TKA After Clamshell Osteotomy for Femoral Diaphyseal Malunion

LCDR ADDISON J. WILSON, MD; SUMON NANDI, MD; CLAIRE E. ROBBINS, PT, DPT, MS; JAMES V. BONO, MD; PAUL TORNETTA III, MD

abstract

Proper component positioning is essential for successful total knee arthroplasty (TKA). Femoral component positioning presents a technical challenge when significant femoral deformity is present. Most commonly, an intramedullary guide is used to make an accurate distal femoral cut. However, in the presence of a significant femoral deformity, this is not a viable option.

The use of clamshell osteotomy to restore anatomic alignment in patients with complex femoral diaphyseal deformity is described in the literature. This article describes a case of a patient who underwent staged TKA after clamshell osteotomy and retrograde femoral nailing to correct femoral diaphyseal malunion. The retrograde intramedullary nail was retained and used as an intramedullary guide, allowing for TKA in a routine manner. Using an intramedullary nail as an alignment guide may be more accurate than using extramedullary alignment and may avoid the increased surgical time and potential pin-site stress risers of navigation. It is a simple, effective way to treat complicated diaphyseal femoral deformities in the face of posttraumatic knee arthritis. Further study of this technique with longer follow-up and multiple surgeons is necessary to validate this treatment algorithm.

Figure: Preoperative lateral radiograph of the right knee (A). Lateral radiograph of the right knee after total knee arthroplasty (B).

ERRATUM

This article has been amended to include a factual correction. An error was identified subsequent to its original printing (2012; 35[6]:e969-e972), which was acknowledged in an erratum printed in 2013; 36(2):119. The online article and its erratum are considered the version of record.
Proper component positioning is essential for successful total knee arthroplasty (TKA). The distal femoral cut during TKA can be performed using 1 of 3 guides: intramedullary, extramedullary, or computer-assisted navigation. Intramedullary femoral alignment is most commonly performed in TKA and is technically simpler than extramedullary or computer-assisted techniques. Intramedullary guides have been shown to accurately yield a distal femoral cut in 5° of valgus with respect to the anatomic axis of the femur. Total knee arthroplasty in patients with severe femoral deformity is a technical challenge because the use of intramedullary guides is not possible.

Russell et al reported the use of clamshell osteotomy to restore anatomic alignment in patients with complex femoral diaphyseal deformity. Ipsilateral femoral osteotomy is indicated for deformities too severe to be corrected at the level of the joint. Angular deformities with a magnitude of 20° to 30° can be corrected using this technique. The current article describes a patient who underwent staged TKA after clamshell osteotomy and retrograde femoral nailing to correct femoral diaphyseal malunion. The retrograde intramedullary nail was retained and used as an intramedullary guide, allowing for TKA in a routine manner.

**Case Report**

A 60-year-old man with no significant medical history was referred to the authors’ institution for evaluation of progressive right knee pain over the past year refractory to anti-inflammatory medications, steroid injections, and physical therapy. At age 17 years, the patient had sustained right femur and tibia fractures in a motorcycle accident. The femur fracture, treated with skeletal traction, resulted in malunion.

On physical examination, the mechanical alignment of the patient’s right lower extremity was in significant varus. He had an antalgic gait and required a cane to ambulate. Right knee range of motion was 5° to 90°.

Plain radiographs of the right knee demonstrated severe tricompartmental arthritis with varus deformity at the joint line (Figure 1). A whole-extremity view showed a well-aligned right tibia but significant malunion in the femoral diaphysis, with an 11° varus deformity in the coronal plain and an 11° apex-anterior deformity in the sagittal plane (Figure 2).

Having failed nonoperative treatment, the patient consented for staged surgical treatment of his right knee posttraumatic arthritis. First, his extra-articular femoral deformity was corrected using a clamshell osteotomy with stabilization over a retrograde intramedullary nail (Figure 3). Once the osteotomy had healed, a TKA was performed. The intramedullary nail was used as an intramedullary guide for the distal femoral cut. A screwdriver was placed into the intramedullary nail end cap (Figure 4), and the intramedullary distal femoral cutting guide was placed over the screwdriver shaft, which allowed for an accurate distal femoral cut in 5° of valgus. The diameter of the screwdriver happened to be the same size as the opening in the distal femoral cutting block. The remainder of the surgery was performed routinely.

Ligament balancing was used to determine femoral rotation. As a result, skewed anatomic landmarks resulting from the femoral deformity did not adversely impact decisions regarding femoral rotation.

The patient’s postoperative course was unremarkable. At 6-week follow-up, plain radiographs of the right lower extremity showed satisfactory position of the total knee (Figure 4). The incision was well healed, and knee range of motion was 0° to 95°. Whole lower-extremity radiographs were not obtained during the first postoperative visit, and subsequent attempts to contact the patient for follow-up failed.

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**Figure 1:** Anteroposterior radiograph showing tricompartmental osteoarthritis of the right knee.

**Figure 2:** Preoperative whole-extremity radiograph of right lower extremity (A). Whole-extremity radiograph of the right lower extremity after clamshell osteotomy (B).
was later determined that the patient died from complications following urologic surgery.

**DISCUSSION**

Restoration of proper lower-extremity mechanical alignment following TKA is important for prosthesis function and longevity. Patients with advanced knee arthritis and concomitant femoral deformity require additional surgical measures to achieve appropriate limb alignment following TKA.

Multiple studies have identified various surgical techniques for correction of extra-articular deformity. Lonner et al. performed TKA and osteotomy simultaneously with tibial tubercle osteotomy for exposure. Mann et al. reported correction of extra-articular deformity through intra-articular bone resection during TKA. Both surgeries yielded acceptable results but were technically demanding, with the latter having limitations in magnitude of deformity correction.

Previous authors have suggested femoral coronal deformity $>10^\circ$ or sagittal deformity as a threshold for performing corrective osteotomy prior to TKA. Ipsilateral femoral osteotomy is indicated once the magnitude of the deformity exceeds that which can be corrected at the joint level. However, in elderly patients, the morbidity of the 2 surgeries make this an undesirable option.

A clamshell osteotomy allows for restoration of the anatomic axis in complicated femoral diaphyseal deformities, as described by Russell et al. Angular correction to neutral can be obtained in deformities ranging from $2^\circ$ to $20^\circ$ in the coronal plane, from $0^\circ$ to $32^\circ$ in the sagittal plane, and from $0^\circ$ to $25^\circ$ in the axial plane. The 10 patients studied were able to mobilize immediately postoperatively, and the osteotomy healed in all patients after 6 months.

The current authors have previously described the use of a retained retrograde intramedullary nail as an intramedullary femoral alignment guide during TKA. The current article describes the novel combination of clamshell osteotomy to correct femoral deformity and retention of the intramedullary nail for use as a TKA femoral alignment guide. This was found to be a powerful tool in treating patients with posttraumatic arthritis and femoral diaphyseal deformity. This technique allowed correction of the patient’s bipolar femoral deformity of $11^\circ$ and performance of a TKA with little deviation from that of a routine primary procedure. Postoperatively, the patient had excellent limb alignment and an unremarkable clinical course (Figure 3).

Using an intramedullary nail as an alignment guide may be more accurate than using extramedullary alignment and may avoid the increased surgical time and potential pin-site stress risers of navigation. This technique places the TKA femoral component in $5^\circ$ of flexion in the sagittal plane secondary to the bow of the nail, which the authors believe to be negligible. Slight femoral component flexion may be advantageous because it decreases the risk of anterior femoral cortex notching and maintains tibiofemoral articulation in high flexion.

**CONCLUSION**

Combining a clamshell osteotomy with retention of the intramedullary nail for use as an intramedullary femoral alignment guide during TKA is a simple, effective way to treat complicated diaphyseal femoral deformities in posttraumatic knee arthritis. Further study of this technique with longer follow-up and multiple surgeons is necessary to validate this treatment algorithm.

**REFERENCES**

1. Kim YH, Kim JS, Yoon SH. Alignment and orientation of the components in total knee


