Supplementary data

Post-test surface roughness

The surface roughness of the plates was carried out at the conclusion of the study using a contacting Form Talysurf with a 2µm conical tipped stylus, analysis of the measurements was carried out using LS line form removal with a 0.25mm upper cutoff. 5 measurements were taken across the wear scar perpendicular to the direction of wear simulation. The surface roughness parameters of interest were:

- Ra – arithmetic mean deviation from the profile
- Rp – maximum profile height
- Rv – maximum valley depth

For Research Question 1 (Influence of contact pressure on the wear of UHMWPE) and for Research Question 2 (Influence of cross-shear ratio on the wear of UHMWPE), one-way ANOVA showed no significant difference ($p>0.05$) for any of the surface roughness parameters of interest.

Study number	Contact area (mm^2)	Contact pressure (MPa)	Cross-shear ratio	Ra (µm)	Rp (µm)	Rv (µm)
Research question 1: Influence of contact pressure on the wear of UHMWPE						
1	38.5	2.1	0.087	0.032 ± 0.015	0.093 ± 0.036	0.133 ± 0.060
2	19.6	4.1	0.087	0.024 ± 0.011	0.086 ± 0.018	0.097 ± 0.059
3	12.6	6.4	0.087	0.025 ± 0.011	0.102 ± 0.026	0.083 ± 0.045
4	7.1	11.3	0.087	0.022 ± 0.006	0.111 ± 0.014	0.070 ± 0.037
5	3.1	25.5	0.087	0.030 ± 0.026	0.129 ± 0.057	0.095 ± 0.096
6	7.1	30	0.087	0.022 ± 0.008	0.114 ± 0.025	0.091 ± 0.051
7	7.1	40	0.087	0.039 ± 0.050	0.146 ± 0.123	0.124 ± 0.122
8	3.1	80	0.087	0.026 ± 0.006	0.115 ± 0.027	0.118 ± 0.037
Statistical analysis				P=0.865	P=0.527	P=0.713
Research question 2: Influence of cross-shear ratio on the wear of UHMWPE						
9	12.6	6.4	0	0.018 ± 0.002	0.093 ± 0.007	0.058 ± 0.008
10	12.6	6.4	0.01	0.025 ± 0.010	0.105 ± 0.026	0.087 ± 0.055
11	12.6	6.4	0.022	0.024 ± 0.011	0.102 ± 0.024	0.066 ± 0.024
12	12.6	6.4	0.18	0.028 ± 0.024	0.101 ± 0.049	0.096 ± 0.0964
Statistical analysis				P=0.760	P=0.969	P=0.711

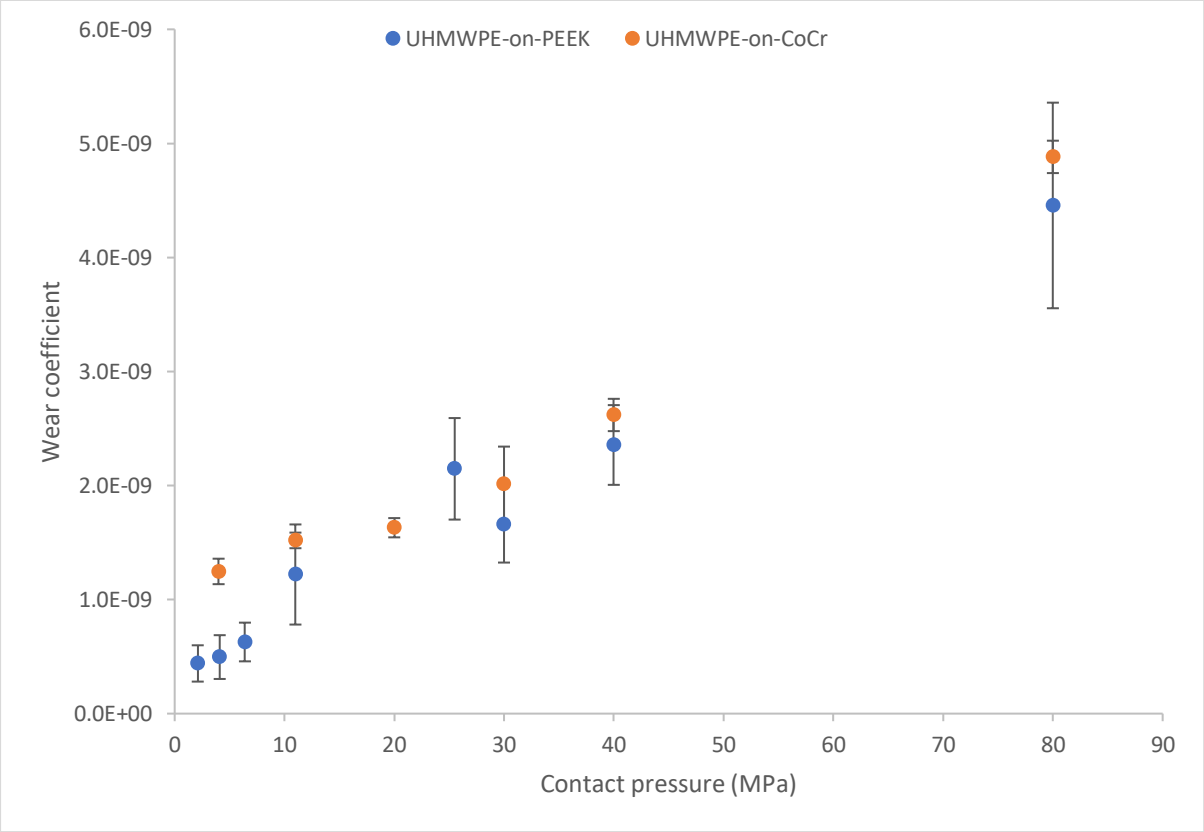
Wear coefficient of UHMWPE-on-PEEK-OPTIMA™ under different contact pressure conditions

To allow direct comparison with data from Abdelgaied et al[1], wear coefficient has been calculated by[1]:

$$C = \frac{W}{A \times S}$$

Where C is the non-dimensional wear coefficient, W the wear volume, A the contact area and S the sliding distance.

Note: In the study by Abdelgaied et al[1], wear coefficients were used because that was what was required as inputs to a computational model and the wear coefficient was plotted against non-dimensional contact stress derived from mechanical tests carried out during the study. This type of mechanical characterisation was beyond the scope of this investigation so in the graph below, wear coefficient has been plotted against contact pressure.



Mean wear coefficient ± 95% confidence limits of UHMWPE pins articulating against PEEK-OPTIMA™ plates under contact pressures from 2.1 to 80 MPa, minimum n=5. Data compared to the mean wear factor ± 95% confidence limits of moderately cross-linked UHMWPE-on-CoCr (cobalt chrome) of similar initial surface topography from Abdelgaied et al[1].

References

1. Abdelgaied A, Fisher J and Jennings LM. A comprehensive combined experimental and computational framework for pre-clinical wear simulation of total knee replacements. *Journal of the Mechanical Behavior of Biomedical Materials*. 2018; 78: 282-91.