



Outcomes of Surgical Treatment of Periprosthetic Femoral Fractures in Cementless Hip Arthroplasty

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Purpose: We aimed to evaluate the results of surgical treatment of periprosthetic femoral fractures in cementless total hip arthroplasty (THA).

Materials and Methods: From June 2002 to May 2012, 40 patients who could be followed-up for more than 1 year after surgery were enrolled in this study. The mean duration of follow-up was 28.5 months (range, 15-97 months) and the average age at the time of surgery was 71.5 years (range, 38-89 years). The fracture types were determined by using the Vancouver classification. Among intraoperative fractures, there were type A in 3 hips, type B2 in 2 hips and type B3 in one. Among postoperative fractures, type AG was present in 5 hips, type AL in 2 hips, type B1 in 15 hips, type B2 in 6 hips, type B3 in 3 hips, and type C in 3 hips. Evaluation of the results was based on bony union, stability of the prosthesis, postoperative complications, and Harris hip score at the final follow-up.

Results: Bony union was achieved in all but one case and the average time for bony union was 21 weeks. The mean Harris hip score was 86 at the final follow-up. Clinical results were above good in 34 of 40 hips (85.0%). Stem loosening occurred in one patient with a type B1 fracture treated with open reduction and plate fixation. Nonunion was observed in 1 patient with an AG type fracture.

Conclusion: Open reduction and fixation using a plate with a screw and cerclage wiring provided good results for periprosthetic fractures in patients who had a stable femoral stem without bone defects. Revision surgery with a cementless long stem should be considered in patients with an unstable stem or suspected stability in B1 type of THA using a proximal fixation type.

Key Words: Cementless hip arthroplasty, Periprosthetic femoral fracture, Surgical treatment

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INTRODUCTION

The incidence of hip disease and fractures has grown substantially with increasing life expectancy. The number of hip arthroplasty procedures performed has been progressively increasing as the range of adaptation following hip arthroplasty has been expanded¹⁾. Among several complications associated with hip arthroplasty, the prevalence of periprosthetic femoral fractures has been increasingly reported²⁻⁴⁾. The use of cementless implants in hip arthroplasty instead of cemented implants has increased over recent years⁵⁻⁷⁾. As cementless hip arthroplasty is performed in elderly patients, who have poor bone quality, intraoperative fracture easily occur when strong compression is applied to achieve initial stability. Moreover, periprosthetic femoral fractures are more likely to occur in patients who underwent cementless hip arthroplasty, despite poor bone quality, after falling down, compared to cemented surgery⁸⁾. Periprosthetic femoral fractures following hip arthroplasty are mostly associated with trauma; however, they may also be caused by local factors including osteoporosis, loosening of prosthesis, and osteolysis^{4,9,10)}. Since the incidence of fractures is influenced by prosthesis design and surface treatment in cementless hip arthroplasty, and prosthetic loosening after operative treatment of Vancouver type B1 fractures is frequently reported, caution is required in determining treatment options for patients with periprosthetic femoral fractures¹¹⁻¹³⁾. In this study, we aimed to identify the causes of periprosthetic femoral fractures in patients who underwent hip arthroplasty with cementless

prostheses and to investigate considerations in managing fractures following cementless hip arthroplasty by evaluating clinical and radiological outcomes after operative treatment.

MATERIALS AND METHODS

From June 2002 to May 2012, 40 patients who underwent cementless hip arthroplasty due to periprosthetic femoral fractures and could be followed-up for more than 1 year were enrolled in this study. The mean age at the time of surgery was 71.5 years (range, 38-89 years) and the patients included 27 males and 13 females. Fractures occurred after primary hip arthroplasty using proximal fixation prostheses in 34 cases and during revision using distal fixation prostheses in 6 cases. The cause of revision was loosening in 4 cases and infection in 2 cases. The cause of fracture after hip replacement was slipping down in 33 cases and falling down in 1 case. On the basis of radiographs taken before and after fractures, the presence of risk factors of periprosthetic femoral fractures (osteolysis, cortical defects, stem loosening, and stress riser) was examined. In addition, a bone mineral density test was conducted to detect osteoporosis. The mean duration of the follow-up after surgery was 28.5 months (range, 15-97 months) (Table 1). The types of intraoperative and postoperative fractures were determined by using the Vancouver classification¹⁴⁾. Three patients had intraoperative type A2 fractures, 2 patients had type B2 fractures, and 1 patient had a type B3 fracture. Among postoperative fractures, type AG (involving the greater trochanter)

Table 1. Baseline Characteristics of Periprosthetic Fracture Patients

Characteristic	Data
Total fracture	40
Intraoperative	6 (15.0)
Postoperative	34 (85.0)
Gender (male/female)	26/13
Age (yr)	71.5 (38-89)
Interval of fracture (yr)	7.8 (0.2-17.2)
Trauma mechanism of postoperative fracture	
Slip down	33
Fall down	1
Radiologic risk factor	
Osteolysis	7 (17.5)
Cortical thinning	3 (7.5)
Osteoporosis	13 (32.5)

Values are presented as number only, number (%), or median (range).

was present in 5 hips, type AL (involving the lesser trochanter) in 2 hips, type B1 in 15 hips, type B2 in 6 hips, type B3 in 3 hips, and type C in 3 hips. Fracture location, degree of displacement, stem stability, bone quality around the prosthesis, causes of fracture, and other factors have to be taken into consideration in choosing surgical treatment of the fractures. According to the degree of fracture displacement, type AG and type AL fractures were fixed with cerclage wiring or a greater trochanteric reattachment (GTR) plate. Revision was done in 1 type AG case with extensive osteolysis in the proximal part of the femoral component. Of 15 cases with type B1 fractures without femoral stem loosening,

plate fixation was performed in 8 cases, and stem revision was performed using distal fitting stems in 7 cases with extensive osteolysis in the proximal part (Fig. 1). Stem revision was performed in patients with type B2 fractures with stem instability and those with type B3 fractures with bone loss; these fractures were managed with plate fixation and bone grafting according to the degree of bone defects. Type C fractures were managed with open reduction followed by plate fixation (Table 2). Revision surgery was performed using long cementless stems to achieve fixation at the femoral isthmus. Plate fixation was performed in the proximal part using unicortical locking screws and cables, and in the distal

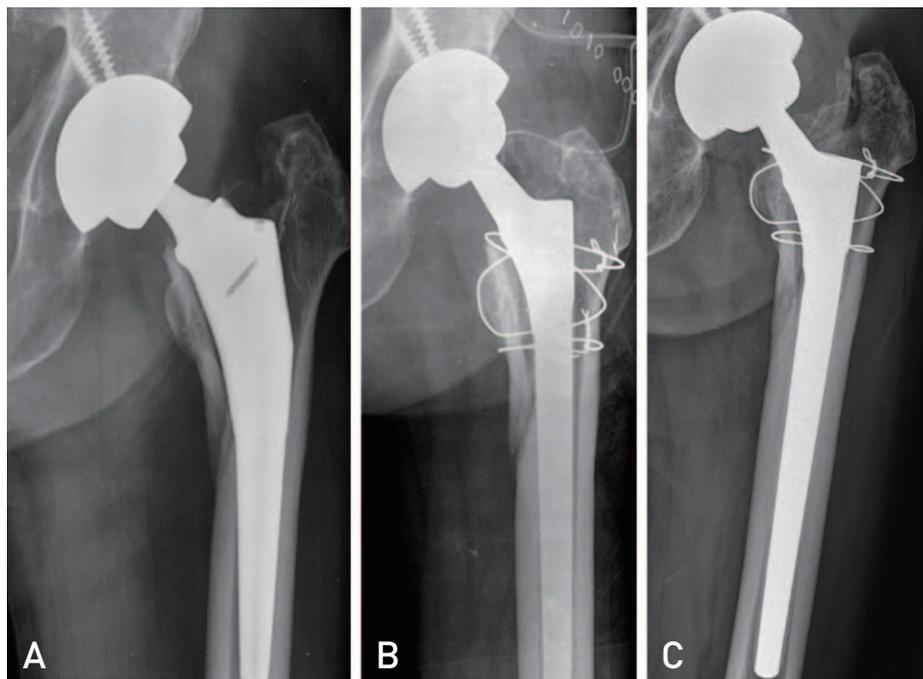


Fig. 1. (A) In a 73-year-old male patient, a Vancouver type B1 fracture occurred when he slipped down. (B) Stem revision was performed using a long distal-fitting-type stem, and internal fixation was performed with wiring. (C) At 19 months after operation, an X-ray showed bony union and no evidence of femoral stem loosening despite stem subsidence of about 5 mm.

Table 2. Treatment Methods according to the Postoperative Fracture Type

Variable	Fracture type*					
	AG	AL	B1	B2	B3	C
Cerclage wiring	1	1	0	0	0	0
ORIF with GTR plate	4	0	2	0	0	0
ORIF with Cable plate	0	0	6	0	0	3
Stem revision with ORIF	0	1	7	6	3	0
Total	5 (14.7)	2 (5.9)	15 (44.1)	6 (17.6)	3 (8.8)	3 (8.8)

Values are presented as number only or number (%).

ORIF: open reduction and internal fixation, GTR: greater trochanter reattachment.

* Classification according to the standard of Vancouver classification.

part using bicortical locking screws. Type A2 fractures, which occurred intraoperatively, were fixed using metal plates. In 1 case, a type B3 fracture with a bone defect occurred during revision due to infection; this fracture was treated with bone grafting and plate fixation.

Early postoperative range of motion exercises were performed and ambulation with crutches was begun by allowing partial weight bearing at 3 postoperative weeks. Crutch walking was continued until radiological bone union was confirmed.

Bony union was defined as the presence of trabeculations across the fracture site and absence of pain on full weight-bearing on postoperative radiographs. Clinical assessment was performed with the use of the Harris hip score and postoperative complications. Loosening of the femoral component was defined as the presence of pain during ambulation and progression of subsidence on radiographs.

RESULTS

The risk factors of periprosthetic femoral fractures following total hip arthroplasty (THA) were osteolysis in 7 cases, a cortical defect in 1 case, weakening of the cortical bone due to stress shielding in 2 cases, and osteoporosis in 13 cases. The fractures occurred within a mean period of 7 years 8 months (range, 2 months-17 years 2 months) after THA (THR). Revision surgery was performed in 17 of 40 cases. Bony union was achieved in all but 1 case and the average time for bony union was 21 weeks (range, 16-40 weeks). Even though fixation using a GTR plate was performed, non-union was observed in 1 patient with a type AG fracture associated with proximal osteolysis. Surgical treatment using plate fixation was performed in 1 patient with a type B1 fracture, but the patient underwent revision due to stem loosening at postoperative 27 months. The mean Harris hip score was 86 (range, 64-98) at the final follow-up. Good or excellent clinical results were obtained in all cases, except for 1 case with revision due to stem loosening and 1 case with non-union.

Besides 3 cases of plate removal due to irritation that occurred after bony union, no other complications were observed such as infection or refracture.

DISCUSSION

The incidence of periprosthetic femoral fractures

following hip replacement varies according to authors, but the prevalence of hip arthroplasty has been on the rise in recent years, along with an expanded range of indications for surgery and growing number of older adults^{1,2,4}. In particular, surgical management needs to be considered carefully in older patients with osteoporosis, who are at high risk of fractures, since treatments that result in fractures are not satisfactory. The mean age of patients was 71.5 years in this study, and 13 of 40 patients were positive for osteoporosis. The increased incidence of periprosthetic fractures is related to the increased incidence of hip arthroplasty in older adults with poor bone quality. Therefore, the incidence of periprosthetic fractures in the future will increase with the increasing elderly population.

Fractures following THA can occur throughout the all surgical process^{15,16}. Since revision has a very high fracture incidence, caution is required before surgery in patients at high risk of fractures^{17,18}. In this study, we found the following risk factors of intraoperative fractures during revision: loosening of prosthesis, a cortical defect around the fracture site due to infection, and osteolysis. McElfresh and Coventry¹⁹ addressed inadequately inserted bone cement, cortical osteolysis, perforation, stress riser, as the risk factors of fractures after surgery. Larsen et al.²⁰ suggested that loosening of the femoral component, osteoporosis, calcar resorption, and varus angular deformity of the prosthesis could be the fracture risk factors. In this study, postoperative fractures were most frequently caused by minor traumas including falls. At the fracture site, osteolysis occurred in 7 cases and cortical bone thinning was observed in 3 cases. Furthermore, a dual-energy X-ray absorptiometry scan revealed osteoporosis in 13 cases. Although all fractures occurred after minor falls, they appeared to be influenced by multiple risk factors around hip implants.

Conservative treatment in patients with periprosthetic femoral fractures after THR results in a high rate of complications, which include atelectasis, pulmonary embolism, and non-union^{4,17}. For this reason, surgical treatment is recommended for elderly patients¹⁹. Surgical treatment is now most commonly performed and treatment options are chosen depending on the presence of stem loosening and the type of fracture²¹. The authors of this study chose surgical management for all patients because of its advantages of early joint exercise and ambulation to avoid the problems of conservative treatment.

Surgical treatment were determined based on the location of the fracture, stem stability, and bone defect according to the Vancouver classification, and internal fixation, bone grafting, or revision was performed. We achieved satisfactory results by conducting cerclage wiring in 3 patients with A2 type fractures, revision with a long femoral stem and plate fixation in 2 patients with type B2 fractures, and plate fixation and an allograft in 1 patient with a type B3 fracture. We suggest that favorable results can be anticipated when intraoperative periprosthetic femoral fractures are managed according to the above treatment principles.

In the case of type A periprosthetic fractures after THA, conservative treatment can be performed in hips with minimal displacement according to the stability of fracture, while open reduction and fixation seem to be appropriate for hips with severe displacement. Despite fixation using a GTR plate, non-union was seen in 1 case with a type AG fracture associated with osteolysis. Bony union is expected to be obtained with a combination of curettage of osteolytic lesions and bone grafting. Thus, different treatment options for type AG fractures can be considered according to the causes of the fractures. Accurate open reduction and solid internal fixation are commonly used for type B1 fractures. However, we performed revision in all patients with type B1 fractures, in cases of the use of proximal stem and extensive or fractures extended proximally. Stem

loosening occurred at postoperative 27 months after open reduction and plate fixation in 1 patient with a type B1 fracture, and revision surgery was performed (Fig. 2). This case indicates that loosening of the stem component can occur over time, although a fracture is classified as type B1 on radiographs. ABG (anatomique benoist giraud; Howmedica, Newbury, UK) hydroxyapatite-coated femoral stems with coating on their proximal part, which were mainly used in this study, have severe problems with stem stability when a fracture occurs around the proximal part of the prosthesis. It will also occur in other proximally fitted prostheses^{12,13}. Unlike fractures developed in femoral stem components because of extensive ingrowth, type B1 fractures in proximal fitting femoral stems should be managed differently based on our experience. In type B2 fractures, a loosened femoral stem was revised using a long femoral stem. To manage type B3 fractures, composite reconstruction was performed using revision of the femoral stem and bone grafting, since proximal bone defects were severe due to osteolysis and comminuted fractures. Type C fractures were managed with open reduction and internal fixation according to the treatment principles for general fractures²²⁻²⁴. As suggested by Dennis et al.²⁵, we fixed periprosthetic fractures using plates with cables. The proximal part was fixed using unicortical locking screws and cables and the distal part was fixed using bicortical locking

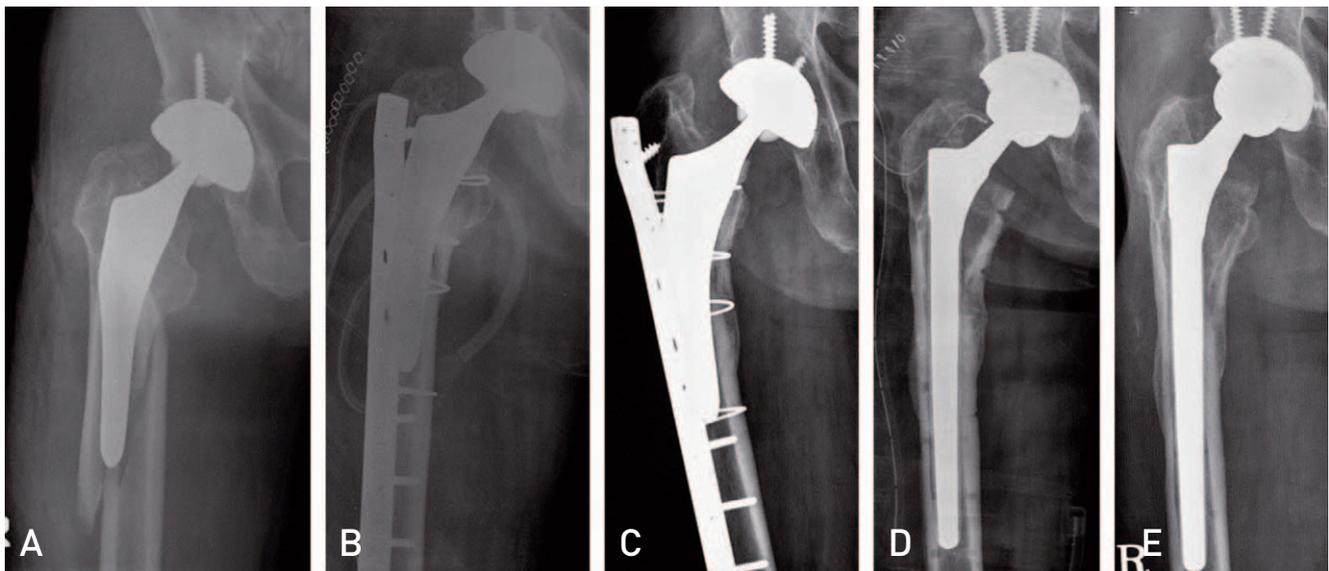


Fig. 2. (A) In a 65-year-old male patient, a Vancouver type B1 fracture without stem loosening occurred after a fall. (B) The fracture was treated with a plate and screw. (C) At 27 months after operation, an X-ray showed progressive subsidence of the femoral stem. (D) Stem revision was performed using a long distal-fitting-type stem. (E) At 9 months after revision surgery, an X-ray showed bony union and stable stem fixation.

screws. Furthermore, stem stability was achieved by wire fixation after stem revision in 1 case of a type AL fracture with osteolysis.

Possible complications of periprosthetic femoral fractures after THR include stem loosening, infection, malunion, non-union, refracture, and shortening of the lower extremity. In the present study, infection, refracture, and other complications were detected, excluding 1 non-union, 1 stem loosening, and 3 cases of plate removal due to metal allergy after bony union. Satisfactory outcomes were obtained with a mean Harris hip score of 86 at the final follow-up.

CONCLUSION

Surgical management according to treatment principles can achieve low incidence of complications and good clinical results in patients with periprosthetic femoral fractures after cementless hip arthroplasty. Based on revision surgery standards, the stability and types of the femoral stem and the degree of osteolysis need to be taken into account.

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