**First-Generation Highly Crosslinked Polyethylene Liners in THA: Clinical and Material Performance**

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**Introduction:** First-generation highly crosslinked polyethylenes (HXLPEs) are approaching a decade of use in THA [1]. Patients are hypothesized to experience lower incidences of loosening, osteolysis, and revision because of the superior in vitro wear resistance of HXLPE compared to conventional polyethylene. In contrast, the resistance to in vivo oxidation is anticipated to be formulation dependent, because thermal stabilization methods differ in efficacy [2]. However, the clinical implications of the potential in vivo oxidation for HXLPE are still unclear [3-4]. In this study, we evaluated the clinical outcomes, as well as the material performance of contemporary HXLPE formulations. We hypothesized that HXLPE would exhibit lower incidence of loosening and polyethylene wear as reasons for revision, and low femoral penetration rates. Furthermore, in vivo oxidation, if any, was hypothesized to not have clinical consequences for patients implanted with HXLPE acetalubar liners.

**Methods:** 155 acetalubar liners were consecutively retrieved after revision surgery during a nine-year period by five urban medical centers in collaboration with two implant retrieval centers. Retrievals were from revision surgery during a nine-year period by five urban medical centers. Methods: 155 acetabular liners were consecutively retrieved after revision surgery during a nine-year period by five urban medical centers in collaboration with two implant retrieval centers. Retrievals were 155 consecutively retrieved after revision surgery during a nine-year period by five urban medical centers. In collaboration with two implant retrieval centers. Retrievals were 155 consecutively retrieved after revision surgery during a nine-year period by five urban medical centers.

**Results:** Patient age, weight, and levels of activity were comparable in the three cohorts (p>0.21 for all cases). Annealed highly crosslinked retrievals were implanted for an average of 2.6y (range: 0.0 – 8.0y) and 1.2y (range: 0.6 – 1.9y), respectively. Overall, the most frequent reasons for revision were femoral head loosening (35%), instability (28%) and infection (20%), and were not significantly affected by patient factors (p>0.4), penetration rate (p=0.24), or oxidation at the articulating surface (p=0.06). Conventional retrieved liners had significantly lower ultimate loads than HXLPE explants at both the inferior (p<0.01) and superior regions (p<0.0001; Table 1). In addition, there were no significant variations in ultimate loads for remelted HXLPE 1 liners. However, conventional liners had significantly lower subsurface ultimate loads at unloaded regions of the articulating surface with respect to loaded regions (p<0.004), whereas annealed HXLPE liners had significantly lower surface ultimate loads with respect to subsurface ultimate loads (p=0.02). According to logistic models, the incidence of reason for revision was not significantly affected by patient factors (p>0.4), penetration rate (p=0.24), or oxidation at the articulating surface (p=0.06). Conventional retrieved liners had significantly lower ultimate loads than HXLPE explants at both the inferior (p<0.01) and superior regions (p<0.0001; Table 1). In addition, there were no significant variations in ultimate loads for remelted HXLPE 1 liners. However, conventional liners had significantly lower subsurface ultimate loads at unloaded regions of the articulating surface with respect to loaded regions (p<0.004), whereas annealed HXLPE liners had significantly lower surface ultimate loads with respect to subsurface ultimate loads (p=0.02).

**Discussion:** This retrieval study documents the clinical failure modes and the material performance for HXLPEs in their first decade of service. As expected, HXLPE liners had reduced penetration rates due to their elevated crosslinking level. Furthermore, our findings suggest femoral head material has no influence on penetration rate. Despite their superior wear performance, loosening remained the most frequent reason for revision. Although high in vivo oxidation was detected at the rim in annealed HXLPE and conventional liners, oxidation does not seem to be a clinical concern for the designs and follow-up considered here. The long-term clinical performance of first-generation HXLPE remains promising, based on their outcomes documented in this study.


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<thead>
<tr>
<th>PE TYPE</th>
<th>Superior</th>
<th>Inferior</th>
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<tbody>
<tr>
<td>Conventional (n=15)</td>
<td>79.4±9.8</td>
<td>74.9±8.7</td>
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<tr>
<td>Annealed (n=63)</td>
<td>93.6±8.2</td>
<td>96.7±10.1</td>
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<tr>
<td>Remelted 1 (n=13)</td>
<td>85.1±12.2</td>
<td>90.9±11.6</td>
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**Figure 1.** Femoral head penetration rates for conventional and HXLPE liners.

**Figure 2.** Maximum ASTM oxidation for conventional and HXLPE liners.