

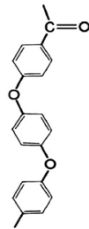
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Introduction

Total knee replacement (TKR) is an increasingly common surgical intervention. Wear of polyethylene continues to significantly influence the clinical success of TKR [1], hence alternative materials and designs have been explored.

Poly-ether-ether-ketone (PEEK) and Carbon-fibre reinforced PEEK (CFR-PEEK) have been used in orthopaedic applications for many years [2].

Most recently explored as a bearing material, with promising wear behaviour in hip simulator studies [3-5] and in highly conforming partial knee replacements [6]



Aim

This study aimed to explore the application of PEEK and CFR-PEEK as alternatives to UHMWPE in knee replacements through:

- Simple configuration pin on plate studies
- Experimental knee wear simulation

Materials and Methods



Pin on plate studies

PEEK (Optima) /CFR-PEEK (Motis) pins & plates
 GUR1020 UHMWPE plates

High carbon CoCrMo pins (35mm radius) and plates
 1 Mc per test; wear assessed every 0.33Mc
 5 cross shear conditions (adjusted rotation/sliding distance)



Knee wear simulator studies

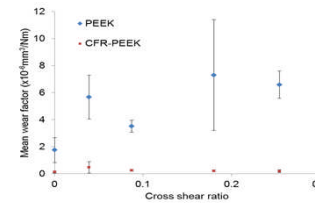
Custom made flat PEEK and CFR-PEEK tibial parts
 Sigma CR femoral bearings (DePuy Synthes, Leeds)
 3Mc studies (n=6 for each material)

'High kinematics' (10mm AP displacement, $\pm 5^\circ$ IE rotation) [7]

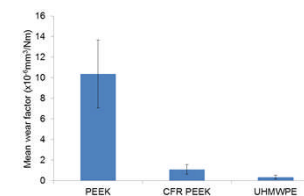
Wear assessed gravimetrically at 1 and 3Mc
 All studies conducted in 25% bovine serum supplemented with 0.1% v/v sodium azide

Results

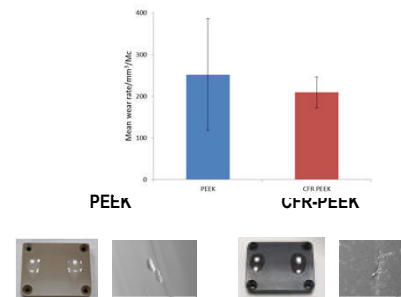
Influence of cross shear on wear factor



Effect of counterface – metal pins on polymer plates



Knee wear study



Discussion

The pin on plate studies demonstrated:

- PEEK appeared to demonstrate a cross-shear dependent wear behaviour
- No cross shear dependency for CFR-PEEK
- CFR-PEEK had lower wear than UHMWPE in polymer pin/metal plate configuration, but significantly higher when metal pin/polymer plate

The knee wear study demonstrated:

- Extensive loss of material for both PEEK and CFR-PEEK
 - Large, deep wear scars for both materials
 - Evidence of material failure with pitting, cracking, and fibre loss from the CFR-PEEK
- Flat inserts would yield higher contact stresses than previous more conforming studies [3-6], which may contribute to the material failure observed

Significance

This study highlights the importance of design when considering new materials for TKR. In highly conforming designs such as total hip replacement and conforming unicompartmental knees, CFR-PEEK has been a low wear material. This study shows in low conformity bearings, where contact stress may be higher, CFR-PEEK may be less suitable.

References

1. Ingham and Fisher 2005
2. Kurtz and Devine 2007
3. Scholes and Unsworth 2008
4. Brockett et al 2012
5. Wang et al 2012
6. Grupp et al 2010
7. McEwen et al 2005

Disclosure

J. Fisher is an NIHR senior investigator, a paid consultant to DePuy Synthes, Invivo, Tissue Regenix Group plc and a share holder of Tissue Regenix Group plc;

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