PATELLO-FEMORAL KINEMATICS AT THE INTACT AND REPLACED KNEE: AN IN-VITRO ANALYSIS.

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INTRODUCTION

Abnormal patellar tracking may result in patello-femoral joint (PFJ) disorders, which are usually source of anterior knee pain. In the intact knee, this is generally due to abnormalities in the PFJ interface and lower limb rotation. After total knee arthroplasty (TKA), maltracking can be accounted to prosthesis component misalignment in both PFJ and tibio-femoral joint (TFJ), erroneous soft tissue balancing and incorrect patellar resurfacing. All these causes might lead to pain and, ultimately, to replacement failure [1]. Many methodological approaches and measurement systems were used to track TFJ and PFJ kinematics. Particularly, it is still unclear which is the most appropriate methodology to investigate PFJ kinematics. All these aspects hinder the identification of a reference for the normal PFJ kinematics, according to which maltracking could be identified. Among the available measurement systems, knee surgical navigators allow the accurate acquisition of large ranges of knee movements. The aim of this study was to assess TFJ and PFJ kinematics in the intact knee and after TKA intra-operatively by adaptation of a current navigation system.

METHODS

Sixteen TKAs were performed on as many fresh frozen legs from cadavers. Eight cruciate-retaining (CR) and 8 posterior-stabilized (PS) prostheses (Scorpio®, Stryker Orthopaedics, Mahwah, NJ-USA) were implanted. Standard clusters (Stryker®, Kalamanzoo, MI-USA) with active markers were pinned on the femur and tibia. A special light prototypal cluster was pinned on the patellar anterior aspect. The standard pointer was used for system control and landmark digitations. Series of five trials of manually driven knee flexions in a 0°-140° flexion arc were performed under condition of 10 N force vertically applied at the quadriceps, with intact knee and after TKA, both with intact and resurfaced patella. TFJ and PFJ kinematics were analyzed using recommended [2,3] and recently proposed [4] anatomical and joint conventions, which included PFJ flexion, tilt, rotation, and translations. Standard deviation (SD) and mean values for all kinematic variables were calculated at each degree of TFJ flexion. Patterns from the intact knees were used as reference. Geometrical parameters on the prosthesis component positioning were also recorded.

RESULTS AND DISCUSSION

Repeatable motion paths throughout the TFJ flex-extension cycle were observed over repetitions from the same intact specimen. All kinematic variables were coupled to TFJ flexion. PFJ rotations and translations had a mean SD over TFJ flexion smaller than 1.1° and 1.0 mm respectively.

The patellar cut for resurfacing was measured of 4.2°±10.7° flexion and 4.6±°10.0° medial tilt on the anatomical patellar reference frame, as averaged over all specimens. In TKA before resurfacing, restoration of original natural motion at the TFJ and PFJ was generally not fully achieved. By resurfacing, the patella tilted more laterally. In CR-TKA, the trend of PFJ translation along femoral medio-lateral axis is opposite to the corresponding in the intact knee (Figure 1). With this design, independently from patellar resurfacing, significant correlations were observed between femoral component orientation in transverse and sagittal planes and, respectively, TFJ internal/external rotation (R=0.81; P=0.02) and knee translation along tibial medio-lateral anatomical axis (R=-0.82 ;P=0.03). After patellar resurfacing, independently from TKA design, significant correlations were observed between final patellar thickness and PFJ flexion (R=-0.77; P=0.02) and tilt (R=-0.73; P=0.03).

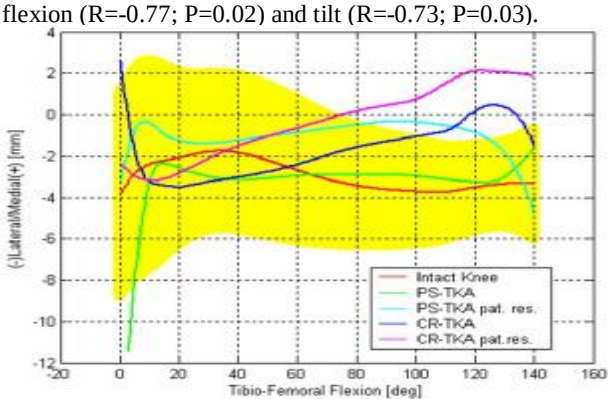

Figure 1: PFJ translation along femoral medio-lateral axis in the intact knee and after different TKA options.

CONCLUSIONS

For the first time, a large series of patterns of TFJ and PFJ kinematics was obtained from intact and TKA knees implanted according to different designs and options. This contributes to the knowledge on physiological motion at these joints, and on the controversies in prosthetic designing and resurfacing. In particular, PFJ kinematics were found to be much affected not only by resurfacing but also by the different TKA designs and relevant femoral and tibial component positioning. The experiments demonstrated also the suitability of the original technique in standard knee navigation and the significance of real-time measurements of joints motion intra-operatively.

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