Institute of Medical & Biological Engineering

WEAR OF PATELLA FEMORAL JOINT: EFFECT OF PATELLA DESIGN AND KINEMATICS

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INTRODUCTION

•Patella femoral joint (PFJ) remains the primary cause of total knee replacements revisions [1 and 2].
•Popularity of patella replacements varies largely between countries like USA and Europe [3, 4, and 5].
•The aim of this study was to determine the effect of design and kinematics on PFJ wear.

MATERIALS

Commercially available Sigma femoral CR component and UHMWPE GUR 1020 (GVF) dome patellae buttons (round and oval) from DePuy International, UK were used for the test.

Figure 1: Components for the wear test (Left to right: Femur CR Sigma, round and oval dome patella buttons).

METHODS

•ProSim/Leeds knee simulator was used for the wear testing of PFJ bearing with 25% bovine serum.
•The active controlled degrees of freedom are shown in Figure 2 [6]. Medial lateral (ML) tilt (<5°) and displacements (<4mm) were passive. However, for one condition, ML displacement was restricted to 1.5mm.

METHODS

•Three test conditions as follows:
-High ML rotations (4°) and uncontrolled ML displacement
-Low ML rotations (<1°) and uncontrolled ML displacement
-Low ML rotations and constrained ML displacement (<1.5mm)
•Volumetric wear was measured gravimetrically in mm^3/million cycles (MC) with 95% confidence limit. One way ANOVA statistical significance was performed for all conditions.

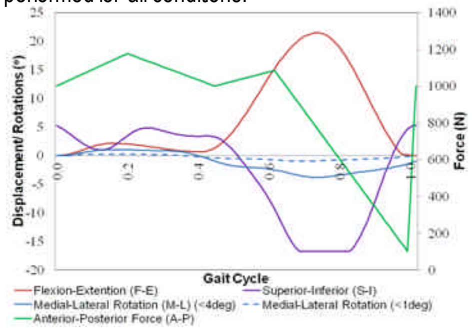

Figure 2: Kinematic Conditions for the wear test [6].

RESULTS

•Wear rate at higher kinematics (ML rotation 4° and uncontrolled ML displacement) was 12.3mm^3/MC and 14.5mm^3/MC for round and oval dome respectively with no significant difference (p>0.05).

RESULTS

•With reduction in ML rotation, wear rate decreased to 8.6mm^3/MC and 6.3mm^3/MC for round and oval dome respectively. However there was with no significant difference between round and oval patella button designs (Figure 3).

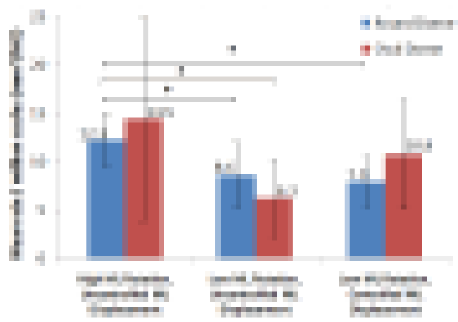

Figure 3: Mean wear rate with 95% CL for PFC Sigma and dome patellae buttons (p<0.05)

•Similarly, with reduction in ML displacement from 4mm to 1.5mm and ML rotations (<1°), the wear rate changed to 7.9mm^3/MC and 10.8mm^3/MC for round and oval dome respectively with no significant difference between the two designs.

•The wear volume of the two patella designs were plotted against the ML tilt, a strong correlation (R square > 0.8) was observed between the tilt and wear volume.

DISCUSSION

•Increase of wear rate with increase in ML rotation was due to the increase of cross shear motion at the polyethylene bearing surface [7,8].

•There was no significant difference in wear rate with respect to patella button designs.
•There was no significant difference in wear rate with respect to change in ML displacement.

•Wear volume increased with tilt. As the patella tilt increased, the sliding distance in the direction perpendicular to polymer orientation increased. This led to the higher wear volume [9].

CONCLUSION

This is the first study in artificial PFJ to consider six axes of freedom with varied kinematics for two patella designs.
The wear rate was influenced with variation in kinematics mainly ML rotation and ML tilt.

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References

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Financial Disclosure

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