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Original article

Do screws and screw holes affect osteolysis in cementless cups using highly crosslinked polyethylene? A 7 to 10-year follow-up case–control study

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ABSTRACT

Background: The use of screws and the presence of screw holes may cause acetabular osteolysis and implant loosening in cementless total hip arthroplasty (THA) using conventional polyethylene. In contrast, this issue is not fully understood using highly crosslinked polyethylene (HXLPE), particularly in large comparative study. Therefore, we performed a case–control study to assess the influence of screw usage and screw holes on: (1) implant fixation and osteolysis and (2) polyethylene steady-state wear rate, using cases with HXLPE liners followed up for 7–10 years postoperatively.

Hypothesis: The screw usage and screw holes adversely affect the implant fixation and incidence of wear-related osteolysis in THA with HXLPE.

Patients and methods: We reviewed 209 primary cementless THAs performed with 26-mm cobalt-chromium heads on HXLPE liners. To compare the effects of the use of screws and the presence of screw holes, the following groups were established: (1) with-screw ($n = 140$); (2) without-screw ($n = 69$); (3) no-hole ($n = 27$) and (4) group in which a cup with screw holes, but no screw was used ($n = 42$). Two adjunct groups (no-hole cups excluded) were established to compare the differences in the two types of HXLPE: (5) remelted group ($n = 100$) and (6) annealed group ($n = 82$). Implant stability and osteolysis were evaluated by plain radiography and computed tomography. The wear rate from 1 year to the final evaluation was measured using plain X-rays and PolyWare Digital software.

Results: All cups and stems achieved bony fixation. On CT-scan, no acetabular osteolysis was found, but there were 3 cases with a small area of femoral osteolysis. The mean steady-state wear rate of each group was (1) 0.031 ± 0.022 , (2) 0.033 ± 0.035 , (3) 0.031 ± 0.024 , (4) 0.029 ± 0.018 , (5) 0.030 ± 0.018 and (6) 0.034 ± 0.023 mm/year, respectively. A comparison of the effects of screw usage or screw holes found no significant between-group differences in the implant stability, prevalence of osteolysis [no acetabular osteolysis and 3/209 at femoral side (1.4%)] and steady-state wear rate.

Discussion: This study suggests that there are no adverse effects on the results of THA with HXLPE from the use of cups with screw holes and the use of screws for cup fixation.

Level of evidence: Level III retrospective case–control study.

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1. Introduction

Total hip arthroplasty (THA) is one of the most successful reconstructive surgeries for the hip joint. However, periprosthetic osteolysis caused by polyethylene (PE) wear particles may be a

factor resulting in the loss of bone fixation in the prosthetic joint and is a major complication associated with THA [1]. PE wear particles causing loosening of the prosthesis may be observed when using conventional polyethylene (CPE), often necessitating revision surgery. In the 1990s, highly crosslinked polyethylene (HXLPE) was introduced to reduce the incidence of periprosthetic osteolysis associated with PE wear particles. Reports of basic experiments and clinical results related to wear rate have indicated that HXLPE is more resistant than CPE [2–5].

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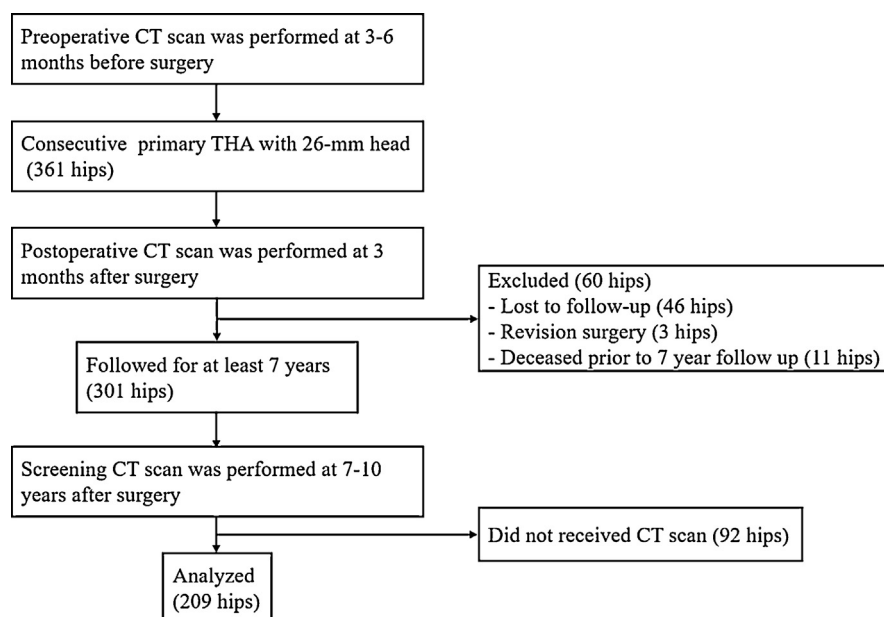


Fig. 1. Flowchart showing the selection of the patients. THA: total hip arthroplasty; CT: computed tomography.

Meanwhile, PE backside damage remains a risk for cementless cups [6]. Most cups have screw holes and may require the use of screws for initial fixation. Latent issues associated with the use of screws and the presence of screw holes include decreased bone ingrowth area, pelvic organ and neurovascular damage caused by acetabular screw penetration, PE liner backside damage, screw-shell corrosion and fretting and acetabular osteolysis [7–9]. In particular, the irregularity of the inner surface of the metal socket due to the screw holes and screws can affect PE backside damage resulting from micromotion between the liner and the socket. PE particles generated from liner-head interface can also be conveyed on the flow of joint fluid to screw holes in the concept of effective joint space [8]. The acetabular osteolysis caused by PE particles from screw holes is an important issue affecting long-term fixation of cups [9].

There are some reports about the influence of screw usage and screw holes on the clinical and radiographical outcomes of THA with HXLPE [10–13]. However, in these reports, the number of cases included was small [10–13], follow-up period was short [11–13], or the acetabular cup was a nonmodular, all-polyethylene cup [10,12].

Therefore, we performed a case–control study, using cases with HXLPE liners followed up for 7–10 years postoperatively to assess the influence of screw usage and screw holes on:

- implant fixation and osteolysis;
- polyethylene steady-state wear rates.

Our hypothesis was that screw usage and screw holes adversely affect the implant fixation and incidence of wear-related osteolysis in THA with HXLPE.

2. Patients and methods

2.1. Patients

This retrospective case–control study was approved by our institutional research ethics committee (IRB number M2000-1099). There was a total of 361 hips (in 289 patients) comprising a continuous series of primary cementless THA with 26-mm femoral head procedures performed at a single institution between 2003 and

2006. All operations were performed by or under the supervision of the senior author (TJ). Of these, 301 hips (248 patients) could be followed for at least 7 years. The point at which CT screening was performed at a minimum of 7 years postoperatively was set as the final evaluation and 209 hips (in 158 patients) that underwent CT screening at 7–10 years postoperatively (8.3 ± 0.6 years; range: 7.0–10.9 years) were analyzed in the present study (Fig. 1) (Table 1). All patient characteristics are shown in Table 1.

2.2. Methods

All patients underwent cementless THA using the posterolateral approach. Because the cup anteversion was determined with reference to the cementless stem anteversion [14], the femoral procedure was performed after resection of the femoral head before the acetabular preparation. The cup was fixed with a press-fit technique and screws were added at the discretion of the surgeon. When there was a hole for connecting a cup holder to the center of the no-hole cup, the hole was closed with a plug. One hundred and thirteen Trilogy HA/TCP cups with Longevity HXLPE liners (Zimmer, Warsaw, IN, USA) and 96 TriAD PSL cups with Crossfire HXLPE liners (Stryker Orthopaedics, Mahwah, IN, USA) were used in combination with proximally coated cementless stems (Table 2). All patients received a 26-mm cobalt-chrome (CoCr) femoral head, which was the type used most commonly in Japan at that time.

To compare the effects of the presence of screw holes and the use of screws, the following groups were established (Fig. 2) (Table 1):

- a with-screw group (140 hips) and a without (w/o) screw group (69 hips) to investigate the influence of the screw usage;
- a group in which a no-hole cementless cup was used (no-hole group; 27 hips) and a group in which a cup with screw holes, but no screw was used (hole w/o screw group; 42 hips) to investigate the impact of the presence of screw holes;
- a hole w/o screw group (42 hips), a group in which 1–2 screws were used (1–2 screws group; 94 hips), and a group in which 3–5 screws were used (3–5 screws group; 46 hips) to investigate how the number of screws affected the clinical and radiological results. The number of hips in which 1, 2, 3, 4 and 5 screws were used was 10, 84, 41, 4 and 1, respectively. To compare the differences

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