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Original Article

# Polyethylene and highly cross-linked polyethylene for cemented total hip arthroplasty: A comparison of over ten-year clinical and radiographic results

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ABSTRACT

*Introduction:* We investigated the long-term tribological outcomes of conventional polyethylene (CPE) and highly cross-linked polyethylene (HXLPE).
*Methods:* Ninety-four consecutive primary cemented THAs were performed using either HXLPE or CPE at our hospital. CPE sockets were used in 26 hips, and HXLPE sockets were implanted in 68 hips.
*Results:* A 10-year follow-up was completed for 69 cases. Linear wear rates of $0.138 \pm 0.074$ mm/year for CPE and $0.011 \pm 0.020$ mm/year for HXLPE were calculated. Osteolysis was identified in 10 cases (CPE group, 7; HXLPE group, 3).
*Conclusion:* HXLPE had significantly less wear than CPE, and polyethylene wear was associated with osteolysis.


## 1. Introduction

Although total hip arthroplasty (THA) is a popular surgical treatment for degenerative hip joint disease, several issues still need to be resolved, with periprosthetic osteolysis and subsequent loosening of the prosthesis being an important problem affecting long-term outcomes. Loosening can possibly be induced by an immunologic response, and may be related, in part, with increase wear of the acetabular polyethylene, which is frequently associated with periprosthetic osteolysis. To solve this problem, highly cross-linked polyethylene (HXLPE) has been developed, with clinical and tribological results of using HXLPE in cementless THA having been reported. Recently, long-term wear performance of HXLPE in cementless THA has also been reported. However, the long-term wear performance of HXLPE in cemented THA remains to be evaluated.

In a previous study, we reported on the clinical outcomes of HXLPE and compared its wear performance to conventional polyethylene (CPE) over a minimum 3-year follow-up after cemented THA.[1] Our aim in our present study was to evaluate the long-term clinical results and wear performance of HXPLE after a minimum 10-year follow-up in patients with cemented THA to determine its clinical relevance.

## 2. Materials and methods

### 2.1. Patients and materials

All patients provided informed consent and the study protocol was approved by the institutional review board of our hospital. Between 1999 and 2001, we implanted a 22.225-mm head in 94 consecutive cases of primary cemented THA in our hospital. Four implant combinations were used, as summarized in Table 1, and patients were classified into groups based on the combination used, as follows. The 26 hips in group A received CPE sockets with a zirconia femoral head and Charnley-type stems (BC socket, PHS head, and KC stem, Kyocera Medical Corp., Kyoto, Japan). HXLPE sockets (Aeonian, Kyocera Medical Corp.) were implanted in all other cases. The 25 hips in group B received PHS zirconia femoral heads and KC stems, with the 23 hips in group C receiving zirconia femoral heads and distal cylindrical stems (HHZ head, K-MAX stem, Kobelco, Kobe steel Ltd, Kobe, Japan), and the 20 hips in group D, stainless steel femoral heads (Elite head, DePuy Inc., Warsaw, Ind.) and C-stems (DePuy Inc.). The surface finish of all femoral head components was similar (Ra, $<0.02\,\mu m$, Ry, $<0.2\,\mu m$). The conventional BC sockets were fabricated with GUR415, with stearic acid applied by ram extrusion, and sterilized

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**Table 1**
Implants for each group.

| | Acetabular socket/ material | Inner head/ material | Femoral stem | N |
|---|---|---|---|---|
| Group A | BC/CPE | PHS/zirconia | KC | 26 |
| Group B | Aeonian/HXLPE | PHS/zirconia | KC | 25 |
| Group C | Aeonian/HXLPE | HHZ/zirconia | K-max | 23 |
| Group D | Aeonian/HXLPE | Elite/stainless-steel | C-stem | 20 |

CPE = conventional polyethylene; HXLPE = highly cross-linked polyethylene.

**Table 2**
Preoperative clinical details and evaluation scores for each group.

| | Group A | Group B | Group C | Group D |
|---|---|---|---|---|
| Age (year) mean (range) | 60 (43–81) | 61.5 (48–71) | 62.6 (45–76) | 60.8 (47–74) |
| Weight (kg) mean (range) | 50.2 (40.6–62.0) | 50.6 (38.5–76.0) | 51 (35.6–70.0) | 54.7 (38.0–82.0) |
| JOA hip score mean (range) | 54 (29–84) | 43.4 (20–76) | 56.8 (39–85) | 49.5 (20–86) |
| UCLA activity score mean (range) | 3.58 (3–6) | 3.60 (3–5) | 3.76 (3–5) | 3.65 (2–5) |
| Follow up period (months) mean (range) | 14.20 (12.5–15.0) | 13.80 (10.0–15.0) | 14.00 (12.6–15.0) | 13.90 (11.1–15.0) |

JOA = the Japanese Orthopaedic Association, UCLA = the University of California at Los Angeles. No significant between-group differences were identified.

by ethylene oxide gas. The CLPE Aeonian sockets were fabricated with GUR1050 without the use of stearic acid, by compression molding, and highly cross-linked using gamma irradiation at a dose of 35 kGy, heat annealed at 110 °C, and sterilized with 25 kGy of gamma irradiation in nitrogen.

### 2.2. Surgical procedures

All surgeries were performed by three experienced surgeons using a direct lateral approach with an anterior-trochanteric osteotomy (Dall's approach). The acetabular sockets and femoral stems were fixed with vacuum-mixed bone cement (Endurance, DePuy Inc., Warsaw, Ind.). Using a cement gun, we inserted bone cement into the femoral stems, the so-called third-generation technique.[2]

### 2.3. Radiographic evaluations

Anterior-posterior radiographs were obtained for each patient annually. We considered the first post-operative year as a 'settling-in' period for the THA and, therefore, measured polyethylene wear at one year post-operatively and every two years thereafter, up to the last follow-up visit. Polyethylene wear was measured by determining the penetration of the center of the head relative to the center of the acetabular socket, using the computer-aided technique described by Sychterz et al.[3] and modified by Tanaka et al.[4] To determine the rate of wear, radiographic measurements

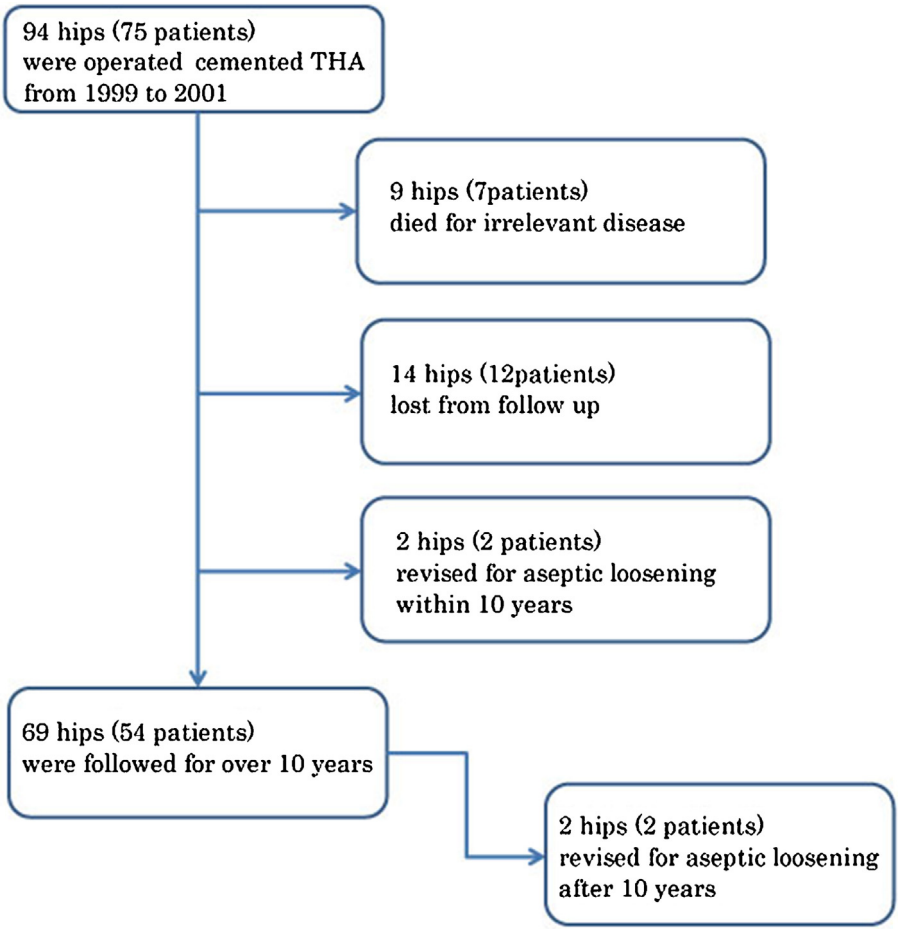


**Fig. 1.** Follow-up flowchart of patients in our study group. For patients who require THA revision, radiographs were evaluated radiographs up to the time of revision surgery. THA = total hip arthroplasty.