

In-Vivo Kinematics for Traditional and Patient-Specific Posterior Stabilized Total Knee Arthroplasty during Activities of Daily Living

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INTRODUCTION

Previous fluoroscopic studies have shown that Customized Individually Made (CIM) cruciate retaining (CR) TKA exhibit kinematic patterns closer to those of the normal knee when compared to off-the-shelf (OTS) CR TKA¹. More recently, the first posterior stabilized (PS) CIM TKA has been introduced. The objective of this study was to compare the in vivo kinematics of subjects having either a CIM-PS TKA or an OTS-PS TKA.

METHODS

Thirty-one successful TKA patients (KSS knee score greater than 80) with either a CIM (13 patients) (iTotal PS, ConforMIS, Inc., Bedford, MA) or OTS (18 patients) (NexGen PS, Zimmer Biomet, Warsaw, IN) TKA were assessed in this study. Fluoroscopic videos were captured of the patients while they performed a deep knee bend to maximum knee flexion. Each video was digitized, corrected for distortion, and then analyzed to determine kinematics using a 2D-to-3D image registration technique. Parameters assessed included; range of motion, anterior-posterior translation of the lateral and medial femoral condyles on the tibia, and femoral axial rotation. Lastly, the cam-post interaction was analyzed during the deep-knee bend activity to determine the flexion angle at which the cam first contacts the post and the nature of contact.

RESULTS

During a deep knee bend, on average, subjects with a CIM-PS TKA experienced significantly higher weight bearing range of motion (average 112°, range 81°-140°) as compared to OTS patients (average 94°, range 64°-113°) ($p \leq 0.05$) (Figure 1). CIM-PS TKA also exhibited significantly higher rollback of the lateral condyle from extension to maximum flexion (average 11.7mm for CIM vs 4.7mm for OTS) ($p \leq 0.05$) (Figure 2). Medial condyle translation between the two groups was also found to be significantly different ($p \leq 0.05$). While subjects in the CIM-PS group experienced a rollback motion of the medial condyle during the DKB activity (average 2.8mm posterior), OTS-PS subjects on average exhibited an anterior slide of their medial condyle (average 1.0mm anterior).

Axial rotation between the two groups was found to be statistically similar ($p > 0.05$), though the magnitude for subjects with the CIM-PS TKA was higher (average 10.9° CIM vs 7.6° OTS). Lastly, cam-post interaction was found to occur at 89°, on average, for subjects with the CIM-PS TKA as opposed to 94° in subjects with the OTS-PS TKA. Additionally, CIM-PS patients typically experienced uniform cam-post contact on the central aspect of the post. OTS-PS subjects exhibited instances of cam-post contact on the medial aspect of the post.

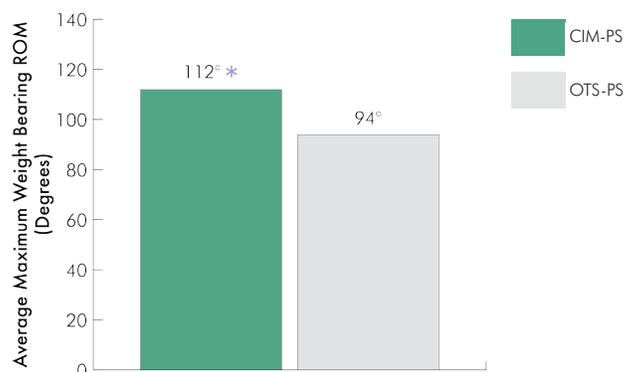


Figure 1: Comparison of weight bearing range of motion for the CIM PS and OTS PS TKAs during Deep Knee Bend.

* Statistically significant difference ($p \leq 0.05$)

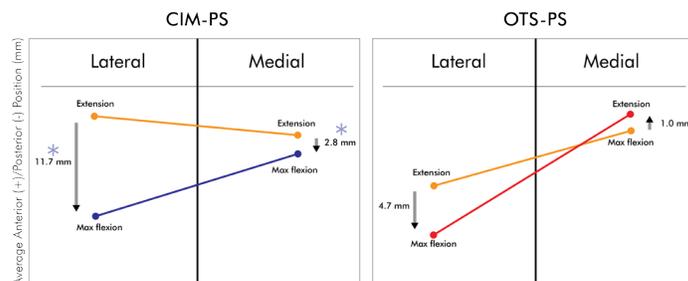


Figure 2: Comparison of average translations and rotation for the CIM PS and OTS PS TKAs during Deep Knee Bend.

* Statistically significant difference ($p \leq 0.05$)

DISCUSSION

In this study, subjects implanted with the CIM-PS TKA experienced significantly greater weight bearing flexion during deep knee bend when compared to the OTS-PS TKA group. CIM-PS subjects also experienced significantly higher femoral translation when compared to OTS-PS subjects. Cam post interaction occurred at similar flexion angles in both groups. However, the nature of contact was uniformly located on the central aspect of the post for CIM-PS patients. This study shows that CIM-PS TKA demonstrate kinematic patterns more closely approaching that of the normal knee. Additional subjects are being analyzed, however, early results show that the customized nature of the CIM-PS TKA design may provide a kinematic benefit to arthroplasty patients.

References:

1. Zeller, Ian M., Adrijia Sharma, William B. Kurtz, Mathew R. Anderle, and Richard D. Komistek. "Customized versus Patient-Sized Cruciate-Retaining Total Knee Arthroplasty: An In Vivo Kinematics Study Using Mobile Fluoroscopy." *The Journal of Arthroplasty* 32, no. 4 (2017): 1344-1350.

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