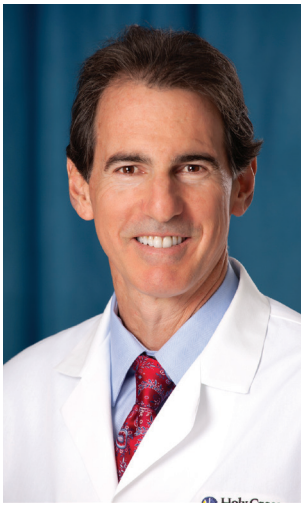

Using Intraoperative Sensing Technology to Guide Revision in the Chronically Painful Total Knee:

Two-Patient Consecutive Case Series

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Introduction

The popularity of total knee arthroplasty coupled with the aging population suggests a dramatic increase in revision TKA procedures [5]. 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]. Up to 20% of TKA patients are dissatisfied with their outcome [7]. As a result of unfavorable clinical outcomes, 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 in the U.S. is $73,696, with a considerably larger cost for patients undergoing surgery because of deep joint infection, patients receiving a three component exchange, and patients receiving hinged or constrained condylar knee implants. The number of TKA revisions is estimated to increase by 66% with projected hospital costs in excess of $2 billion by 2030. [3]. Patients who undergo revision TKA are at a greater risk for complications than patients who have a primary TKA, exhibiting poorer functional outcomes and, oftentimes, requiring additional invasive procedures [3].

It is imperative that more precise methods are developed to accurately guide implant positioning and soft-tissue balance during primary TKA to yield a more consistent clinical result. It is also critical that such methods are developed to diagnose specific problems during revision TKA to facilitate surgical correction and implant salvage when feasible. Therefore, the purpose of this consecutive, two-patient case series was to test the efficacy of using intraoperative sensing technology 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 tenderness. Pain exacerbated with activity, often keeps patient awake at night. Exhibited a compressed, tentative and slow gait.

Diagnosis: Failed left total knee replacement. Tibial component loosening; rotational incongruency between femoral and tibial components (Fig 1).

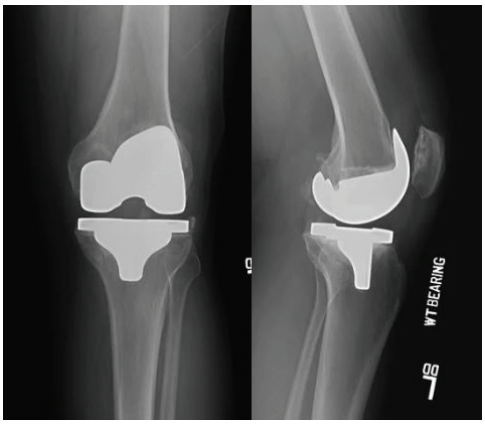

Figure 1

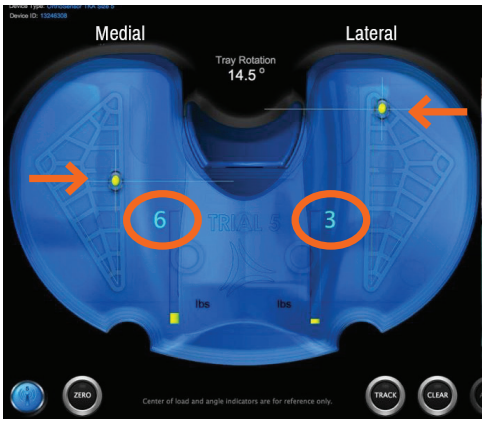

Figure 2

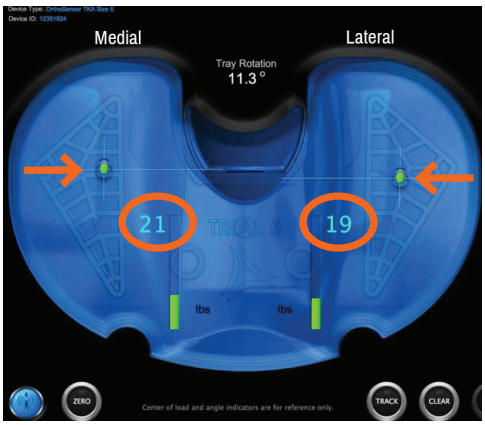

Figure 3

Operative Finding:

The tibial tray was found to be loose with deficiencies between the metal tray and cement while the femoral and patella components were stable and appropriately positioned.

Prior to making adjustments and removing the tibial tray, the original polyethylene insert was removed and the VERASENSE™ sensor was inserted to evaluate the pre-revision position of tibial tray rotation (with referencing to the mid-third of the tubercle) in relation to the femur. The data from the sensor (displayed on user interface depicted in Figure I) showed **excessive internal rotation of tibial component** indicated by incongruent contact points on the virtual tibial surface (non-parallel contact points indicated by arrows, Fig 2). The femoral contact point on the medial surface was located in the central third of the tibial tray while the femoral contact point was displaced posterior on the lateral side. Laxity in the medial and lateral compartments was indicated by loading pressures of < 10 lbs (circled, Fig 2) in each compartment.

Operative Reconstruction:

A new tibial tray was placed and rotated more externally until medial and lateral contact points were parallel or congruent and located within the central third of the tibial tray. Five-millimeter hemiblocks were added to the medial and lateral sides of tibial component to induce normal tension in each compartment. A small cemented stem was also added for improved stability. The knee was reduced using a 13 mm VERASENSE spacer. The data measurements displayed on the user interface confirmed final rotational congruency between the femoral and tibial components (arrows, Fig 3), as well as favorable induced tension in both the medial and lateral compartments of approximately 20 lbs. (circled, Fig 3).

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 was walking nicely without any detectable limp and no longer using an assistive device. His knee fully extended with no lag or laxity present and is able to actively flex 100°.

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 stiffness with inability to obtain full extension (lacked 14°) or flexion (80°). Previous closed manipulation under anesthesia to improve range of motion has 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.

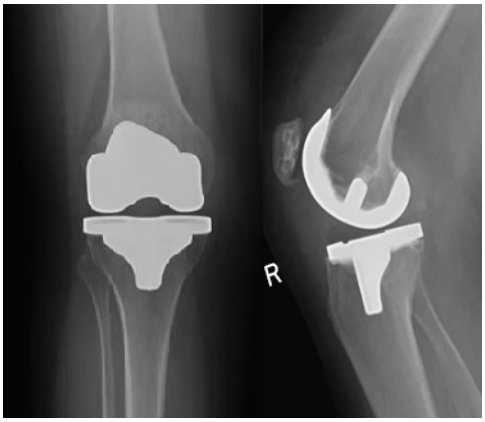

Figure 4

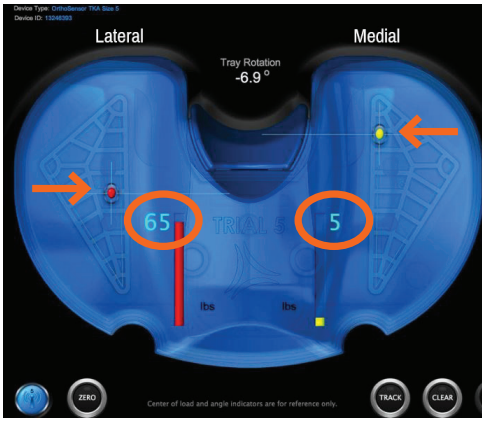

Figure 5

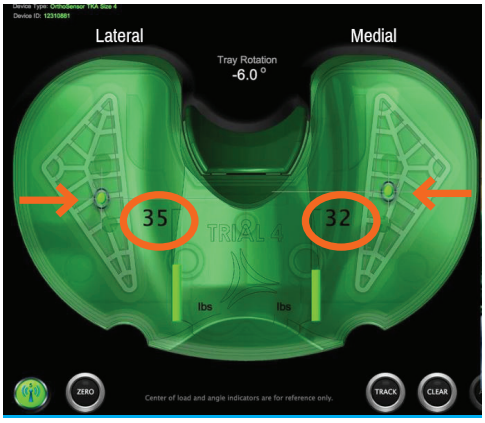

Figure 6

Diagnosis: Painful total knee replacement with medial instability; rotational incongruency between femur and tibia due to tibial external rotation (Fig 4).

Operative Finding:

Patient lacked 14° of terminal extension; medial laxity present in extension and various degrees of flexion. Femoral component stable and appropriately rotated relative to the epicondylar axis, though slightly lateralized. Tibial tray exhibited visual external rotation. PCL was tight with no pivot.

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

Operative Reconstruction:

After recutting the proximal tibia and down-sizing the tray, the approriate size 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 now appeared to be functioning appropriately as a result of correction of the tibial tray rotation.

6-Week Follow-up:

Patient states that she feels very good. She repeatedly stated that the 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 hesitation, no presence of limp, and without an assistive device. Her range of motion was completely pain-free; she is now able to achieve full extension and 105° of flexion. She exhibited no laxity or lag.

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 dynamically guide the surgeon through complex cases may help more precisely diagnose the specific mechanical or soft tissue problems leading to unsatisfactory outcomes. These methods may result in a more directed approach to revision surgery, potentially avoiding the removal of some components and diminish unnecessary soft tissue dissection or release; subsequently sparing the patient morbidity and unwarranted costs.

In this short case series, two patients presenting with chronic and debilitating pain have had revision total knee arthroplasty performed using intraoperative sensing technology. At the 6-week post-operative visit, both patients are fully ambulatory without the need of assistive devices, 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 and has expressed eagerness to have his contralateral side re-operated.

Both Cases I and II presented with tibial tray malrotation, which was diagnosed and corrected with the guidance of the intraoperative sensor. In Case II, mediolateral intercompartmental loads— as well as PCL restrictions—corrected after optimizing tray rotation. No other releases were necessary. This confirmation by the sensor system obviated the need for the surgeon to further address any ligament tension. In Case I, the need for increased tension was indicated by the sensor system, prompting the surgeon to add medial and lateral hemiblocks and a thicker tibial spacer until appropriate bearing surface loading was obtained.

This small case series provides promising results for the efficacy of using intraoperative sensing during complex revision cases. Further case studies and longer follow-up will need to be obtained to understand long-term outcomes.

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