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Cementless total hip arthroplasty for patients previously treated with femoral osteotomy for hip dysplasia: the incidence of periprosthetic fracture

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Abstract

Purpose Femur deformities can make stem fixation difficult in total hip arthroplasty (THA). We report the clinical results of cementless THA using a press-fit stem in patients who had previously undergone femoral osteotomy for hip dysplasia.

Methods The subjects included 66 hips in 64 patients, with the mean follow-up period of 7.3 years. THA was performed at a mean period of 17.1 years after intertrochanteric femoral osteotomy. Valgus osteotomy was performed in 42 hips, and varus osteotomy in 24. Clinical results were evaluated by using the Merle d'Aubigne-Postel score. Implant survival was determined with revision as the end point, and any related complications were investigated.

Results The Merle d'Aubigne-Postel score improved from 9.4 to 16.1 at the final follow-up, without any implant loosening. However, periprosthetic femoral fractures were observed in four hips (6.0 %), one intra-operatively and three within three weeks after THA. Among these cases, three hips previously had varus osteotomy (12.5 %) and one hip had valgus osteotomy (2.3 %). Two hips were revised with full porous stems and circumferential wiring. The five and ten year cumulative survivorship rates were 97 % (range, 88.8–99.3 %) and 97 % (88.8–99.3 %), respectively.

Conclusions Although the use of a press-fit cementless stem yielded acceptable results in most of the patients, perioperative femoral fracture was a major complication especially in the patients previously treated with intertrochanteric varus osteotomy. Careful planning and implant selection could be emphasized for these cases.

Keywords Femoral osteotomy · Total hip arthroplasty · Periprosthetic fracture

Introduction

In order to delay the progression of osteoarthritis (OA) secondary to developmental dysplasia of the hip (DDH), various corrective osteotomies have been developed [1]. Peri-acetabular osteotomies are currently the most preferred procedure [1, 2]. However, femoral osteotomies had been widely used for the treatment of DDH. Intertrochanteric varus femoral osteotomy is aimed at increasing the acetabular coverage of the femoral heads [3]. Intertrochanteric valgus femoral osteotomy was performed in patients with femoral head deformities in order to improve joint congruency and to relieve pain [4].

When total hip arthroplasty (THA) is subsequently required in these cases, femur deformity due to the previous osteotomy could lead to various problems such as perforation of the femur or difficulty in controlling stem anteversion [5, 6]. These concerns make implant selection difficult and may make the durability of the implants questionable. A literature review showed comparable long-term results of the use of cemented stems in patients who were or were not previously treated with femoral osteotomies [5, 7–9]. However, reports on the use of cementless stems are still limited [6, 10, 11]. As cementless stems need direct contact and anchoring with bone, they confer higher risk of periprosthetic fracture than cemented stems do. The purposes of this study were: (1) to examine the results of cementless THA with commonly used

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press-fit stems for patients previously treated with femoral osteotomies, (2) to investigate the incidence of periprosthetic fractures, and (3) to determine which type of osteotomy is associated with higher risk of periprosthetic fractures.

Materials and methods

Patients

The institutional review board approved this study. Between 1998 and 2010, 71 THAs were performed in 66 patients who had previously undergone femoral osteotomies in our institution. Of these cases, four highly dislocated hips in two patients were excluded due to the use of a modular femoral stem (S-ROM; Depuy, IN, USA) in combination with shortening femoral osteotomy. One patient who had undergone anterior rotational osteotomy of the femoral head was also excluded. The remaining 66 hips in 63 patients were included in this study. The mean age at THA was 69.8 years. The mean age of the patients was 7.3 years (range, 1–14 years). Previous femoral osteotomies consisted of intertrochanteric valgus osteotomy in 42 hips and varus osteotomy in 24 hips. Three hips had received concomitant acetabuloplasty and one had received a Chiari osteotomy.

Implants and operation

The AMS acetabular cup and PerFix HA femoral stem (Kyocera, Osaka, Japan) were used in 62 hips. The PerFix HA femoral stem is a straight and tapered press-fit titanium stem [12, 13]. The proximal aspect is treated with a rough surface coated with hydroxyapatite (Fig. 1a). In five cases, the Trilogy and Versys systems (Zimmer, Warsaw, IN, USA) were used. VerSys taper is a tapered and press-fit stem with a titanium fiber mesh and tricalcium phosphate coating in the proximal aspect (Fig. 1b).

Conventional polyethylene had been used until December 1999. Since January 2000, conventional polyethylene has been replaced with highly cross-linked polyethylene.

Pre-operative planning was made by the conventional two-dimensional templating using anteroposterior and lateral radiographs. All the operations were performed through the posterolateral approach. The acetabular cup was inserted via the press-fit technique. After the operation, the patients were allowed full-weight bearing as tolerated, with the use of crutches or a walker as ambulatory aid and then advised to progress without the ambulatory aid as usual.

Clinical and radiographic analyses

All of the patients were evaluated preoperatively and at the time of the latest observation according to the Merle

Fig. 1 A Kyocera PerFix HA femoral stem (a) and Zimmer Versys femoral stem (b)

d'Aubigne-Postel score [14]. At the time of the latest observation, all of the patients underwent radiological evaluation for possible implant loosening and periprosthetic osteolysis. According to the method by Engh et al. [15], the absence of radiolucency along the rough surface of the femoral stem was defined as stable, radiolucency less than half of the rough surface was defined as fibrous stable, and radiolucency more than half of the rough surface was defined as unstable. Progressive femoral stem subsidence>5 mm was judged as stem loosening. Both intra-operative and post-operative complications were observed. Periprosthetic fractures were classified according to the Vancouver classification [16].

Statistical analysis

Statistical analysis was performed with JMP 6.0.3 (SAS Institute, Tokyo, Japan). Differences between pre-operative and post-operative Merle d'Aubigne-Postel scores were compared
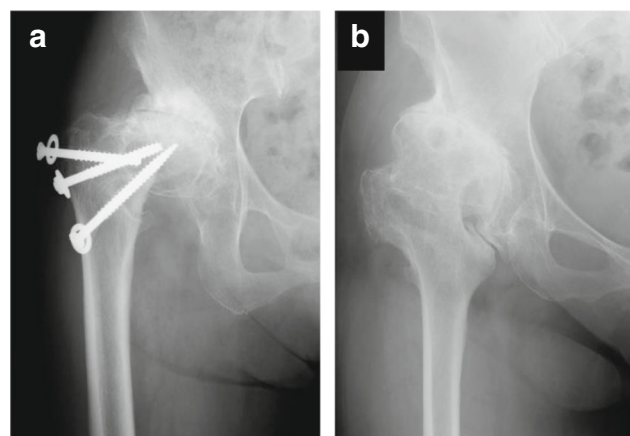

Fig. 2 Radiographs showing typical deformities after the following osteotomies: a varus and b valgus osteotomies
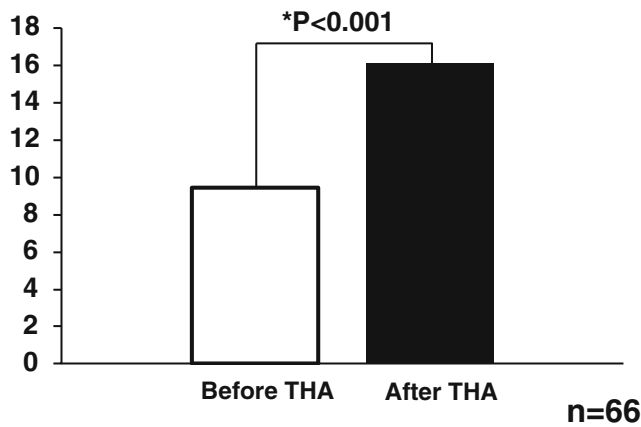
Fig. 3 Merle d'Aubigne-Postel scores before and after THA (*n*=66)

by using the chi-square test. Occurrence of periprosthetic fractures was compared between the varus and valgus osteotomy cases by using the Fisher exact test. For all the statistical analyses, a *p*<0.05 was considered statistically significant. Cumulative survivorship was analyzed by using the Kaplan-Meier method, with revision for any reason as the end point.

Results

Previous intertrochanteric osteotomies resulted in various femoral deformities, as shown in Fig. 2. The mean age at the previous osteotomy and at THA was 45.0 years (range, 6–66 years) and 62.2 years (range, 45–81 years), respectively. The mean resultant interval was 17.1 years (range, 3–51 years). The mean pre-operative Merle d'Aubigne-Postel score was 9.4 points (range, 4–14 points), which improved to 16.1 points (range, 9–18 points) at the most recent follow-up (Fig. 3). All of the stems showed bone ingrown fixation with no progressive radiolucency. No implant loosening was observed at the latest follow-up. Although two cases where conventional polyethylene was used showed obvious penetration of the femoral head into the liner, no apparent periprosthetic osteolysis was observed.

The perioperative complications are listed in Table 1. One case showed superficial wound infection and was managed with antibiotics. No dislocation was observed throughout the observation periods. Notably, four cases (6.0 %) of

periprosthetic fractures occurred. The detail of the fractures are listed in Table 2. One was previously treated with a intertrochanteric valgus osteotomy, and three with varus osteotomies. The incidence of periprosthetic fractures was 2.3 % in the patients with valgus osteotomy and 12.5 % in those with varus osteotomy. A fracture was observed during the stem insertion in one case previously treated with varus osteotomy. This case was managed with circumferential wiring. Other three fractures became apparent after the patients started walking. The fractures showed a displaced lesser trochanter and attached cortex with the stem subsidence, which were assumed as type B2 fractures according to the Vancouver classification, or a clamshell fracture. In none of the cases did the operators recognize obvious signs of fractures during the operation. One patient with 12-mm subsidence was treated conservatively with delayed weight bearing. Two patients with gross stem subsidence required revision surgery; both were revised with cementless full porous stem and circumferential wiring (Fig. 4). These fracture cases showed stable bone ingrown fixation and no evidence of loosening at the latest follow-up.

Except for these two cases, no revision was performed during the follow-up period. The 5- and 10-year cumulative survivorship rates were 97.0 % (range, 88.8–99.3 %) and 97.0 % (88.8–99.3 %), respectively (Fig. 5).

Discussion

Although cementless THA with a press-fit stem yielded acceptable results in most patients, perioperative femoral fracture (6.0 %) was a major complication in patients with previous intertrochanteric osteotomy for hip dysplasia. The fracture occurred in cases previously treated with varus osteotomy (12.5 %) and valgus osteotomy (2.3 %).

This study has several limitations. First, the sample size might be small with 66 hips in 63 patients in this study. However, the similar studies in the literature included less than 50 patients [10, 11]. We also limited the patients with intertrochanteric varus or valgus osteotomy for hip dysplasia to homogenize the patient group. Second, as this study analyzed a press-fit stem only, our findings may not be applied to

Table 1 Intra-operative and post-operative complications

Complication	Total	Varus osteotomy (*n*=24)	Valgus osteotomy (*n*=42)
Superficial wound infection	1	0	1
Deep wound infection	0	0	0
Dislocation	0	0	0
Gross polyethylene wear	2	0	2
Periprosthetic fracture	4	3	1

Table 2 Characteristics of the patients with periprosthetic fractures

Case	Age/sex	Osteotomy	Fractures recognized	Management of the fractures
1	62/F	Varus	Intra-operatively	Circumferential wiring
2	73/F	Varus	18 days post-operatively	Revised with full porous stem and wiring
3	73/F	Varus	14 days post-operatively	Conservative treatment
4	57/F	Valgus	6 days post-operatively	Revised with full porous stem and wiring

other stem designs. Theoretically, the press-fit stem is susceptible to fractures due to thick anteroposterior size. However, future studies could address if other stems display similar problems. Third, other kinds of osteotomy such as subtrochanteric osteotomy may result in the distinct clinical results.

As have been pointed out, changes in the proximal femurs after femoral osteotomies make reaming, control of the anteversion, and implant stability difficult [6, 9, 10]. The calcar is usually thickened and possibly interfere with the stem after varus osteotomy. Despite the careful preparation of the posteromedial calcar, we experienced three fractures in patients with previous varus osteotomy. Calcar thickness is generally mild in hips with previous valgus osteotomies. Haverkamp et al. [9] reported that the long-term outcome of cemented THAs in patients who had undergone a previous femoral osteotomy was not compromised. However, the frequency of intra-operative perforation of the femurs was higher in the patients who had undergone a previous osteotomy (5 %) than in those who had not undergone a previous osteotomy (3 %). Breusch et al. [10] experienced two (4.8 %) intra-operative fractures during stem preparation in 41 patients who underwent uncemented THA for failed intertrochanteric

osteotomy. Boos et al. [8] reported 5 (6.7 %) cases of perioperative fractures in 74 THAs performed in patients who had undergone a previous femoral osteotomy, which did not affect the overall survivorship. These results indicate that THA in patients previously treated with femoral osteotomies is a technically demanding operation. We also experienced four cases of periprosthetic fracture.

The reported prevalence of post-operative periprosthetic femoral fractures with the cementless stem ranges from 0.1 to 4 % [17, 18]. Compared with these series, the present study showed a higher incidence rate of post-operative fractures (6.0 %). Interestingly, two fractures looked like what Capello et al. [19] and Mallory et al. [20] called "clamshell fracture". Van Houwelingen and Duncan [21] named it "pseudo A(LT)" or "new B2 fracture" in order to differentiate it from A(LT) fracture, which is a Vancouver type A fracture involving the lesser trochanter (LT). A(LT) is basically a fracture of the attachment of the iliopsoas and does not destabilise the stem. In contrast, the new B2 fracture involves not only the lesser trochanter but also the segment of the proximal medial femoral cortex, which can result in the instability of the stem. They mentioned that the new B2 fracture occurs within six weeks post-operatively when a tapered cementless stem was inserted
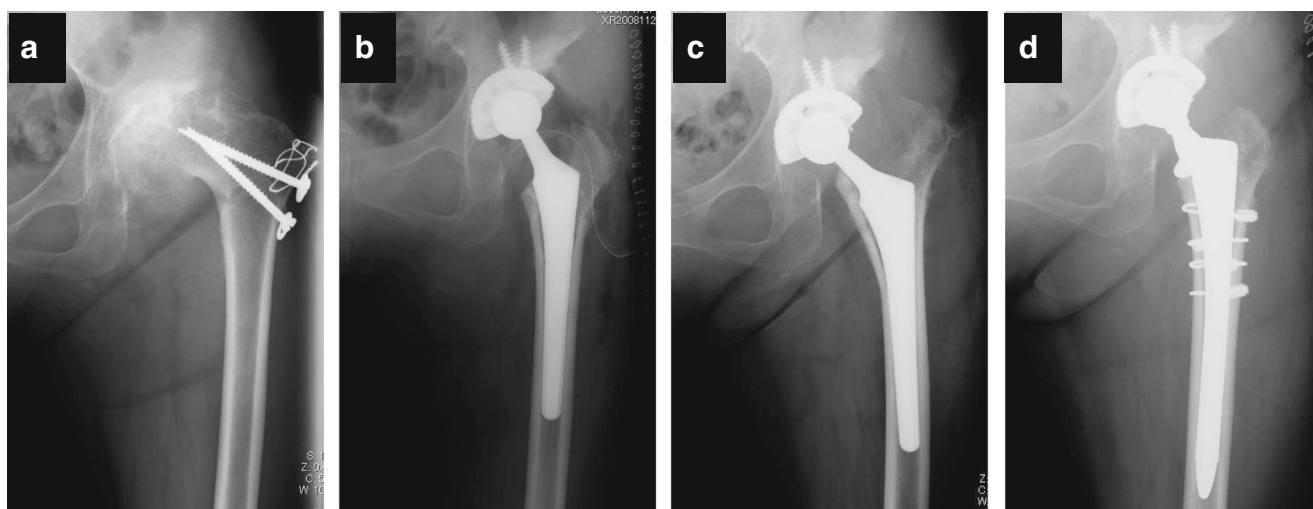
Fig. 4 A 73-year-old woman with a post-operative periprosthetic fracture. THA was performed (**b**) after a failed varus osteotomy (**a**). Eighteen days after the primary THA, when she was in weight-bearing rehabilitation, she complained of a severe acute pain. Radiographs showed sinking of the femoral components (**c**). The femoral components were revised with a full porous long-stem and circumferential wiring (**d**)

Fig. 5 Cumulative prosthetic survival estimate for all of the patients (with 95 % confidence interval)
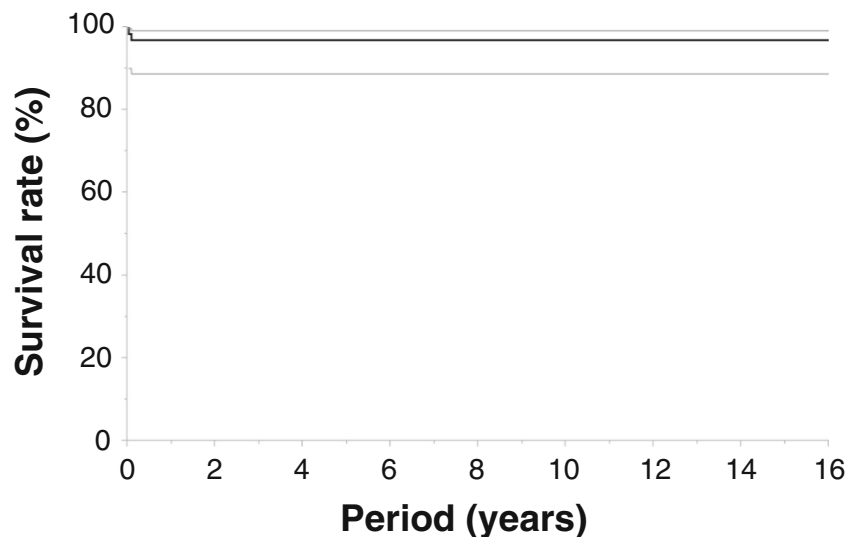
within a demineralised femur. They considered it to have occurred intra-operatively and worsened after weight-bearing rehabilitation or occurred during weight-bearing rehabilitation. Three cases in our series were diagnosed during the post-operative rehabilitation. Although we cannot exclude the possibility that the fractures occurred during the operations, these fractures might have occurred because the severely deformed femurs could not withhold the weight.

Bone fragility might be one of the causes. Four patients with fractures had undergone femoral osteotomies at a mean period of 30.75 years (13, 31, 28, and 51 years, respectively) prior to THA and possibly had disuse atrophy. Moreover, they were all female, with a mean age at THA of 66.2 years (62, 73, 73, and 57 years, respectively). Bone fragility due to these factors may have contributed to the periprosthetic fractures. To this end, Thien et al. [22] reported that cementless stems had a higher incidence rate of periprosthetic fractures within two years after THA using a cementless stem and that being female was a risk factor of fractures in cases with cementless stems.

For the prevention of periprosthetic fractures, special care should be paid in terms of planning and implant selection. Femoral deformity after osteotomy is usually more complicated than it looks on plain radiography. Hence, the use of three-dimensional templating with computed tomographic data must be helpful. It provides information about the bone-implant contact and possible size of the stem. Careful implant selections have to be made. Cemented stem may be safer than cementless stem for cases of severe femoral deformity [23]. Ferguson et al. [8] reported only seven cases of fracture in their series of 305 hips treated with cemented THAs. The report by Thien et al. [22] also suggested that cemented stems may be safer than cementless stems in terms of fracture prevention. As the femoral calcar is often narrow in cases treated with osteotomy, the use of a modular stem such as the S-ROM

is another option. This type of stem does not necessarily fit with the medial calcar, thus possibly reducing the risk of fractures.

The surgical approach also plays an important role on the periprosthetic fracture. The trans-trochanteric approach possibly reduces the risk of fractures compared with the conventional posterior or lateral approach, as this approach enables the femoral canal widely visible and gives us better orientation for the insertion of the femoral stem. Although additional attention should be paid to the fixation of great trochanter after implant placement, this approach must be one of the alternatives to avoid the periprosthetic fracture. The prophylactic wiring is also a technique to prevent fractures for the cases with higher risk of fractures.

In conclusion, although the use of a press-fit cementless stem yielded acceptable results in most of the patients, perioperative femoral fracture was a major complication especially in the patients with previous intertrochanteric varus osteotomy. Careful planning and implant selection could be emphasized for these cases.

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