Institute of Medical & Biological Engineering

INFLUENCE OF KINEMATICS ON THE WEAR RATE OF THE ARTIFICIAL PATELLA FEMORAL JOINT

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INTRODUCTION

- A prevalent cause of TKA revision is Patella Femoral Joint (PFJ) complications [1, 2 and 3].
- Limited *in vitro* wear simulations studies [4 and 5].
- The aim this study was to investigate the influence of kinematic parameters (patellar rotation, medial lateral displacement and tilt) on the wear of PFJ.

MATERIALS

- The commercially available PFC Sigma femoral component (Co-Cr-Mo alloy) and the round dome patella specimen (UHMWPE, Figure 1, DePuy International , Leeds, UK) was used for the test.

Figure 1: Components for the wear test.

METHODS

- Six station Leeds ProSim knee joint simulator was modified for investigation of wear in PFJ for a total of 12 million cycles (MC) using 25% serum as lubricant.
- Active controlled degrees of freedom are shown in Figure 2. Medial lateral (ML) tilt was passive and ML displacement was either kept free or fixed (<1.5mm).

METHODS

The test conditions were:

- 'Low ML rotation with free ML displacement' - physiologically relevant scenario
- 'High ML rotation with free ML displacement' to investigate the influence of rotation
- 'Low ML rotation with fixed ML displacement' to investigate the influence of ML displacement.

Volumetric wear was determined gravimetrically and statistical analysis was performed using One way ANOVA (significance at $p<0.05$).

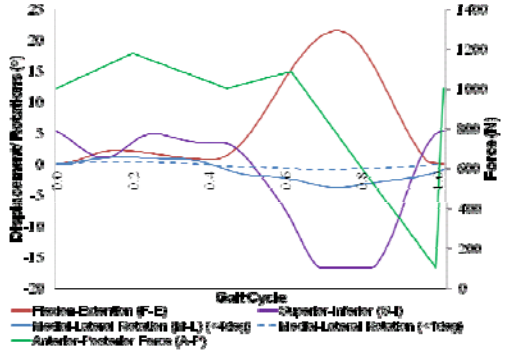

Figure 2: Control Strategy for the wear test [4].

RESULTS

- Increasing ML rotation (1° to 4°) significantly increased the wear rate from 8.6 mm^3/MC to 12.3 mm^3/MC ($p < 0.05$) (Figure 3).

RESULTS

- Decreasing the ML displacement from free (4mm) to fixed (<1.5mm) resulted in no significant change in the wear rate (8.6mm^3/MC to 7.9mm^3/MC).
- A linear correlation was observed between ML tilt and volume loss (Figure 4).

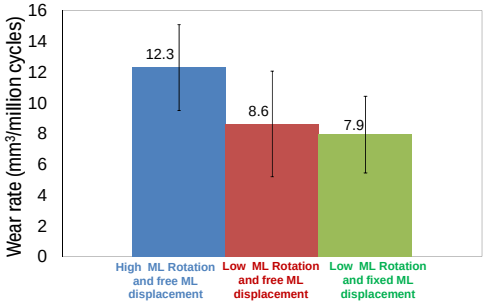

Figure 3: Wear Rate with 95% CL for PFC Sigma Round Dome Patella.

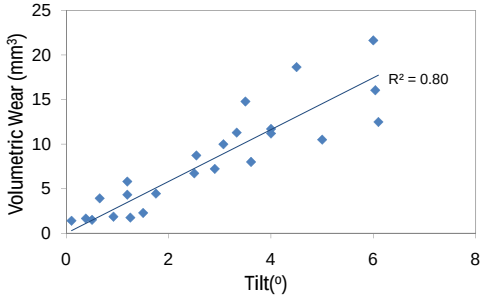

Figure 4: Correlation of wear volume with tilt with R^2values.

DISCUSSION

- The increase in wear rate of the PFJ with increased ML rotation was due to the increase in cross shear motion at the polyethylene bearing surface. The change in the frictional force direction led to higher cross shear causing a higher wear rate [6 and 7].
- Linear increase in the wear rate was observed with increasing ML tilt. As well as cross-shear, uneven loading on the patella may have created elevated contact stresses [8], resulting in this correlation.

CONCLUSION

A six axis in vitro simulator for the assessment of ~~wear in the patella femoral joint has been developed.~~

The wear rate of the round dome patella button design tested in this study was influenced by ML rotation.

ACKNOWLEDGEMENT

This research was supported by the EPSRC, NIHR and LMBRU. DePuy International, a Johnson & Johnson Company, supplied the components.

References

[1] Bohm, et al., 1998 J Bone and J Surg 80 pp302-309; [2] Callaghan, et al., 2000 J Bone and J Surg 82 pp705-711; [3] Beuchel, et al., 2001 Clinical Orthopaedic and Related Research pp41-50; [4] Ellison, et al., 2008 J Biomechanics 41 pp1407-1416; [5] Vanbiervliet, et al., 2011 J Bone and J Surg Br 93-B pp1348-54; [6] Fisher et al. 2010 Clinical Orthopaedic and Related Research 468 pp12-18; [7] Kang et al. 2008 J Biomechanics 41 340–346; [8] Jennings, et al., 2007 IMechE Part H J Engg in Med 221 pp305-314.

Financial Disclosure

J. Fisher is a consultant to DePuy International Ltd, UK, a Director and share holder of Tissue Regenix plc and BITECIC Ltd and a Director of Medilink.