OPEN Case Report

Revision of Well-Fixed Mechanically-Aligned Total Knee Arthroplasty Using Kinematic Alignment for the Restoration of Joint Line Obliquity: Report of a Surgical Technique

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ABSTRACT

Despite advances in technology and procedures, primary total knee arthroplasty can still result in an unsatisfied patient up to 20% of the time. Many indications for revising total knee arthroplasty have been established, including infection, aseptic loosening, wear, and instability. A newer indication being used in our center is that of a mechanically aligned knee, in which the prosthetic joint line has been substantially altered with respect to the native joint line. In this surgical technique report, we describe a method of revising a painful mechanically aligned total knee arthroplasty using the principles of kinematic alignment, using either the patient's preoperative long-axis radiographs, if available, or those of their contralateral limb, as a guide for the measurement of native joint line obliquity. Although this may be controversial, in our practice, this diagnosis has become an established indication for revision knee arthroplasty, with high success rates and patient satisfaction. In this brief surgical technique report, we present the details of one of our cases.

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Despite advances in prosthesis design, fixation, bearings, surgical technique, technology assistance, and length of stay, up to 20% of patients express dissatisfaction after undergoing total knee arthroplasty (TKA).[1–3] Various studies have attempted to identify the causes of dissatisfaction and pain following TKA, implicating variables such as age, body mass index, preoperative deformity, chronic narcotic use, prior knee surgery, arthrofibrosis, comorbid pain, contralateral knee pain, psychological distress, and various patient-reported outcome measures.[4–7]

Mechanical alignment (MA) has been considered the benchmark for TKA for years. Kinematic alignment (KA) is an alternative to MA that matches the patient's native prearthritic joint anatomy, particularly their native coronal plane joint line obliquity (JLO). It has been shown to produce results that are superior or noninferior to MA, and it holds promise for better patient-reported outcome measures.[8–11] Kinematic alignment may also reduce the

length of stay and opioid use compared with mechanically aligned total knee arthroplasty.[12]

Standard indications for revision total knee arthroplasty include aseptic loosening, mechanical wear, infection, malalignment, and instability.[13] We have recently begun performing a limited series of revisions for a new diagnosis: nonanatomic joint line obliquity in the well-fixed MA total knee. Patients with this diagnosis share similar characteristics: first, all other problems are excluded, such as loosening, wear, infection, malalignment, or gross instability. These patients underwent a properly indicated primary total knee, and their long-axis alignment falls within the established guidelines for mechanical alignment (hip/knee/ankle (HKA) +/− 3°). The final element required for this diagnosis is that their JLO differs by 3° or more from their native JLO, based on either their preoperative long-axis radiographs, if available, or that of their contralateral limb. Our experience suggests that for such patients meeting these criteria and experiencing dissatisfaction with an MA total knee, KA revision with restoration of natural joint line obliquity leads to improved outcomes.

To our knowledge, no published reports have described the revision of an MA total knee to a KA total knee in a patient without indications for revision. This report describes the surgical technique for converting a well-fixed MA TKA to KA TKA.

Surgical Technique

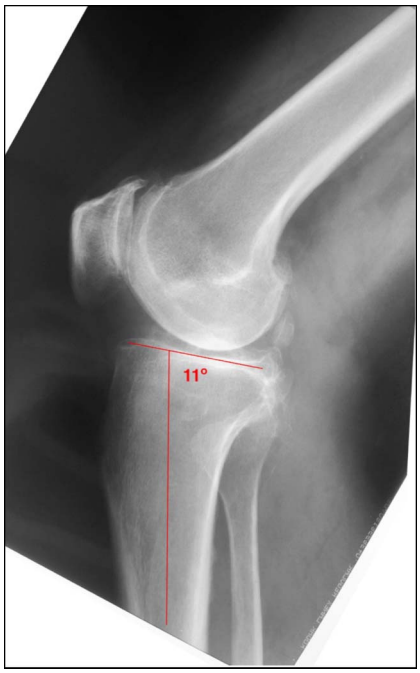
This 74-year-old man underwent a primary right TKA in 2015 by another surgeon. The patient had previously undergone a left TKA performed with KA by the senior author. The patient remained very satisfied with his left KA knee but was dissatisfied with the function, performance, and pain level of his right MA knee. Because we had previously treated his left knee, we had prior radiographs of his opposite, right knee, including a standing long axis view, and thus measured his anatomic lateral distal femoral angle (aLDFA), medial proximal tibial angle (MPTA), and posterior slope, before and after his MA TKA. Preoperative long-standing and lateral radiographs are included in Figures 1 and 2. Postoperative primary MA TKA radiography is included in Figures 3 and 4.

A preoperative workup, including laboratory tests (C-reactive protein [CRP], erythrocyte sedimentation rate [ESR], white blood count [WBC]) and a negative aspiration, ruled out infection. A bone scan was also done, revealing no increased uptake. After extensive patient counseling, we indicated the patient for a revision of his MA TKA. The surgery was done under general anesthesia with an adductor canal block, using a tourniquet. We conducted a medial parapatellar arthrotomy and everted the patella. We examined all components to confirm that no loosening or other mechanical complication was observed. We removed the femoral and tibial components with osteotomes. We recut the distal femur and proximal tibia to match the patient's preoperative joint line angular values. We also increased the posterior slope to match the preoperative anatomy. We internally rotated the revision femoral component approximately 3° to correct the previous position of external rotation of the femoral component of the original MA knee. We implanted posterior-stabilized components with short stems, using cement fixation.

Figure 1

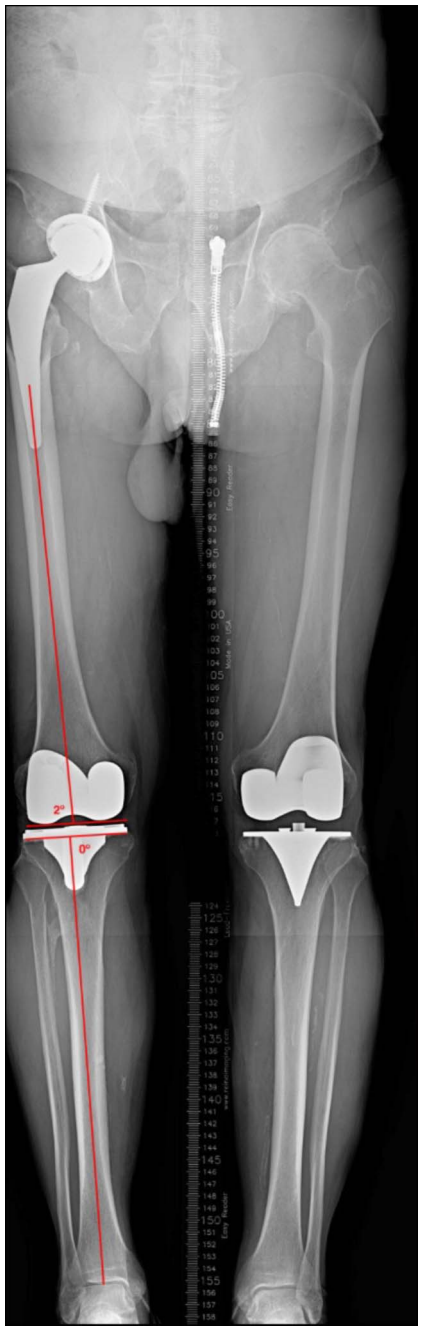
preoperative long standing.

Figure 2



preoperative lateral.

Figure 3



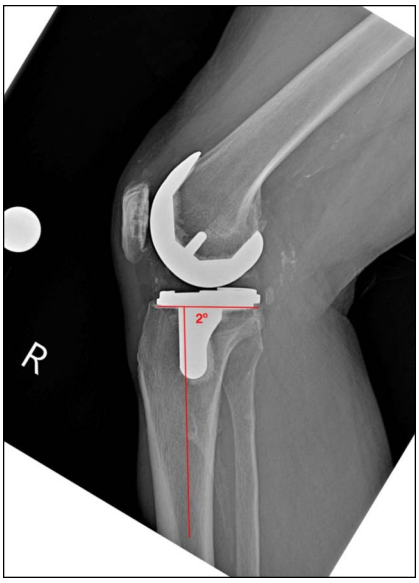
primary MA TKA long-standing. MA = mechanical alignment, TKA = total knee arthroplasty

Although no gross long-axis extremity malalignment was present in this primary MA TKA (HKA was 176°, 4° of overall varus), the obliquity of the prosthetic joint line did not match his preoperative joint line anatomy, which is common with MA knees. The patient had 6° of natural varus in the proximal tibia, and this was changed to 0° in the MA TKA. The aLDFA was 7° preoperatively, and this was converted to 2° in the MA TKA. After revising using this KA technique, the aLDFA was restored to the patient's anatomic alignment of 7°, and the MPTA was also corrected back to 5°. The patient's native posterior slope was 11°, which was changed to 2° in the primary MA surgery and then restored closer to the patient's normal value of 6° with the KA revision (Table 1). Postoperative radiographs show the short-stem revision components in KA alignment (Figures 5 and 6). We did not attempt to fully match the preoperative slope due to concerns that the excess slope could cause the tip of the tibial stem to abut or perforate the anterior tibial cortex. Matching the native varus was also limited by the tibial stem.

Discussion

There is currently little in the literature discussing the treatment of painful mechanically aligned total knee arthroplasty, beyond standard care medications, physical therapy, and other nonsurgical treatments. Studies continue to demonstrate that pain can persist in up to 20% of patients one year after total knee arthroplasty,[14] with some newer studies showing that 12.7% of patients still report dissatisfaction with their TKA 5 years postoperatively.[1]

Figure 4



lateral view of MA TKA. MA = mechanical alignment, TKA = total knee arthroplasty

Kinematic alignment offers potential benefits over mechanical alignment. Patients undergoing TKA with KA experienced less pain than those with MA six weeks after surgery.[8] Knee kinematics of patients with kinematically aligned TKAs more closely resemble those of normal healthy controls than those of patients with mechanically aligned TKAs.[15] Compared with MA, KA produces an excellent range of motion and balance while preserving bone stock and minimizing soft-tissue trauma.[16]

There are some challenges with this technique. One is that stem extensions can limit the degree of correction possible; therefore, we are using shorter stems going forward. Another issue is that prearthroplasty radiographs may not be available. In this case, we enjoyed the benefit of long-axis radiographsobtained before the primary TKA procedure. However, the alignment measurements of the opposite extremity (if unreplaced or if prearthroplasty radiographs are available) could be used as a surrogate for ipsilateral radiographs. Finally, instrumentation for the distal femoral and proximal tibial angular corrections could be improved. Alternatively, robotics, augmented reality, or patient-specific instruments could be used, with appropriate modifications for this indication.

By reporting this surgical technique, we hope to encourage a discussion of our approach to this clinical problem. However, we recommend caution before considering the revision of a well-fixed, painful MA knee, with absence of any indications for revision. A full revision of this nature is a very invasive procedure with the potential for notable morbidity. In the past, in most practices, these patients would not be candidates for revision. Most would not consider a dissatisfied patient with a mechanically aligned total knee, without aseptic loosening, infection, or implant failure, as a candidate for revision surgery. Just because this procedure can be done does not necessarily mean that it should be done in all patients. This approach should be taken with caution and careful evaluation.

Nonetheless, as long as MA TKAs are performed, there will be potential for dissatisfied patients.[8,15] A well-fixed, mechanically aligned total knee arthroplasty lacking any of the indications for revision, such as wear, loosening, sepsis, or instability, may represent a new indication for revision surgery. Conversion to that patient's individual joint line obliquity, using kinematic alignment principles, may improve outcomes when the preoperative alignment is known. However, it is too early to report the outcomes of a group of these patients; our early results have been very encouraging, and we are carefully following these patients in a prospective outcomes trial.

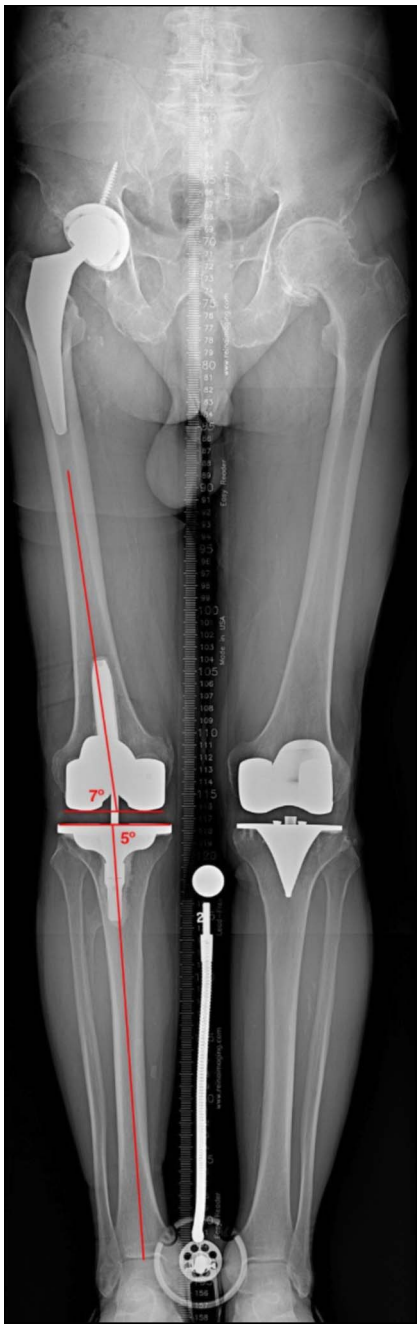
Conclusion

This surgical technique report is presented to describe our indications and technique for the revision of a well-fixed, mechanically aligned TKA, using the principles of kinematic alignment to reposition the revision components and restore the natural obliquity of the individual patient's native joint line. We acknowledge that this diagnosis is not a universally accepted indication for

Table 1. Preoperative, Postoperative, and Revision Alignment Angles

	Preoperative	Mechanical Alignment Primary	Kinematic Alignment
aLDFA	7	2	7
MPTA	6	0	5
Posterior slope	11	2	6

Figure 5



revision KA TKA long-standing. KA = kinematic alignment, TKA = total knee arthroplasty.

Figure 6

revision KA TKA lateral. KA = kinematic alignment, TKA = total knee arthroplasty.

revision total knee surgery. Further data must be collected regarding the long-term outcomes in kinematically aligned total knee revisions of failed MA TKA before this procedure can be recommended without reservation. However, this has become an established indication for revision knee arthroplasty in our practice, indicated for a small, carefully selected group, with remarkable success rates and patient satisfaction. We intend to follow-up this report with the results of our outcomes trial of a larger group of patients.

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