**Introduction and Aim**

- Cervical total disc replacements (C-TDR) [Figure 1] are often made utilising ultra high molecular weight polyethylene (PE) and cobalt chromium (CoCr) bearing surfaces.
- However, PEEK (polyetheretherketone) has begun to be implanted as a C-TDR bearing [1] and there is growing interest in other combinations of PEEK and carbon fibre reinforced PEEK (CFRP) [2].
- The aim of this experiment was to assess the frictional response of PEEK and CFRP bearing material combinations under contact stress and sliding velocities approximating conditions in the cervical disc.

**Materials & Methods**

- A pin-on-plate rig used a pin loaded and displaced against a counterface plate, submerged in diluted bovine serum [Figure 2].
- Frictional force ($F_R$) was converted to a friction coefficient using $\mu = F_R/F_N$, where $F_N$ = Normal reaction force to the load applied.
- Results of PEEK and CFRP combinations were compared to a baseline control (PE on CoCr).
- Experimental methods and materials are listed in Table 1. Light microscopy (10x) and 3d profilometry were employed.

<table>
<thead>
<tr>
<th>Table 1 Materials and methods</th>
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<tr>
<td>Test Parameters</td>
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<tr>
<td>Lubricant</td>
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<td>25% bovine serum</td>
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<tr>
<td>Contact pressure</td>
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<td>1 MPa</td>
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<td>Sliding velocity</td>
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<td>4 mm s$^{-1}$</td>
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<td>Sliding displacement (x)</td>
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<td>20 mm</td>
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</table>

- Frictional tests
  - PE pin on CoCr plate
  - PEEK pin on PEEK plate
  - PEEK pin on CFRP plate
  - CFRP pin on PEEK plate
  - CFRP pin on CFRP plate

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- Light microscopy (10x) and 3d profilometry were employed.

**Results**

- PEEK pins showed signs of debris re-attachment [Figure 3]; PEEK plates had deep grooves [Figure 4]; CFRP plates were resilient to wear scar formation [Figure 5]; control CoCr plate showed no wear scar [Figure 6].
- No significant difference in friction between PEEK and CFRP combinations (1-way ANOVA, $\alpha=0.05$), however, all were significantly and substantially higher than the PE-on-CoCr control [Figure 7].
- Squeaking and/or low-pitched humming were present on all tests except the PE-on-CoCr control.
- Friction was generally much lower at the start of the experiments and reached steady state by approximately two minutes; some transient changes in friction were observed.

**Discussion**

- High friction of all-polymer PEEK and reinforced PEEK bearing couples are important considerations for implant performance. Small transient changes in friction may have been due to attachment and subsequent loss of polymer material to the pin bearing face [Figure 3].
- Friction factor of ceramic-on-reinforced-PEEK total hip replacement has been shown to be 0.23 [3] which is ~2x lower than PEEK on PEEK in this study. Bearing combinations using different materials typically produce lower friction coefficients.

**Financial Disclosures**

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