ONLY IN UNLOADED ACTIVITIES TKA DESIGN FEATURES DOMINATE IN THE AMOUNT OF ROLLING AND SLIDING

Philippe Moewis (1), Rainald Ehrig (1,2), Hagen Hommel (3), Adam Trepczynski (1), Leonie Krahl (1), Georg N. Duda (1)

1. Julius Wolff Institute, Berlin Institute of Health at Charité – Universitätsmedizin Berlin, Germany; 2. Zuse Institute Berlin, Germany; 3. Krankenhaus Märkisch-Oderland GmbH, Wriezen, Germany

Introduction

Although total knee arthroplasty (TKA) is an established procedure with 95% survivorship, around 14-39% of patients report dissatisfaction with the outcome [1]. One of the reported causes is anterior knee pain due to paradoxical anterior sliding or insufficient femoral rollback during flexion [2]. Despite a wide number of available TKA designs, there is no clear consensus about how specific design geometrical features lead to either sliding or rolling of the femoral component and therefore to specific anterior knee kinematics during flexion. The aim of this study was to analyze whether TKA design features impact the in-vivo rolling/sliding ratio during loaded and unloaded activities and thus could help to minimize the dissatisfaction of patients.

Methods

Four cohorts (10 subjects each) of patients operated with TKA in diverse designs were analysed: 1) with a gradually changing radius posterior stabilized (G-Curve PS), 2) with a gradually changing radius cruciate retaining (G-Curve CR), 3) with an asymmetric bicruciate stabilized (A-BCS) and 4) with an asymmetric CR (A-CR). All patients underwent in-vivo fluoroscopic measurements in loaded lunge and unloaded flexion-extension knee movements to collect the 3D TKA motion from extension to maximal flexion [3]. To do so, 3D CAD Models of the TKA components were registered to the fluoroscopic images and movement data extracted. Medial and lateral distal points (Figure 1) were used to determine the anterior-posterior (AP) translation. Their path on the femoral condyles (Figure 1) were also determined. The Rolling/Sliding ratio was defined as the quotient of the tibia relative AP- translation and the femoral path length.

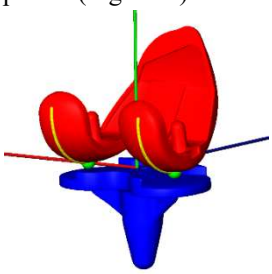

Figure 1: Femoral and tibial components after registration with determined femoral condyles arc (yellow trail) and medial and lateral distal points (green spheres).

Results

During **unloaded flexion-extension** the G-Curve PS and G-Curve CR designs showed a behavior near a hinge joint from extension until mid-flexion followed by an increase in rolling towards posterior. Both asymmetric BCS and CR designs slid spontaneously towards anterior during early flexion but then continuously rolled posterior. During **loaded lunge**, both G-Curve cohorts behaved near to a hinge joint from extension until the maximal flexion was achieved (80°). Anterior sliding – however reduced – was found in early flexion with some rolling in the asymmetric cohorts, especially pronounced in the A-BCS.

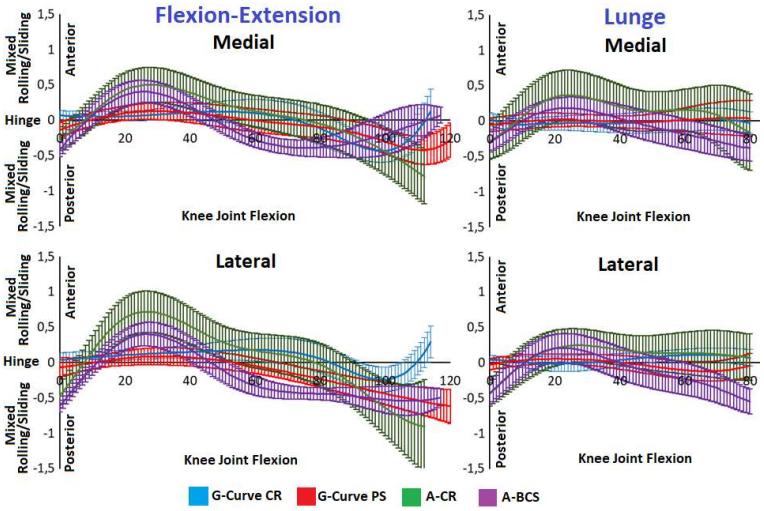

Figure 1: Rolling/Sliding ratio during unloaded flexion-extension (left side) and loaded lunge (right side) on both knee joint compartments. Ratio=0: hinge-joint; Ratio>0: paradoxical anterior sliding; −1<Ratio<0: mixed-rolling/sliding. Ratio=−1 pure rolling.

Discussion

Both versions (PS and CR) of the gradually changing radius designs seem to limit paradoxical anterior sliding. On the other hand, the PS version achieved a mostly continuous translation (increased rolling) towards posterior. This may be due to a combination of radius changes and the post-cam mechanism. However, in both asymmetric designs (BCS and CR) an anterior sliding was observed but compensated by continuous translation (increased rolling) towards posterior. The kinematics of the TKA was substantially influenced by loading with unloaded settings allowing to identify kinematic differences between designs while under loading these vanished. However, these conclusions require further in-depth analysis in eventually larger cohorts.

References

1. Maratt et al., J Arthroplasty. 2015
2. Donadio et al., Sports Traumatol Arthrosc. 2015
3. Pfitzner et al., Knee Surg Sports Traumatol Arthrosc. 2017

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