**Introduction**

- Cobalt chromium (CoCr) alloys have been successfully used in total knee arthroplasty (TKA) but are susceptible to roughening, with increased potential for polyethylene wear.
- Oxidized zirconium (OxZr) femoral components have a hard ceramic surface to address the problem of roughening.
- The purpose of this study is to compare the roughness of retrieved CoCr and OxZr femoral components.
- Hypothesis: The harder OxZr surface will roughen less than CoCr in clinical use for TKA.

**Materials and Methods**

- Nine CoCr and 16 OxZr explanted femoral components were cleaned and analyzed (Profix and Genesis designs; Smith & Nephew, Memphis, TN).
  - CoCr retrievals: 0.69-4.63 years in vivo.
  - OxZr retrievals: 0.46-5.58 years in vivo.
- Three CoCr and three OxZr never-implanted femoral components (Genesis II, Smith & Nephew) were also analyzed.
- Both condyles of each specimen were scanned in flexion using an optical profilometer (10x magnification, 632 µm x 474 µm scan size), with 14 measurements per specimen.
- After subtracting the macroscopic curvature from each scan, surface topography was obtained.
- Roughness measurements included average roughness (Sa) and skewness (Ssk), which describes whether the roughness was due to positive (Ssk > 0) or negative (Ssk < 0) features.
- Roughness was linearly correlated to age in vivo, with p < 0.05 for significance; never-implanted data were compared by t-tests.

**Results**

![Typical surface topography of never-implanted and retrieved femoral components: A. CoCr; B. OxZr.](image)

- The surface topography of CoCr specimens was dominated by carbides (positive features).
- CoCr retrievals also exhibited scratches, mainly in the A-P direction.
- The topography of OxZr specimens revealed shallow negative features (about 0.5 µm deep), with some retrievals also exhibiting small positive features (about 0.5 µm high).

**Discussion**

- CoCr femoral components were significantly rougher than the OxZr femoral components for both the never-implanted and the retrieval groups (p < 0.05).
- The high roughness and positive skewness of the CoCr specimens can be attributed to the presence of embedded carbides that became exposed during in vivo wear.
- The absence of significant roughening in CoCr specimens up to 5 years in vivo is consistent with previous studies, but roughening may become a problem for longer-term implantation.

**Conclusion**

- The OxZr data did not illustrate roughening with age in vivo, even among the specimens that had been implanted with bone cement.
- Ten of 16 retrieved OxZr specimens exhibited a negative skewness (roughness mainly caused by negative features), which implies less potential for polyethylene wear.
- The OxZr retrieval data appeared to show that the surface becomes more smooth with use, but this trend disappeared when the oldest two specimens were excluded; additional specimens are needed to further study this effect.

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- The authors also thank Abraham Salehi, PhD (Smith & Nephew Orthopaedics, Inc., Memphis, TN) for supplying the never-implanted specimens and seven OxZr retrievals.

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**Table 1. Roughness statistics (average ± S.D) from never-implanted and retrieved femoral components: A. CoCr; B. OxZr**

<table>
<thead>
<tr>
<th></th>
<th>Never Implanted</th>
<th>Retrieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. CoCr</td>
<td>B. OxZr</td>
<td>CoCr (n = 3)</td>
</tr>
<tr>
<td>Roughness, Sa (nm)</td>
<td>63.0 ± 8.1</td>
<td>41.3 ± 0.74</td>
</tr>
<tr>
<td>Skewness, Ssk</td>
<td>0.553 ± 0.057</td>
<td>-1.22 ± 0.19</td>
</tr>
</tbody>
</table>

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