

Using Intraoperative Sensing Technology to Guide Revision in the Chronically Painful Knee: A Two-Patient Case Study

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Abstract

The number of revision total knee arthroplasty (TKAs), performed annually, is expected to rise, in concert with the exponential demand for primary surgical procedures. These costly revision cases will continue to place an increased financial strain on an already burdened healthcare system. Therefore, it is imperative to explore methods which may provide more objective data to surgeons performing these complicated revision surgeries. Access to more empirical data may assist surgeons in more appropriate operative planning, and may mitigate the need for total component exchange. In this case study, the surgeon uses a disposable, intraoperative sensing device to guide complex procedures in patients presenting with chronic pain. At 6-weeks, both patients exhibit alleviated pain, increased function, and highly favorable outcomes.

Keywords: *Revision; Total Knee Arthroplasty; Intraoperative Sensors*

Introduction

At some point in their lives, over 50% of patients suffering from knee osteoarthritis will undergo a total knee arthroplasty (TKA) [1]. While this procedure has proven to be an effective treatment for late-stage osteoarthritis, many recipients return to clinic reporting pain and instability [2, 4]. As a result of unfavorable complications, the risk of revision after primary TKA is 14.9% for men and 17.4% for women [1].

Revision TKA is costly, both financially and to the health of the patient. The average charge for a TKA revision surgery is \$73,696, with a considerably larger cost for patients exchanging the femoral, tibial, and polyethylene components [3]. Patients in receipt of a revision TKA are also at a greater risk for complications than patients in receipt of a primary TKA, exhibiting poorer functional outcomes and, oftentimes, requiring additional invasive procedures [3].

With the projected proportion of revision TKA expected to increase [5], it is imperative—both economically and for the well-being of the patient—that new methods are developed to mitigate unnecessary costs and complications. Therefore, the purpose of this consecutive, two-patient case series was to test the efficacy of using intraoperative sensing technology (OrthoSensor Inc., Dania Beach, FL, USA) to effectively guide revision surgery in patients with debilitating and chronic pain.

Case I

Patient: 60-year old male; BMI of 33.5 kg/m². Uni-recipient previously revised to total.

Clinical Presentation: Persistent and debilitating pain, posteromedially in flexion. Proximal medial tibia and medial joint line tender. Pain exacerbated with activity, often keeps patient awake at night. Compressed, tentative, slow gait.

Diagnosis: Failed total knee replacement. Progressive loosening of tibial component; rotational incongruity between femoral and tibial components.

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Figure 1

Operative Report: Tibial tray previously positioned slightly anteriorly with deficiencies between cement-bone interface. Femoral and patellar components both stable.

After tibial recut and tray placement (based on mid-third of tibial tubercle), VERASENSE™ sensor was inserted. Excessive internal rotation of tibial component indicated by incongruent contact point location (non-parallel contact points indicated by arrows, Figure 2). Laxity in the medial and lateral compartments was indicated by loading < 10lbs (circled, Figure 2).

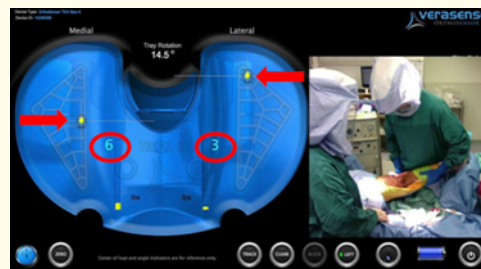


Figure 2

Tibial rotation was optimized. To induce tension, the tibial component was assembled with 5mm medial and lateral hemiblock; knee reduced using 13mm trial spacer. VERASENSE™ sensor indicated congruent rotation between femoral and tibial components (arrows, Figure 3), as well as favorable induced tension in both the medial and lateral compartments of approximately 20 lbs. (circled, Figure 3).

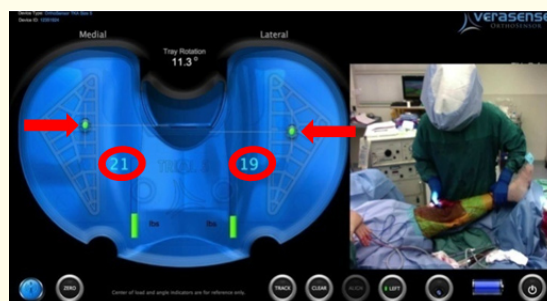


Figure 3

Patient returned to recovery room without difficulty.

6-Week Follow-up: Patient continuing physical therapy regimen, states that he is feeling well. Patient also states that the knee feels very stable, and that he is eager to have the contralateral side revised as well. Patient gait is uninhibited, and no ambulatory assistance is needed. Patient has full extension, 100° of flexion; no laxity and no lag.

Case II

Patient: 55-year old female; BMI of 31 kg/m²; underwent primary total knee replacement one year prior.

Clinical Presentation: Persistent pain, swelling, and prolonged inability to obtain full extension or flexion. Previous, closed manipulations to improve range of motion have proven futile. Persistent limp and discomfort upon walking or standing. Pain makes it difficult to get comfortable for sleep. Despite efforts by physical therapy, foot tends to externally rotate with extension.

Diagnosis: Painful total knee replacement with medial instability (Figure 4).



Figure 4

Operative Report: Patient lacked 5° of terminal extension; medial laxity present at extension and various degrees of flexion. Femoral component stable, though slightly lateralized. Tibial tray exhibited visual external rotation. PCL tight with no pivot.

VERASENSE™ was activated and inserted. The sensor system confirmed both excessive external rotation of the tibial tray (non-parallel contact points indicated by arrows, Figure 5), as well as lack of loading medially/excessive loading laterally (circles, Figure 5).

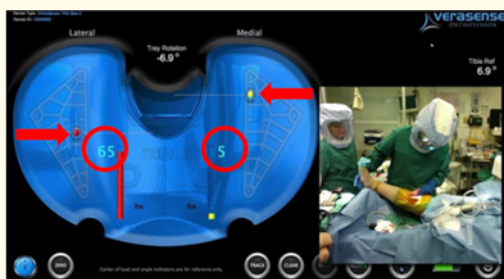


Figure 5

After recutting the proximal tibia and down-sizing the tray, VERASENSE™ was used to guide the optimization of tibial tray rotation (arrows, Figure 6). With rotational congruency established the medial and lateral loading auto-equalized without intervention (circles, Figure 6). The PCL appeared to be functioning also as a result of malrotation correction.

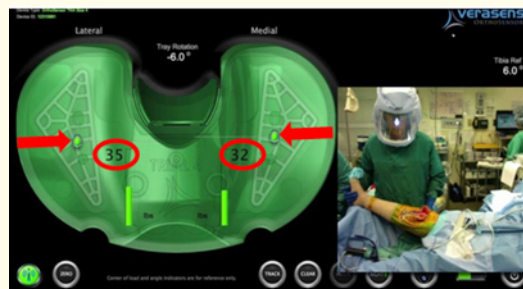


Figure 6

The patient experienced no intraoperative difficulty, and was returned to the recovery room in stable condition.

6-Week Follow-up: Patient states that she feels very good. She continually states that revised knee now feels like a “real knee.” Patient also states that the knee feels “sturdy” and that she is eager to begin riding her bike again. Patient stood and walked without ambulatory assistance, and range of motion was completely pain-free. No laxity or lag detectable.

Discussion

Revision total knee arthroplasty presents intraoperative challenges to the surgeon; recovery hurdles for the patient; and greatly contributes to the already staggering financial burden associated with TKA [1, 3, 6]. Thus, developing new methods with which to guide the surgeon through complex cases may help to mitigate post-operative complications and unnecessary costs.

In this short case series, two patients presenting with chronic and debilitating pain have had revision total knee arthroplasty performed with intraoperative sensing technology. At the 6-week post-operative visit, both patients are fully ambulatory without aid, report that they are satisfied with their new knee, and that the knee feels “good”. Most notable is the patient from Case I. This patient had previously undergone several revision surgeries without alleviation of symptoms. However, at the 6-week post-operative interval, he no longer limps with ambulation and has expressed eagerness to have his contralateral side re-operated.

Both Cases I and II presented with tibial tray malrotation, which was fully corrected for via the guidance of the intraoperative sensor. In Case II, mediolateral intercompartmental loads as well as PCL restrictions were confirmed as corrected simply after optimizing tray rotation. This confirmation by the sensor system prevented the need for the surgeon to further address any ligament tension. In Case I, the need for induced tension was indicated by the sensor system, prompting the surgeon to add both hemiblocks and a thicker tibial spacer until appropriate bearing surface loading was obtained.

Conclusion

This small case series provides promising results for the efficacy of using intraoperative sensing during complex revision cases. Specifically, the surgeon was able to avoid unnecessary ligament release and/or bony adjustment by utilizing the medial and lateral contact point locations, as shown by the sensor, to correct for previously undetected tibial malrotation. As a result of revision surgery, with the use of quantitative feedback from the sensorized tibial trials, both patients reported full ambulation and decreased pain at 6-weeks, post-operatively. Further case studies and longer follow-up will need to be obtained to understand long-term outcomes of sensor-assisted, revision knee arthroplasty.

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