern is global in nature; that is, ligamentous instability is present both in full extension and at 90° of flexion. On examination, the patient goes into recurvatum and also is ligamentously lax in the AP mode at 90° of flexion. If the degree of instability is similar in both extension and flexion, an increase in polyethylene thickness should reliably solve this instability problem.

A type 4 instability involves flexion instability as a result of posterior cruciate incompetence in a patient with a posterior cruciate retaining implant. Such incompetence can be a result of unrecognized incompetence or iatrogenic injury at the time of primary surgery. More commonly, posterior cruciate incompetence can occur late after a period of stability. Successful management can be obtained without major component removal if an anterior constrained polyethylene implant is available. If this is not available, conversion to a posterior cruciate substituting femoral implant and polyethylene must be used.

A type 5 instability pattern is a combined instability pattern. Gross multidirectional instability is noted on physical examination. The cause of this pattern is variable; however, one must consider the possibility of a Charcot joint as an etiology. Management usually requires revision to a constrained condylar design or a hinge.

PE is one treatment alternative for prosthetic knee instability; however, the results have been inconsistent. Theoretically, isolated poly exchange should only be used in select types of prosthetic knee instability after primary TKA. These usually include only coronal instability with competent ligaments or global instability. On occasion, this option could be used in a posterior cruciate retaining knee but only if an anterior constrained poly was available. Additionally, this option could be used in coronal instability with incompetent ligaments; however, this would require a varus-valgus constrained poly and a compatible femoral implant in place.

In our retrospective review of patients treated with PE only for prosthetic knee instability, we noted that the results were less than optimal regardless of the appropriate indications for its use. Only about half of the patients felt they were stable after revision, and only half were satisfied with their pain relief. However, it must be recognized that the
major limitation of this study is due to its retrospective design. Another limitation is that the sample size is relatively small (n = 71). However, this reflects the infrequency of the appropriate use of this treatment option from two high-volume revision centers where it was used in only 4% of revision total knees (71 of 1606). Patients may have been misclassified, making it difficult to determine through review of records whether the procedure itself was not very effective or whether it was used inappropriately where isolated poly exchange was not indicated. Additionally, 9 of the 36 patients treated with poly exchange only for an appropriate indication were reluctant to answer specific questions related to pain and instability when contacted in follow-ups. The reasons for this remain unclear.

 regard less, we have learned that this procedure is infrequently used at two tertiary referral centers to manage prosthetic knee instability. Isolated PE was only used in 2.5% of more than 1600 revision knee cases over a 10-year period.

We also have learned that despite the use of this technique when indicated, the results of PE only with regard to pain and instability are unpredictable. Only approximately 50% of patients became stable and had adequate pain relief via PE only for prosthetic knee instability. The importance of classifying a patient’s instability pattern remains paramount in successfully managing prosthetic knee instability. The classification system described here has value in identifying the various instability patterns and treatment alternatives available for each. PE should be used infrequently and only for specific instability patterns. The inappropriate use of PE only for certain instability patterns, such as flexion-extension mismatch, must be understood.

**Conclusion**

Patients and surgeons alike should understand that this low morbidity option does not guarantee a good result regardless of whether it is used for an appropriate indication. Obtaining stability and pain relief in a patient with prosthetic knee instability remains a significant challenge. Therefore, the key to avoiding prosthetic knee instability is through prevention at the time of primary surgery. A successful stable knee requires proper alignment, a complete concave release of the coronal deformity, and equalization of the flexion-extension gaps. Failure to meet each of these basic technical criteria for knee arthroplasty puts the patient at risk for a difficult problem to treat. The concept of leaving a knee loose in flexion to promote an early range of motion should be abandoned. Prosthetic knee instability remains difficult to manage despite intuitive and appropriate indications for PE only.

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