Wear of highly cross-linked polyethylene is not influenced by material of femoral head in THA

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Introduction
Highly cross-linked polyethylenes (HXLPEs) were clinically introduced to reduce the polyethylene wear in total hip arthroplasty (THA) and the successful results have been reported. The purpose of this study was to evaluate the effects of head material, head size and postoperative duration on the wear performances of HXLPE.

Materials and Methods
This retrospective study was approved by our institutional review board. 332 hips in 300 patients who had primary THAs between January 2001 and December 2006 were retrospectively reviewed. The average follow-up periods were 6.1 years with minimum 4 years. Patient demographics are summarized in Table 1.

<table>
<thead>
<tr>
<th>Head material</th>
<th>zirconia</th>
<th>alumina</th>
<th>Co-Cr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hips</td>
<td>240</td>
<td>72</td>
<td>20</td>
</tr>
<tr>
<td>Male : Female</td>
<td>41 : 199</td>
<td>5 : 67</td>
<td>4 : 16</td>
</tr>
<tr>
<td>Age (years)</td>
<td>61.4</td>
<td>63.2</td>
<td>64.1</td>
</tr>
<tr>
<td>OA/ON/RA</td>
<td>20/12/19</td>
<td>66/6/0</td>
<td>17/3/0</td>
</tr>
<tr>
<td>F/U (years)</td>
<td>6.7</td>
<td>4.9</td>
<td>4.79</td>
</tr>
</tbody>
</table>

Table 1. The demographic data.

Implant: All the patients received cementless porous acetabular and femoral components (AMS & PerFix, JMM, Osaka, Japan). Three femoral head materials (alumina, zirconia and Co-Cr) and two head sizes (22mm, 26mm) were used in this study. From 2001 to 2004, zirconia femoral heads and occasional cobalt-chrome (CoCr) heads were used. From 2004, femoral head was changed to alumina. Head size was changed to 26mm from 22mm in 2004.

HXLPE: Gamma ray irradiated and annealed HXLPE liners (Acenian, JMM, Osaka, Japan) were used in all the patients. To manufacture the highly cross-linked polyethylene liners, calcium-stearate-free GUR 1050 resin was utilized to create compression-molded sheets, which were then machined into the final implant geometry. Prior to machining, the compression-molded sheet was subjected to a process consisting of gamma-ray irradiation of 3.5 Mrad (35 kGy) to achieve the desired level of cross-linking with annealing (110 °C) for free-radical reduction. The final liners were then sterilized with use of gamma-ray irradiation of 2.5 Mrad (25 kGy) in nitrogen gas.

Wear measurement: The penetration of femoral head into HXLPE was measured on anteroposterior pelvic radiographs at 1 week, at 1 year, 4 years and 8 years postoperatively using the measurement software (Polyware; Draftware Developers Inc, Vevay, IN). With reference to the radiograph at 1 week postoperatively, penetration was evaluated at each period. To reduce the disproportionate effects of bedding-in and creep, Analyses was also performed with radiograph at 1-year as initial image. Statistics: Statistical analysis was performed between groups and values of P<0.05 were considered significant, using Turkey-Kramer test for the material analysis and Student t test for the diameter analysis.

Results
Radiographical penetration at each time point with three femoral head materials were showed in Figure 1. Bedding-in phenomenon was observed in all head materials in the first 1 year. After 1 year, little penetration were noted. There was no significant difference between penetration of 1 to 4 years and that of 4-8 years in the cases with both zirconia and Co-Cr.

![Figure 1. Penetrations of Zirconia, Alumina and Co-Cr.](image)

Effect of head size
No significant difference was apparent between 22mm and 26mm zirconia femoral heads (Table 2).

Discussion
As reported in the literatures, penetration rate of HXLPE was much lower than conventional PE. According to the meta-analysis of Kurtz et al., the mean penetration of HXLPE rates was 0.042 mm/year, which is compatible with our result. This is the first study comparing three femoral head materials, showing that steady penetration rate of HXLPE was so low not to be influenced by material or size of femoral head.

Conclusion
The amount of penetration of HXLPE is so small to outstrip the influences of material and size of femoral head.

Significance
HXLPE is less-wearing independently of material and size of femoral head and contribute to clinical success.

References

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