

# **In-Vivo Articular Contact Analysis during Strenuous Activities in Patients with Asymmetrical Tibial Polyethylene Geometry Cruciate Retaining Total Knee Arthroplasty**

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**Summary:** Although lateral femoral rollback and lateral pivoting patterns were observed during strenuous functional daily activities, asymmetric contact kinematics still persisted in unilateral CR TKA patients, suggesting that asymmetrical tibial polyethylene geometry CR TKA design does not fully replicate healthy knee contact kinematics during strenuous functional daily activities.

## **Introduction:**

Although cruciate retaining (CR) total knee arthroplasty (TKA) designs preserve the posterior cruciate ligament with the potential to restore healthy knee joint kinematics, concerns related to asymmetric gait patterns still persists in unilateral CR TKA patients. A new CR TKA design with concave medial and convex lateral tibial polyethylene bearing components was introduced recently to improve functional outcomes. This study aimed to investigate in-vivo articular contact kinematics in unilateral asymmetrical tibial polyethylene geometry CR TKA patients during strenuous knee flexion activities.

## **Patients and Methods:**

Fifteen unilateral CR TKA patients were evaluated for both knees during sit-to-stand, single-leg deep lunges and step-ups using a validated combined computer tomography and dual fluoroscopic imaging system (Figure 1). Medial and lateral condylar contact positions were quantified during weight-bearing flexion activities.

## **Results:**

Contact excursions of the lateral condyle in CR TKAs were significantly more anteriorly located than the contralateral non-operated knee during sit-to-stand ( $3.7 \pm 4.8\text{mm}$  vs  $-7.8 \pm 4.3\text{mm}$ ) and step-ups ( $-1.5 \pm 3.2\text{mm}$  vs  $-6.3 \pm 5.8\text{mm}$ ; Figure 1). Contact excursions of the lateral condyle in CR TKAs were significantly less laterally located than the contralateral non-operated knee during sit-to-stand ( $21.4 \pm 2.8\text{mm}$  vs  $24.5 \pm 4.7\text{mm}$ ), step-ups ( $25.2 \pm 3.5\text{mm}$  vs  $27.6 \pm 4.2\text{mm}$ ) and single-leg deep lunges ( $22.6 \pm 4.4\text{ mm}$  vs  $26.2 \pm 5.7\text{ mm}$ ,  $p < 0.05$ ; Figure 2). Lateral condyle posterior rollback was not fully restored in CR TKA patients during sit-to-stand ( $9.8 \pm 6.7\text{mm}$  vs  $12.9 \pm 8.3\text{mm}$ ), step-ups ( $8.1 \pm 4.8\text{mm}$  vs  $12.2 \pm 6.4\text{mm}$ ) and sit-to-stand ( $7.6 \pm 4.5\text{ mm}$  vs  $11.3 \pm 6.1\text{ mm}$ ; Figure 3). Lateral pivoting patterns were observed in 80%, 73% and 69% of patients during sit-to-stand, step-ups and single-leg deep lunges respectively.

## **Discussion:**

Although lateral femoral rollback and lateral pivoting patterns were observed during strenuous functional daily activities, asymmetric contact kinematics still persisted in unilateral CR TKA patients. This suggests the contemporary asymmetrical tibial polyethylene geometry CR TKA design does not fully replicate healthy knee contact kinematics during strenuous functional daily activities.

Figure 1: Dual fluoroscopic imaging system (DFIS) approach used for registration of 3D models on fluoroscopic silhouettes.

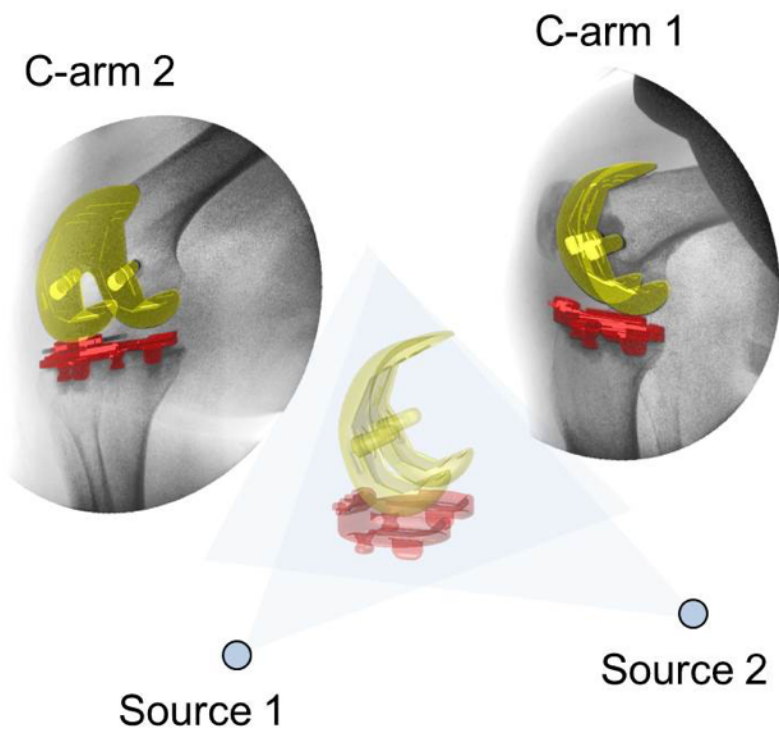


Figure 2: Average of excursion of condylar contact points shown on the medial and lateral polyethylene inserts of CR TKA patients at selected knee flexion angles during sit-to-stand.

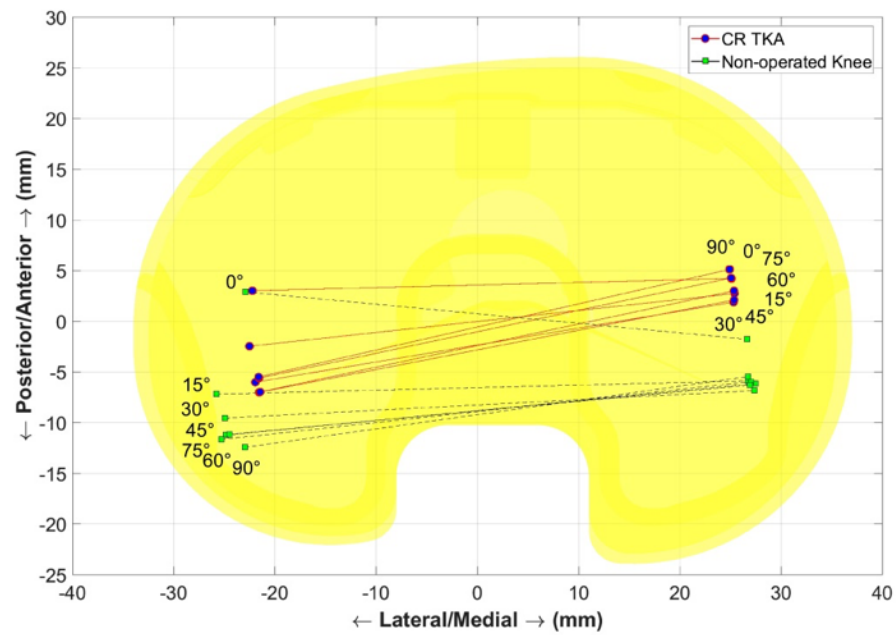


Figure 3: Lateral and medial condyle anterior-posterior (AP) excursion, lateral-medial (LM) excursion, and femoral axial rotation exhibited in CR TKAs and the contralateral non-operated knees during sit-to-stand. Black bars on the horizontal axex (Knee Flexion) indicate statistitcal significance difference between limbs.

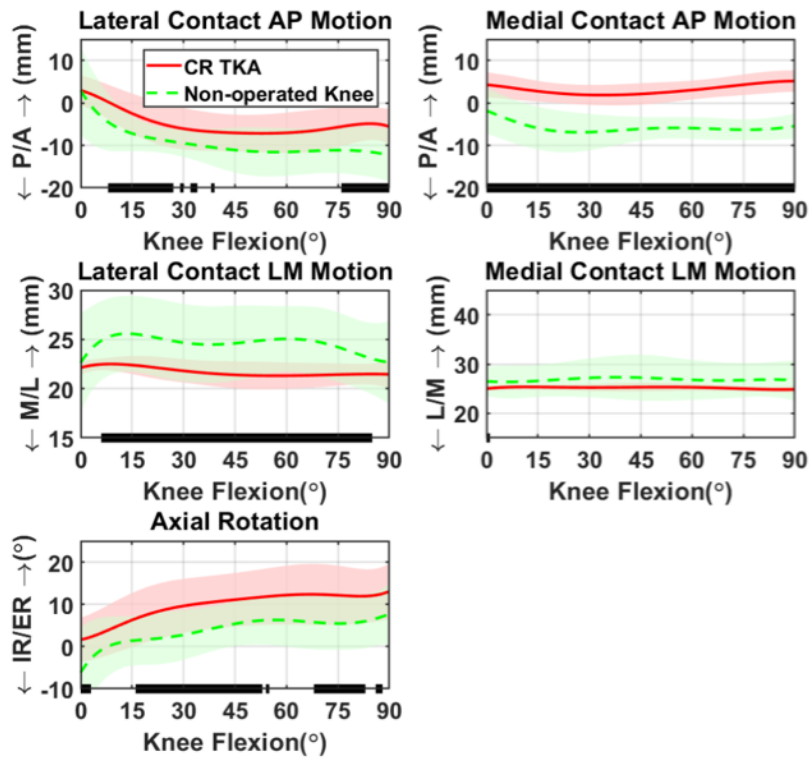


Figure 4: Average of excursion of condylar contact points shown on the medial and lateral polyethylene inserts of CR TKA patients at selected knee flexion angles during step-ups.

