FE STUDY ON THE EFFECT OF PATIENT-RELATED VARIATIONS ON THE PRIMARY FIXATION OF A CEMENTLESS PEEK TIBIAL COMPONENT

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Introduction

The use of polyetheretherketone (PEEK- OPTIMA™) for the cementless tibial component is of interest because of its potential solution to avoid bone resorption due to peri-prosthetic stress-shielding. A new material for the cementless tibial component may have implications for the primary fixation, quantified by the micromotions between the tibial tray and bone. The micromotions may be dependent on patient-related factors. Therefore, the aim of this finite element (FE) study was to define the effect of patient-related variations, including sex, age and BMI, on the resulting micromotions of a cementless PEEK tibial component.

Methods

In this study, a CT database was used consisting of 74 healthy knees including the patient information on sex, weight, length and age. Consecutively, a workflow was created to generate FE models of these 74 tibiae including tibial tray and insert. The tibial tray was simulated with a Young's modulus for either PEEK (3.7 GPa) or titanium (109 GPa). A musculoskeletal model was used to derive the implant-specific tibiofemoral contact forces including centers of pressure of a gait and squat activity. The contact forces were incrementally applied during four loading cycles. To quantify the primary fixation, the 95th percentile of the maximum resulting micromotions was defined.

Results

The largest resulting micromotions were generated at the anterior side and posterior lateral side of the tibial tray (Figure 1). The PEEK components generated significantly larger micromotions values than the titanium components (mean PEEK: 67.63 µm, mean titanium: 38.69 µm, $p<0.001$). No significant differences in micromotion values were seen between the sex and age groups (Figure 2). Higher BMI resulted in larger resulting micromotions (Figure 2). The difference between all three BMI groups was statistically significant ($p<0.001$).

Discussion

The current FE study demonstrates that a higher BMI results in larger micromotions, while variations in sex and age did not significantly influence the primary fixation. The current analysis provides some preliminary insights on primary fixation of cementless TKA components. We are currently performing a more in-depth multivariate analysis to identify the underlying mechanisms, such as interactions with bone quality. In addition, we plan on performing a more detailed analysis of outliers to investigate potential risk factors.

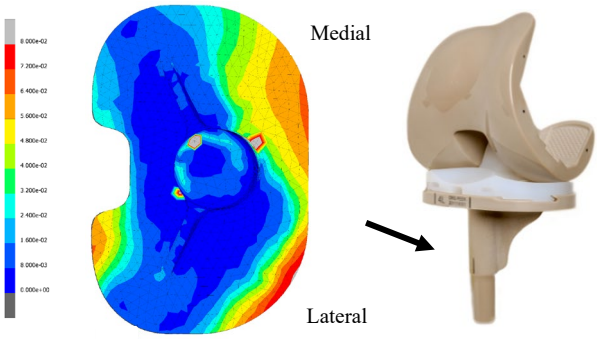

Figure 1: Resulting micromotion distribution (mm) at a left PEEK tibial tray interface after the 4th loading cycle of a squat activity.

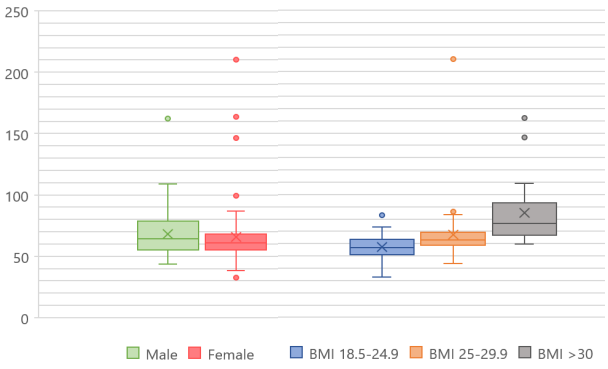

Figure 2: 95th percentile of maximum resulting micromotions (µm) per sex and BMI groups for all PEEK tibial trays.

Acknowledgements

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