IN-VIVO 3D TIBIOFEMORAL ARTICULAR CONTACT AFTER CR AND PS TKA

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INTRODUCTION

Accurate in-vivo 3D tibiofemoral contact analysis after total knee arthroplasty (TKA) is essential for gaining insight into knee kinematics and the mechanism of polyethylene wear. This study investigated the tibiofemoral articular contact of two major TKA designs, cruciate-retaining (CR) and posterior-substituting (PS), using a dual orthogonal fluoroscopic system [1]. Specifically, the contact kinematics of the CR and PS TKA during weight bearing flexion was compared.

MATERIALS and METHODS

Prior to the initiation of the study, approval from the authors’ institutional review board and informed patient consent were obtained. Fifteen patients after CR TKA (NexGen CR, Zimmer) (age 46-86, 3 females, 12 males, single-surgeon series) and five patients after PS TKA (NexGen LPS, Zimmer) (age 60-72, 1 female, 4 males, single-surgeon series) performed a single leg lunge while being imaged by two fluoroscopes (GE 9800, GE Medical) positioned in an orthogonal manner. The knee was scanned at approximately every 15° from full extension to maximal flexion. The orthogonal images and a 3D CAD model of the corresponding TKA were used to create a virtual dual orthogonal fluoroscopic imaging system. The TKA components were adjusted in all 6DOF within the virtual system to reproduce the in-vivo joint position [1]. Contact was determined as the centroid of the contact area and reported with respect to flexion. Anterior and lateral translations were positive; posterior and medial translations were negative.

RESULTS

Contact was observed to move in both the anteroposterior (AP) and mediolateral (ML) directions on the tibial plateau for both the CR and PS TKA, and differences in contact were observed between the two groups (Fig. 1). In the AP direction, the two components had significantly different contact positions in the medial condyle at 15°, 30°, 45° and maximum flexion (Fig. 2A). The average total excursion of the CR contact point was less than 4.0 mm while the PS TKA showed an average total excursion of about 10.0 mm. In the lateral condyle, contact was significantly different at 0° (Fig. 2B). The average total excursion of the CR contact point was only about 10.0 mm while the PS TKA had an excursion of approximately 20.0 mm.

DISCUSSION

When comparing the two TKA designs, differences were observed mainly in the AP direction (Fig. 1). The PS TKA showed larger AP contact range of motion than the CR TKA in both the medial and lateral condyles. At full extension, contact in the lateral condyle of the PS TKA was significantly anterior to that of the CR TKA. In the medial condyle between 15° and 45°, the PS TKA exhibited more posterior contact, while the CR TKA showed almost no contact movement until maximal flexion. At maximum flexion, the contact points of the PS TKA translated more posteriorly than the CR TKA and may be the result of the post/cam engagement. Since the range of flexion, on average, was higher in the PS group (126.4±13.5°) than that observed in the CR group (117.1±16.5°), posterior translation of the tibiofemoral contact at high flexion may represent an important factor in achieving higher flexion.

The 3D in-vivo contact determined in this study provides an accurate knowledge of CR and PS TKA contact pattern and may aid in the development of future surgical techniques and component design.

REFERENCES

1. Hanson G et al. JOR, 2005, accepted

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Fig. 1: Average AP and ML contact patterns from full extension to maximum flexion of the A) CR and B) PS TKA. The dashed lines indicate the contact from 105° to average maximum flexion.

Fig. 2: AP translation of the CR and PS TKA in the A) medial and B) lateral condyles (* = p<0.05).