ORIGINAL ARTICLE
Hip Pelvis 26(4): 256-262, 2014
http://dx.doi.org/10.5371/hp.2014.26.4.256

Print ISSN 2287-3260
Online ISSN 2287-3279
Hip & Pelvis

The Early Result of Cementless Arthroplasty for Femur Neck Fracture in Elderly Patients with Severe Osteoporosis

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Purpose: The purposes of the current study were to assess the early results of cementless hip arthroplasty (HA) for femoral neck fractures in elderly patients with severe osteoporosis and to compare the clinical outcomes between those who underwent total HA (THA) or bipolar hemiarthroplasty (BHA).
Materials and Methods: From April 2011 to May 2012, we performed 87 cementless HAs for displaced femoral neck fractures in elderly patients (≥65 years) with severe osteoporosis. Among them, we studied 70 hips that were able to be followed-up for >24 months. Of these, 34 underwent THA and 36 underwent BHA. Clinical results were evaluated using the Harris hip score (HHS), Koval classification, and radiographs.
Results: Only one instance of femoral stem loosening was observed. Additionally, no dislocations were observed and no revision surgeries were required. The mean changes in the functional items of the HHS scores were 2.8 and 5.2 for those who underwent THA and BHA, respectively (P<0.05). According to the Koval classification used for the ambulatory status analysis, the mean perioperative change in the grade was 0.8 (0-4), with no significant differences noted between the THA and BHA groups.
Conclusion: The early results of cementless HA for femur neck fractures in elderly patients with osteoporosis were satisfactory, and THA was found to have a functional advantage over BHA.

Key Words: Elderly, Osteoporosis, Femur neck fractures, Cementless arthroplasty

Submitted: October 16, 2014 1st revision: November 1, 2014
2nd revision: November 4, 2014 3rd revision: November 24, 2014
Final acceptance: November 26, 2014
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INTRODUCTION

Displaced femoral neck fractures typically require surgical management. The aims of such surgical interventions include providing immediate pain relief, restoring functional activity, enhancing the rate of rehabilitation, and preventing complications[1]. Cemented hip prostheses have been used traditionally in patients with osteoporosis; however, cement-related cardiopulmonary complications have been observed in these patients[2-4]. Cementless total hip arthroplasty (THA) has been used with increasing frequency in recent years, as this

procedure lowers the risk of cement-related cardiopulmonary complications and has the advantages of short operation times and high survival rates[5-8]. The choice of prostheses remains controversial due to the clinical outcomes observed following THA or bipolar hip hemiarthroplasty (BHA)[9]. As compared to THA, BHA has the advantages of lower probabilities of dislocation, shorter operation times, lower degrees of blood loss, and lower operation costs. However, THA has been associated with functional advantages over BHA[1]. The aim of the current study was to assess the early clinical and radiological results of cementless hip arthroplasty (HA) for femoral neck fractures in elderly patients with osteoporosis.

MATERIALS AND METHODS

1. Materials

Of the 91 patients aged ≥65 years who underwent cementless HA due to displaced femoral neck fractures from April 2011 to May 2012 in Seoul Medical Center (Seoul, Kroea), 87 patients were included and 4 were excluded due to bone mineral density (BMD) T-scores higher than –3.0. The mean age was 79 years (range, 65-104 years), and the mean BMD T-score was –3.8 (range, –3.1-–5.3). The patient population included 20 men and 67 women. BHA was performed on 38 hips from patients with a short life expectancy due to severe medical complications, dementia, low compliance, or indoor ambulation only, while THA was performed on hips from the remaining 49 patients.

2. Surgical Methods

All operations were conducted by the same surgeon using an anterolateral approach and cementless femoral stems (Bencox Stem; Corentec, Cheonan, Korea)[8]. BHA was performed using Bencox bipolar cups (Corentec) and Bencox forte heads (Corentec) and THA was performed using cementless acetabular cups (Bencox cementless cup; Corentec) and ceramic-on-ceramic articulation. The trial stem was placed into the intramedullary canal by rasping the proximal medullary canal of the femur, and then the real stem was fixed rigidly in the medullary canal after confirming femoral stem size, stability of the hip joint, and leg length differences. The cementless acetabular cup was compressed and fixed the same way by rasping the acetabulum in THA. In most hips, compression was sufficient to obtain stability without using screw fixation of the acetabular cup. A Hemovac drain was placed for 72 hours postoperatively. Patients were maintained with the placement of an abduction pillow in bed and the use of graduated compression stockings and intermittent pneumatic compression. Low-molecular-weight heparin was administered prophylactically to patients at high risk for deep vein thrombosis. Rehabilitation was conducted using tilt-table standing, p-bar standing, and p-bar walking, in that order, according to patient compliance. Patients able to perform p-bar walking began ambulating with a walker in the ward, and maintained walker-assisted walking for a minimum of 3 months after discharge.

3. Statistical Analysis

All patients were evaluated preoperatively and at 6 weeks and 3, 6, and 12 months postoperatively. Clinical results were evaluated with the Harris hip score (HHS), a scale for rating pre- and postoperative function, pain, deformity, and range of motion. Ambulatory status was analyzed pre- and postoperatively according to the Koval classification[10]. For radiologic assessment, radiographs taken postoperatively on a regular basis were analyzed. Femoral component fixation was graded according to Engh's criteria[11]. Subsidence of the femoral component was evaluated by measuring the distance between the tip of the greater trochanter and superior lateral aspect of the femoral component, and considered significant with vertical subsidence >5 mm[12]. The acetabular component was divided according to the three zones defined by DeLee and Charnley[13], and acetabular loosening was defined in those with radiolucent lines wider than 2 mm around the acetabular cup, any increase in the width of the radiolucent line, screw breakage, component migration >2 mm, or changes in the coverage angle >4° [14]. Leg length discrepancy was defined when the difference between the distances from the inter-teardrop line to the tip of the lesser trochanter was >2 cm[15]. The degree of ectopic bone formation was determined using the classifications of Brooker et al.[16] In addition, the incidence of complications or revision surgeries was examined, and component loosening or revision was defined as failure of HA.

All statistical analyses were performed using IBM SPSS Statistics version 20.0 software (IBM Co.,

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Armonk, NY, USA). A paired *t*-test was used to compare continuous variables, while a chi-square test (or Fisher's exact test) was used to analyze categorical variables. *P*-values <0.05 were considered to represent statistically significant differences between groups.

RESULTS

Of the 87 included cases, no patients died before discharge, 7 were unable to be followed-up, and 10 (11.5%) died within the first postoperative year. Excluding those patients, 70 cases were followed-up for a minimum of 24 months (mean, 28.4 months; range, 24-37 months). THA was conducted 34 patients, and the remaining 36 patients underwent BHA. The mean age of the 70 evaluated patients was 77.8 years (range, 65-94 years), and the mean postoperative hospital stay was 22.4 days (range, 7-89 days) (Table 1). The mean durations of the operations were 86.8 minutes (range, 80-100 minutes) and 65 minutes (range, 50-105 minutes) for those who underwent THA and BHA, respectively ($P<0.05$). Changes in perioperative hemoglobin levels were 2.4 mg/dL (0.7-3.7 mg/dL) and 1.4 mg/dL (0.6-2.7 mg/dL) in those who underwent THA and BHA, respectively ($P<0.05$) (Table 2). The overall change in the functional items of the perioperative HHS scores was 3.6 (0-28), and significantly better results were achieved for those who underwent THA (mean, 2.8; range, 0-9) than for those who underwent BHA (mean, 5.2; range 0-28; $P<0.05$). At the final follow-up, mean HHS scores reflected better outcomes for those who underwent THA as opposed to BHA (80.4 vs. 61.9, $P<0.05$). In the ambulatory status analysis, the mean perioperative change for all patients according to the Koval classification grade was 0.8 (0-4). Perioperative changes were 0.7 (0-3) and 1.0 (0-4) in those who underwent THA and BHA, respectively, and no significant difference was detected between the two groups (Table 3).

Radiologic evaluation revealed subsidence of the femoral stem associated with component loosening in

Table 1. Patient Demographics

Parameter	Total	Total hip arthroplasty	Bipolar hemiarthroplasty
Numbers of hips	70	34	36
Gender (male/female)	13/57	13/21	0/36
Age (yr)	77.8 (65-94)	74 (65-87)	81 (71-94)
Body mass index (kg/m^2)	22.3 (16.0-31.1)	22.7 (17.3-27.8)	22.0 (16.0-31.1)
Bone mineral density (T-score)	−3.8 (−5.3-−3.1)	−3.7 (−4.9-−3.1)	−4.0 (−5.3-−3.2)
Follow-up (mo)	28.4	29.0	27.8
Underlying disease			
Cardiopulmonary disease	61	23	32
Diabetes	14	6	8
Chronic renal failure	2	2	0
Dementia	20	3	17
Parkinson's disease	5	4	1

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

Table 2. Comparison of Perioperative Parameters

Parameter	Total hip arthroplasty	Bipolar hemiarthroplasty	*P*-value
Duration of operation (min)	86.8 (80-100)	65 (50-105)	0.01*
Hemoglobin (Hb) change (mg/dL)			
Preoperative Hb (A)	11.6 (9.8-14.9)	11.1 (9.5-12.7)	
Postoperative Hb (B)	9.1 (7.7-12.1)	9.9 (7.4-11.7)	
Change (A-B)	2.4 (0.7-3.7)	1.4 (0.6-2.7)	0.01*
Transfusion (Units)	1.5 (0-3)	1.1 (0-3)	0.12
Postoperative hospital stay (day)	18.4 (7-54)	24.7 (13-89)	0.058

Values are presented as median (range).
**P*-values <0.05 were considered to represent statistically significant differences between groups.

Table 3. Clinical Outcomes after Last Follow-up

Outcome	Total hip arthroplasty	Bipolar hemiarthroplasty	*P*-value
HHS			
Post-operative	80.44±9.43	61.94±18.27	0.01†
Function*	35.52±4.30	29.52±10.71	0.01†
Pain	36.94±5.89	29.33±10.39	0.01†
Deformity	4.46±0.56	4.31±0.63	0.17
Motion	3.44±0.61	3.11±0.73	0.04†
Pre-operative			
Function*	38.38±4.17	34.73±10.76	0.01†
Function* change (pre-post)	2.76±3.07	5.21±3.99	0.01†
Koval grade			
Preoperative (A)	1.79±0.80	2.17±1.70	0.01†
Postoperative (B)	2.47±0.86	3.18±1.71	0.01†
Change (A-B)	0.67±0.84	0.95±1.23	0.17

Values are presented as mean±standard deviation.
*Function pertains to Harris hip score questions regarding support, distance walked, limp, activities, stairs, public transportation, and sitting.
† *P*-values <0.05 were considered to represent statistically significant differences between groups.

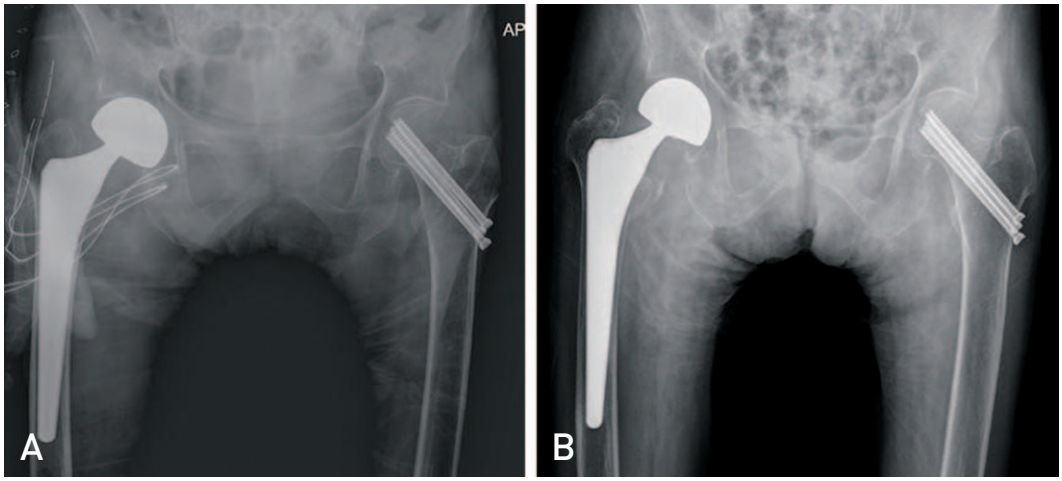

Fig. 1. (A) An 87-year-old woman (T-score, –4.6) with a displaced femoral neck fracture who had undergone a bipolar hemiarthroplasty using a cementless implant. (B) On anteroposterior radiographs obtained 2 years postoperatively, the implant is well fixed with a stable bone ingrowth.

one case (1.4%) on the sixth postoperative week. This patient rejected revision surgery and is currently under follow-up with wheelchair ambulation only. Excluding this case, all patients demonstrated bony ingrowth fixation of implants at the final follow-up (Fig. 1).

Intra-operative femoral cracks occurred during femoral stem fixation in 3 cases (3.4%) and were treated with cerclage wire fixation (Fig. 2). Dislocation as a postoperative complication was not observed in any case, and no revision surgeries were conducted. Ectopic bone formation of Brooker grade I was detected in 2 cases. Deep infection was not observed in any case, although other complications, such as pneumonia and deep vein thrombosis, were noted in 10 cases and one case, respectively (Table 4).

DISCUSSION

Lee et al.[8] have previously reported the achievement of satisfactory outcomes from BHA with a cementless femoral stem in patients with femur neck fractures. A survival rate of 98.6% was shown using the same femoral stem without any specific complications in the current study, with the exception of a case (1.4%) of

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Table 4. Postoperative Complications

Complication	Total	Total hip arthroplasty	Bipolar hemiarthroplasty
Dislocation	0		
Infection	1		
Superficial	1		1
Deep	0		
Revision surgery	0		
Pneumonia	10	3	7
Deep vein thrombosis	1	1	
Implant loosening	1		1
Intraoperative femoral crack	3	1	2

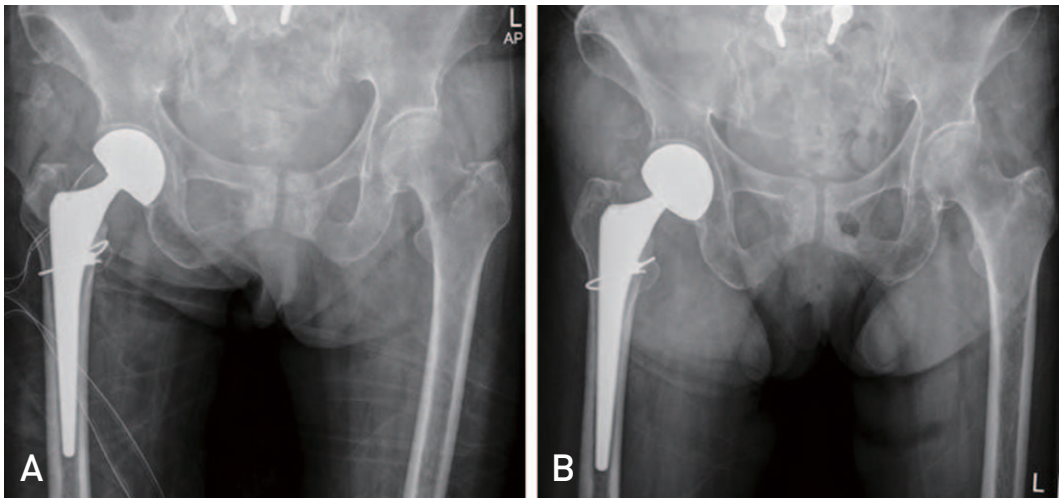

Fig. 2. (**A**) A 74-year-old woman with a displaced femoral neck fracture who had undergone a bipolar hemiarthroplasty using a cementless stem. An intraoperative femoral crack was treated using Dall-Miles cable. (**B**) On anteroposterior radiographs obtained 2 years postoperatively, the stem is well fixed.

femoral stem loosening. Although cementless arthroplasty has been associated with difficulty in achieving early stability, bone resorption, and other problems as compared to cemented arthroplasty, it remains a commonly applied procedure due to the advantages of short operation times and low rates of cardiovascular complications[17-19]. The known complications of cementless hip arthroplasty include intraoperative periprosthetic fractures, weakening of the cortical bone due to stress shielding, micromotion of the femoral stem end, and thigh pain[11,20,21]. Although intraoperative femoral cracks were noted in 3 cases (3.4%) after femoral stem fixation for early stability in the current study, they were simple cracks associated with stability of the femoral stem and managed with cerclage wire fixation without any complications. However, the problem of increasing stem size was detected in elderly osteoporotic patients in the current study due to the nature of the tapered-wedge stems used to fix the femoral stems.

The controversy surrounding the superiority of either THA or BHA for elderly osteoporotic patients with femoral neck fractures has a long history. Since its introduction in 1974, bipolar arthroplasty has been widely used. However, Langan[22] reported that no movement of the acetabular cup was found in 86% of subjects in the first postoperative year after BHA, and wear of the acetabular components occurred due to the increased outer movement and decreased inner movement in the acetabular cup[18,19]. As the potential adverse effects of BHA have been addressed, several studies have investigated the advantages of THA over

BHA. Recent studies have reported that, despite a higher risk of early dislocation and longer operation times in THA as compared to BHA, there was an insignificant difference in complications between two groups[23-26]. Moreover, several studies have suggested the benefits of THA with respect to HHS and revision rates[23-27]. In the current study, changes in the functional items of the perioperative HHS were significantly more favorable in THA patients. Furthermore, the total HHS was significantly better in THA patients postoperatively. To account for between-group differences in compliance and early functioning, changes in the functional items of the pre- and postoperative HHS were compared. The results for patients who underwent THA were significantly better using this approach. Thus, THA may be considered as more beneficial in patients with good compliance.

None of the patients in either group showed postoperative dislocations. This may be attributable to the adoption of surgical procedures using an anterolateral approach, consistent postoperative education for patients, abduction pillow use in the ward, and bed confinement for 3 months, all of which have lowered the incidence of dislocation in the hip.

The current study had several limitations. The answers to questions asked during a 24-month follow-up may be inaccurate in elderly patients with dementia in a retrospective study. Additionally, the complications experienced by patients who were unable to be followed-up were excluded. Furthermore, good compliance and the systemic state of patients may have caused selection errors in the comparison of the two groups. Lastly, meaningful comparisons are difficult due to the relatively small sample size.

CONCLUSION

The early (24-month) follow-up results of cementless HA for femoral neck fractures in elderly patients with osteoporosis were satisfactory. Although objective comparisons were difficult due to differences in patient selection between the THA and BHA groups, THA showed more favorable results in functional changes in the pre- and postoperative HHS of patients who underwent THA. Routine follow-up is warranted to improve the long-term survival rate of cementless THA, and further studies comparing the long-term outcomes between the two different HAs are essential.

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