#7501

Assessing Knee Mechanics of Revision TKA Solutions and Continuum of Care

*Lauren Ferris - DePuy Synthes - Warsaw, United States of America
Amit Mane - DePuy Synthes - Warsaw, USA
Richard Komistek - The University of Tennessee - Knoxville, USA
Paul Sade - DePuy Synthes - Warsaw, USA

*Email: lferris3@its.jnj.com

Introduction: More than 700,000 Primary Total Knee Arthroplasty (TKA) are performed annually in the US; 12% of these TKA require revisions (rTKA)[1]. TKA failures leading to debilitating conditions are loosening, infection, and instability, resulting in decreased function. TKA revision surgery initially require a surgeon to determine, based on many options, which rTKA system provides the patient the best outcomes with respect to bony fixation, stability, and range of motion. Furthermore, implant continuity between TKA and rTKA solutions must be considered. If a legacy design philosophy of a Primary solution is carried over to rTKA, patients can benefit from the Continuum of Care. Therefore, the first objective was to evaluate performance of one rTKA solution compared to the corresponding Primary solution, and second, to further extend rTKA comparisons with two additional commercially available rTKA solutions.

Methods: Three Fixed Bearing (FB) rTKA systems and one FB PS TKA were assessed using a previously validated Forward Dynamics Model (FDM) (Fig.1)[2]. rTKA solutions analyzed were Construct-ATR, Construct-ST and Construct-NXG (Fig.2). The FB PS offering of Construct-ATR was referred to as Construct-AT. For each construct, a Deep Knee Bend (DKB) from 5â ° to 120â ° flexion with neutral tibial rotational alignment was simulated. Analyses were focused on kinematic measures included AP translation of the femoral medial and lateral condylar lowest points (LP), and force measures of Quadriceps, Patella-Femoral (PF) Contact, and Patellar Tendon (PT).

Results: The AP motion of the medial and lateral condyles of Construct-ATR were within 0.5mm of Construct-AT (Fig.3). Construct-AT and Construct-ATR experienced anterior medial translation of 0.9mm and 1.25mm respectively, until cam-post engagement at 72â ° and 73â ° of flexion, while Construct-ST and Construct-NXG translated anteriorly 2.4mm and 3.8mm respectively, until cam-post engagement at 83â ° and 82â °, respectively. Peak Quadricep, PF, and PT forces for Construct-AT and Construct-ATR were within 150N (Fig.3). Construct-ST and Construct-NXG experienced peak forces higher than those of Construct-ATR and Construct-AT.

Discussion: Construct-AT LP motion characteristics observed are similar to those reported by Khasian[2] with twenty patients performing DKB. Observed similarities of LP results with *in vivo* patients demonstrates the predictive capabilities of the FDM. Construct-ATR and Construct-AT are designed with identical sagittal plane Femoral J-Curve-GRADIUS™, PF mechanism-GLIDERIGHT™ and cam-post engagement-SOFCAM™. The observed similarities in Tibio-Femoral AP motions and PF mechanics between Construct-AT and Construct-ATR demonstrates continuation of the design philosophies from Primary and Revision solutions. J-Curve of Construct-ST and Construct-NXG contains distinctive multiple radii potentially influencing observed larger anterior translation until cam-post engagement, which was concurrent with the increased Quad, PF and PT forces. Fitzpatrick et al. correlated post-cam engagement velocity and abrupt changes in LP kinematics in PS TKA solutions[3]. Construct-AT and Construct-ATR utilizes ‘S’ shape design of the post, promoting smooth transition from condylar control to cam-spine control, unlike Construct-ST and Construct-NXG. In summary, as the design of rTKA evolves, implementation of primary design philosophies, kinematics, and force measurements can aid in determining the optimal design parameters for rTKA patients.

References:

1. Hamilton et al 2015, 2. Khasian et al 2020, 3. Fitzpatrick et al 2013

Figures

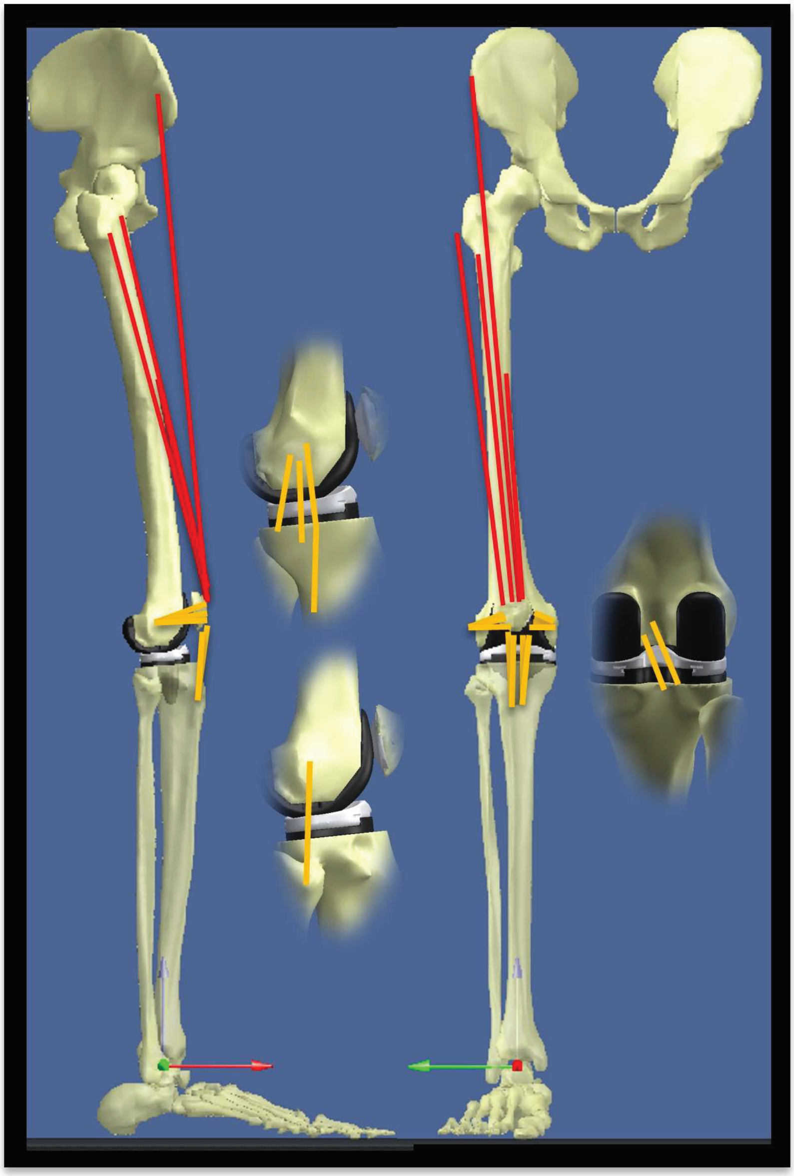


Figure 1. Forward Dynamics Model setup with the modeled collateral and cruciate ligaments, along with the four heads of Quadriceps muscle group.

Figure 1

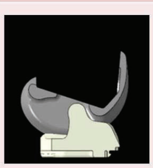
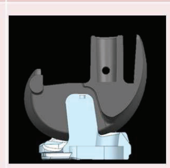
	Construct-AT	Construct-ATR	Construct-ST	Construct-NXG
Femoral Sagittal Radius of Curvature	GRADIUS™ (Gradually reducing radius)	GRADIUS™ (Gradually reducing radius)	Multi- radius	Multi- radius
Internal/ External Rotational Constraint at 0°	Unconstrained	± 4°	± 4.3°	± 2°
Varus/Valgus Constraint at 0°	Unconstrained	± 1.25°	± 2.2°	± 1.25°
Cross Sectional sagittal view at full extension				

Figure 2. Design parameters for Construct-AT, Construct-ATR, Construct-ST, and Construct-NXG.

Figure 2

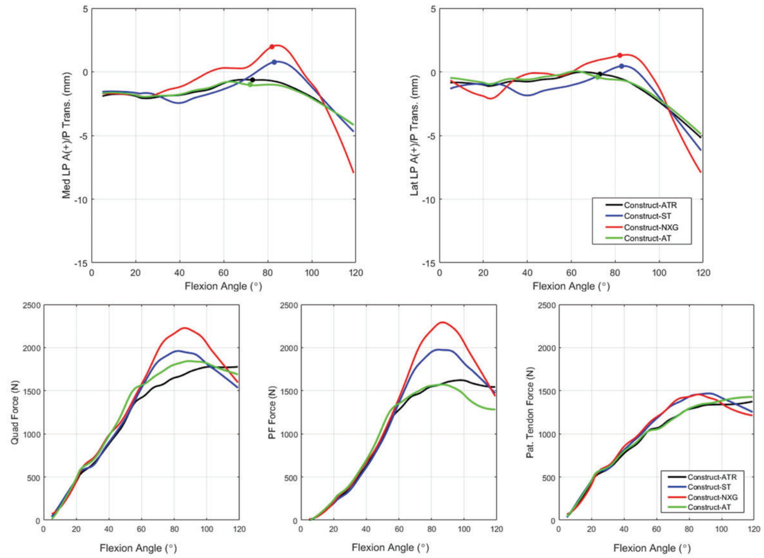


Figure 3. Top row shows the Medial and Lateral Anterior Posterior Translation of the Lowest Point for Construct-AT, Construct-ATR, Construct-ST, and Construct-NXG. Dots indicate flexion angle where post-cam engagement occurs during a DKB. Bottom row shows the Quad Forces, PF Forces, and PT Forces throughout the flexion range during a DKB for all four constructs.

Figure 3