Kinematic Comparison Between Customized and Traditional TKA Designs Using Fluroscopy

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Summary of two presentations at ICJR Pan Pacific Orthopaedic Congress 2016: "In Vivo Kinematics for Customized, Patient Specific Vs. Two Generations of Traditional TKA During Various Activities" and "Kinematic Comparison Between Customized and Traditional TKA Designs Using Fluoroscopy"

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INTRODUCTION

Until recently, knee implants were designed using average patient geometry. Advances in technology have allowed for customized posterior cruciate retaining (PCR) total knee arthroplasty (TKA) to be individually made based on the patient's anatomy, using a CT scan pre-operatively while correcting any acquired deformities. The objective of these studies was to determine the in vivo kinematics for subjects having one of two modern designs of off-the-shelf (OTS) knee implant versus subjects having a customized, individually made (CIM) TKA.

METHODS

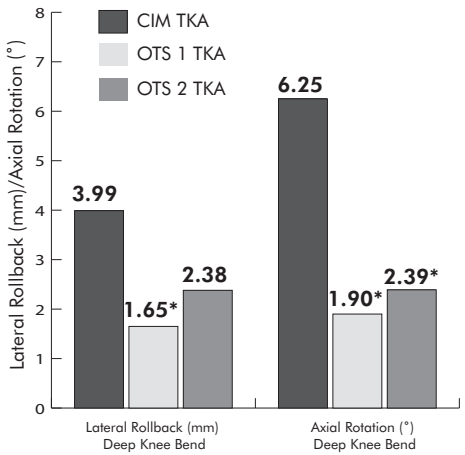
Seventy-three subjects, having either a CIM (24 patients) (iTotal, ConforMIS, Inc., Bedford, MA), OTS 1 (24 patients) (Attune, DePuy Synthes, Warsaw, IN), or OTS 2 (25 patients) (Persona, Zimmer, Warsaw, IN) were recruited. All the subjects were implanted by one of two surgeons and each patient was deemed clinically successful (HSS Score >90) without any laxity or pain. Fluoroscopic videos were captured while patients performed the deep knee bend (DKB) and chair-rise under mobile fluoroscopic surveillance. Each video was digitized, corrected for distortion, and analyzed to determine kinematics using 2D to 3D image registration. Comparison of kinematics between the designs focused on range of motion, femoral roll back, and axial rotation.

RESULTS

During the DKB, subjects with a CIM TKA experienced 3.99mm of lateral femoral rollback compared to 1.65mm ($p<0.05$ vs. CIM) for OTS 1 and 2.38mm ($p>0.05$) for OTS 2 (Figure 1). There were no significant differences with respect to medial condyle translation.

The CIM TKA patients demonstrated 6.25° of axial rotation compared to 1.90° ($p<0.05$) for OTS 1 and 2.39° ($p<0.05$) for OTS 2 (Figure 1). 88% of CIM TKA patients, 71% of OTS 1 patients, and 80% of OTS 2 patients exhibited normal rotation patterns.

On average, CIM subjects experienced similar weight-bearing flexion to OTS TKA 2 (105° vs 105°), but slightly less than OTS TKA 1 (110°) (Figure 2) which were not found to be significant.



*** Represents statistical significance with respect to CIM TKR**

Figure 1: Comparison of average anterior/posterior translation and axial rotation for the CIM and OTS TKAs during Deep Knee Bend.

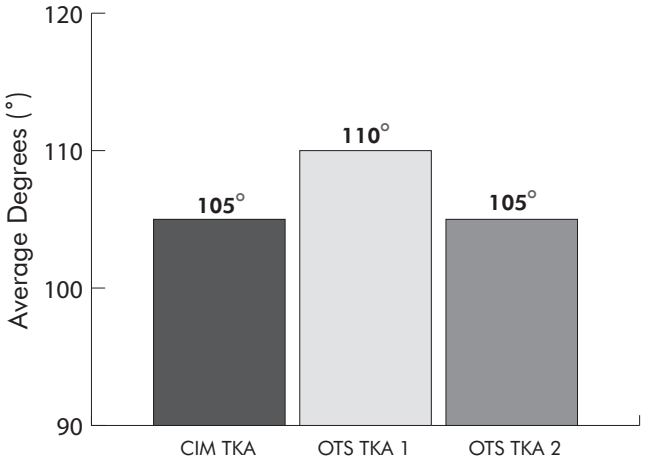


Figure 2: Comparison of weight bearing flexion for the CIM and OTS TKAs.

DISCUSSION

During DKB, CIM subjects experienced greater lateral condyle femoral rollback and axial rotation than the OTS TKA groups. The CIM TKA group exhibited higher magnitudes of lateral motion compared with the two OTS groups, as well as better approximation of normal knee kinematics during flexion. Some of these kinematic differences may be due to the manner in which OTS knee implants are designed based on J-curves derived from anatomic averages. These statistically derived geometries may not consistently match the natural J-curves of the individual patient or their natural condylar offsets. Matching implant shape to patient anatomy using a CIM total knee replacement may improve kinematic function.

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