COMMENTARY ON:

A Preclinical Numerical Assessment of a Polyetheretherketone Femoral Component in Total Knee Arthroplasty During Gait

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LEVEL OF EVIDENCE: Peer Reviewed, Pre-clinical, *In-vitro* Study

Summary

According to OECD health statistics, in 2015 there were approximately 2.6 million total knee replacement (TKR) surgeries. Studies estimate that 20% of people who have undergone TKR surgery are not happy about the result.[1,2] In order to improve patient satisfaction there is current interest in the effects of replacing the metal (cobalt chrome, CoCr) femoral component in a TKR device with a component manufactured from PEEK-OPTIMA™ high performance polymer. This paper has used established computational techniques to model the gait cycle in a segmented representation of the knee that has been implanted with a TKR device and to compare the physical effects on the stresses and strains seen in the system when changing to a PEEK-OPTIMA high performance polymer femoral component.

Because this testing was computer based, stiffness properties for bone, to represent the distal femur, were calculated using a CT scan. For all other components, properties were assumed to be homogeneous. Loading conditions were as described for gait simulation in ISO 14243. The stresses in the implant, cement and bone were analysed, as well as the expected influence on the bone cement-to-implant interface. Results were expressed as a percentage of material failure stress to give a good indication for the likelihood of one component failing compared to the other.

The results demonstrate that, while cobalt chrome is an inherently stronger material than PEEK-OPTIMA polymer, the change in the stiffness leads to a very different sharing of stresses throughout the system. This, in turn, potentially enables the PEEK-OPTIMA femoral component to bear more than enough load to remain safe under the levels of stresses expected in this study. Additionally, the sharing of this stress with the underlying materials means that the bone experiences a closer load stimulus to that of the intact state, potentially minimizing stress shielding (often seen as a problem with metal femoral components), and maintaining healthy mass (ref. figure 1).

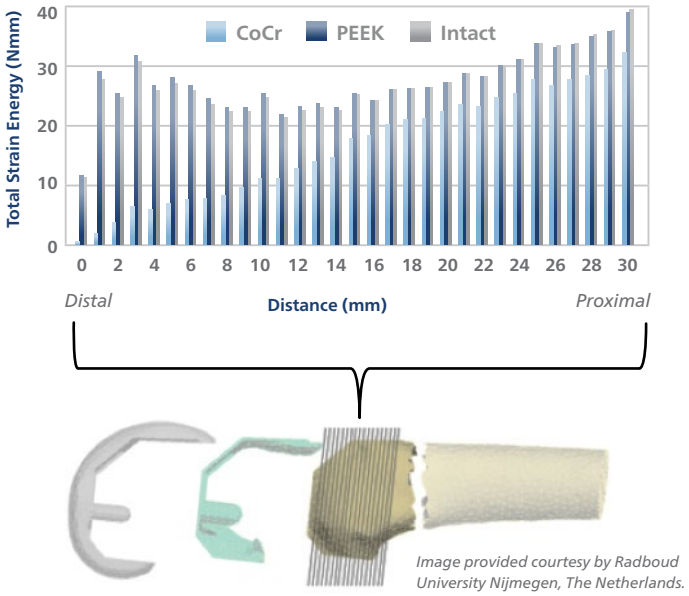

Fig 1: Modeling reflecting the comparison of the natural bone with PEEK-OPTIMA™ and CoCr femoral components. It shows the significant difference all-round the distal femur.

Key Findings

Based on this computational study there is no expected difference in the safety of a PEEK-OPTIMA component, compared with a CoCr alternative with the same geometry. There is strong evidence to suggest that load stimulus seen in the peri-prosthetic bone will be close to the intact case under a PEEK-OPTIMA polymer prosthesis and this may lead to a healthy bone mass retention.

Commentary

This paper gives confidence for the potential of an all-polymeric total knee replacement and assists in the pre-clinical demonstration of expected safety. Caution must be taken as this computational analysis model reflects only one walking pattern and may not account for other patterns experienced *in-vivo*. Further computational and physical experimental evidence has now been collated on the component for use in a clinical setting. ▲

ABOUT THE AUTHOR

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Dr Adam Briscoe is the Technology Manager for Orthopedics at Invibio Biomaterial Solutions. He has more than 15 years of experience working in research and development for orthopedic medical devices. In 2007, he received a PhD in biomechanical engineering from the University of Southampton, in the United Kingdom. Since April 2017, he has been a visiting research fellow at the University of Leeds, in the United Kingdom, focused on tribology research.

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