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Cementless bipolar hemiarthroplasty for unstable intertrochanteric fractures in octogenarians

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Objective: The aim of this study was to evaluate the clinical and radiographic outcomes of bipolar hemiarthroplasty with cementless stem for the unstable intertrochanteric fracture in octogenarians and to determine the influencing factors associated with subsidence of the stem.

Methods: The study included the 143 hips of 139 patients (119 females, 20 males). Mean follow-up period was 3.8 (range: 2.2 to 9.0) years. The displaced lesser trochanteric fragment was reduced anatomically and fixed with 16-gauge stainless steel cerclage wire. Clinical outcomes included Harris Hip Score (HHS), thigh pain, groin pain and walking ability. Radiographic outcomes included stem fixation and stability, osteolysis, heterotopic ossification and subsidence. The stable reduction group was determined when anatomic reduction of posteromedial fragments was achieved with ≤1 mm gap of fragment.

Results: Mean HHS was 82 (range: 78 to 99) at the final follow-up. Thirty-one hips (21.7%) experienced thigh pain and 19 (13.3%) groin pain. One hundred and twelve patients (80.6%) regained their pre-injury level of ambulation. All femoral stems showed osseointegration without aseptic loosening and osteolysis. The mean stem subsidence was 3.1±2.4 (range: 0 to 18) mm. The extent of subsidence was significantly higher in patients with unstable reduction. The survival rate was 94.2%.

Conclusion: Cementless bipolar hemiarthroplasty appears to be a suitable method for the treatment of intertrochanteric fracture in octogenarians. However, stable fixation of the posteromedial fragment is necessary to avoid stem subsidence.

Key words: Hemiarthroplasty; intertrochanteric fracture; octogenarians; osteoporosis.

Intertrochanteric fractures occur frequently in elderly patients with osteoporosis. Due to the high prevalence of cardiovascular and pulmonary comorbidities, surgery of intertrochanteric fractures in these patients is extremely challenging and is thought to account for the majority of direct medical costs to the community worldwide.[1]

The treatment of choice for intertrochanteric fractures is osteosynthesis. An accurately reduced and stable fracture can be expected to have an excellent union rate of up to 100%. Conversely, unstable fracture types, poor surgical technique and incorrect choice of implant have been associated with failure, which often leads to profound functional disability and pain, may increase patient death.[2] Consequently, primary bipolar hemiarthroplasty has been recommended as the treatment of choice for intertrochanteric fracture in elderly patients.[3-5]

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Use of cementless stems avoids problems related with the polymethylmethacrylate (PMMA) or bone cement.[6,7] Nonetheless, achieving sufficient stem stability in osteoporotic bone is difficult due to the stove-pipe shape of the femoral canal, the fact that the fracture is usually severely comminuted, and eventually, stable fixation of cementless stem is difficult, leading to stem subsidence.[8] Excessive subsidence results in leg length discrepancy, dislocation and stem loosening, all of which contribute to poor surgery outcomes.

The purpose of this study was to evaluate the clinical and radiographic outcomes and to determine the influencing factors associated with subsidence of stem in the treatment of unstable intertrochanteric fracture in octogenarians using bipolar hemiarthroplasty with cementless stem.

Patients and methods

Of 184 octogenarians admitted with an intertrochanteric femoral fracture between March 2001 and April 2009, 161 underwent cementless bipolar hemiarthroplasty. Fourteen patients died and 8 were lost to follow-up. This study included 139 patients (20 males, 119 females) who underwent 143 hip hemiarthroplasties. Mean age at the time of surgery was 84.9 (range: 80 to 97) years, mean height 154.0 (range: 143 to 165) cm, mean weight 51.1 (range: 38 to 65) kg, and mean BMI 21.5 (range: 16.0 to 28.4) kg/m2. All patients had osteoporosis, with a mean T-score of total femur BMD of -3.6 (range: -2.5 to -4.9). Pre-injury ambulatory ability was scored according to Koval's classification (Table 1).[9] Mean follow-up period was 3.8 (range: 2.2 to 9.0) years.

All surgeries were carried out by two surgeons (IYC, YHK). The ABG II® stem (Stryker, Caen, France) was used in 72 hips, the Versys® (Zimmer Inc., Warsaw, IN, USA) in 59 and the SL-PLUS® (Plus Orthopaedics AG, Rotkreutz, Switzerland) in 12.

Procedures were performed by a standard posterolateral approach. The gluteus maximus tendon insertion was partially released. A 16-gauge stainless steel wire was passed through this portal around the lesser trochanter and tightened carefully while maintaining the anatomic position of the lesser trochanter. The endosteal cavity of the proximal femur was gradually shaped by rasping to match the exact shape of the femoral stem and the stem was firmly fitted into the canal. Finally, the cerclage wires were tightened to fix the fracture fragment onto the stem. Multiple wire sutures or cortical screws were used to reduce and fix the greater trochanteric fragment.

For rehabilitation, passive range of motion exercise of hip and knee were started at the 1st postoperative day and patients were permitted tolerable weight-bearing using a walker at the 2nd postoperative week.

Clinical and radiographic evaluations were performed by two observers (YSK, JKM) who did not participate in the surgery. For clinical outcomes, operation time, blood loss, the quantity of blood transfusion and duration of hospitalization were included. In addition, Harris Hip Score (HHS),[10] thigh pain, groin pain, time of walking with full weight-bearing and walking ability according to Koval's classification[9] were investigated.

Table 1. Ambulatory ability of the patients before injury and at final follow-up.

		Categories of ambulation at the final follow-up							
		1)	2)	3)	4)	5)	6)	7)	Total
Categories of pre-injury ambulation	1)	46	5	0	0	0	0	0	51
	2)		44	10	2	0	0	0	56
	3)			9	4	3	0	0	16
	4)				8	1	0	1	10
	5)					4	0	0	4
	6)						1	1	2
	7)							0	0
Total	46	49	19	14	8	2	2	139	

Categories of ambulation according to Koval.[9]
1) Independent community ambulator
2) Community ambulator with cane
3) Community ambulator with walker or crutches
4) Independent household ambulator
5) Household ambulator with cane
6) Household ambulator with walker or crutches
7) Non-functional ambulator

For radiographic outcomes, pelvis anteroposterior (AP) radiographs were obtained preoperatively, immediately after the surgery, and at the final follow-up. Fixation and stability of the stem, osteolysis, early stem subsidence and heterotopic ossification were investigated. Stability of the femoral component was classified using the method of Engh et al.[11] Osteolytic lesions were classified according to the criteria of Engh et al.[12] and the location in seven zones as described by Gruen et al. was recorded.[13] Subsidence of the femoral stem was defined as a change in the distance from the superolateral edge at the shoulder of the prosthesis to the tip of the greater trochanter on the AP radiograph of the hip, and subsidence of greater than 3 mm was classified as a subsided stem.[14] Heterotopic ossification was classified according to Brooker et al.[15] The stable reduction group was determined when anatomic reduction of posteromedial fragments was achieved with ≤1 mm gap of fragment. Otherwise, the unstable reduction group was determined.

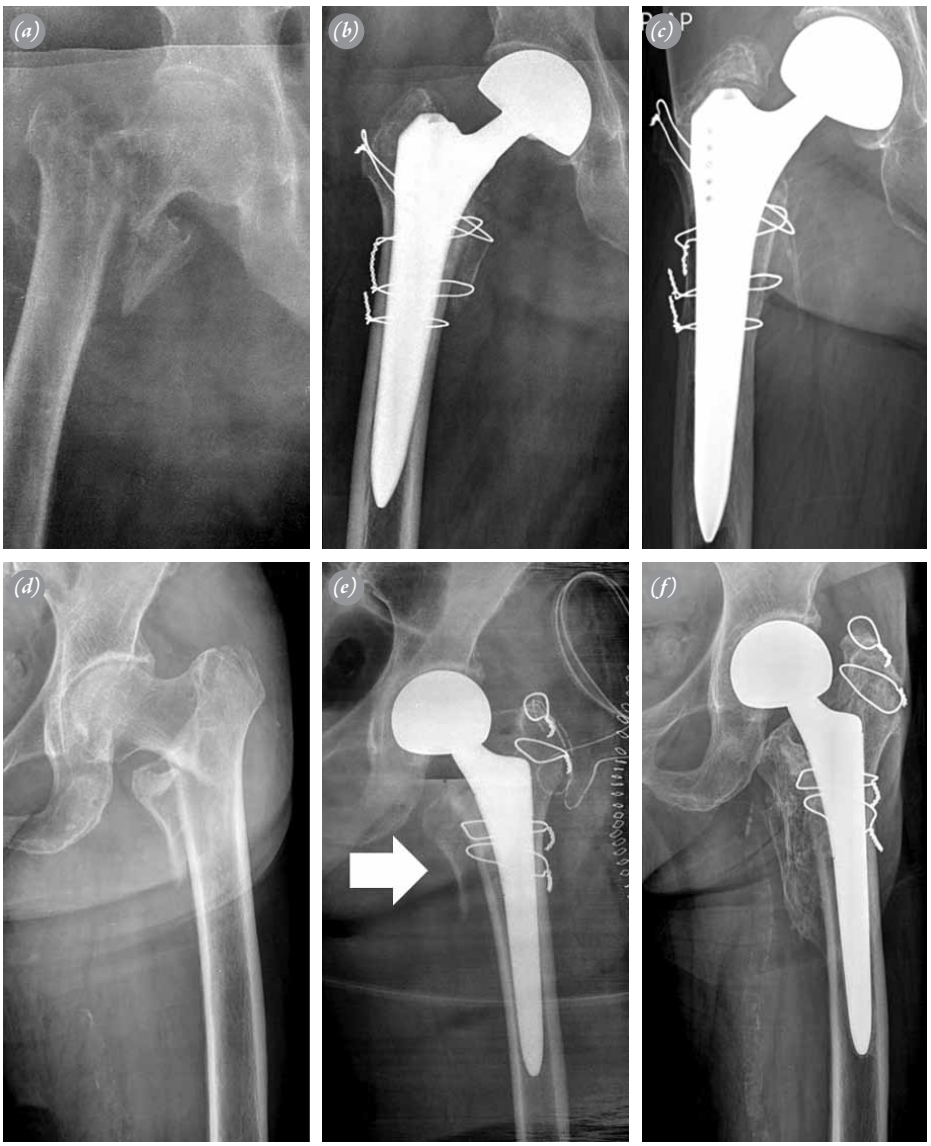

Fig. 1. **(a)** An unstable intertrochanteric fracture in an 81-year-old female patient. **(b)** AP radiograph obtained 2 weeks after surgery shows stable reduction of the posteromedial fragment and stable fixation of the stem. **(c)** Five years postoperatively the stem remains stable, with osseointegration around the stem. **(d)** A sustained unstable intertrochanteric fracture in an 83-year-old female patient. **(e)** Anteroposterior radiograph obtained immediately after surgery shows failed fixation of the posteromedial fragment (arrow). **(f)** Four years postoperatively, 11 mm subsidence of the femoral stem is observed. However, fracture union is achieved and the femoral stem remains stable.

Table 2. Stem subsidence according to stability of the posteromedial fragment reduction including the lesser trochanter.

Variables	Groups		p
	Stable reduction (n=107)	Unstable reduction (n=36)	
Sex			
Male	23	12	0.180
Female	84	23	
Age (years)	84.9±3.5	85.1±3.7	0.784
Height (cm)	154.2±6.2	153.7±5.2	0.848
Weight (kg)	52.2±9.1	49.0±8.0	0.341
Body mass index (kg/m^2)	21.9±3.2	20.7±3.3	0.356
Bone mineral density (T-score)	-3.5±1.3	-3.7±0.8	0.352
Implant (hips)			
ABG II®	51	21	0.289
Versys®	45	14	
SL-PLUS®	11	1	
Harris Hip Score	82.3	81.9	0.781
Groin pain (hips)	13	60	0.571
Thigh pain (hips)	19	12	0.062
>3 mm subsidence (hips)	23	23	<0.001
Subsidence (mm)	2.5±1.7	4.8±3.4	<0.001

SPSS v.18.0 (SPSS Inc., Chicago, IL, USA) software was used for data management and statistical analysis. Categorical variables were analyzed using the chi-square test, and continuous variables using two-tailed Student's t-tests. Kaplan-Meier survivorship analysis was performed.[16] P values of <0.05 were considered significant.

Results

Mean operation time was 54.3±12.8 min. The average blood loss was 247.9±82.4 ml and average quantity of blood transfusion was 1.6 (range: 0 to 4) units. The mean duration of hospitalization was 18.7±5.6 days.

Mean HHS was 82 (range: 78 to 99) at the final follow-up. Thirty-one hips (21.7%) experienced thigh pain and 19 hips (13.3%) groin pain; all cases were mild and managed with medication. Pre-injury level of ambulation was achieved in 112 patients (80.6%) (Table 1). In terms of medical complications, 2 patients (1.4%) were bed ridden, 3 (2.2%) suffered deep vein thrombosis treated with medication and 1 (0.7%) complained of a superficial coccyx sore, treated with dressing. There were 6 intraoperative periprosthetic fractures (4.3%) and 1 periprosthetic fracture (0.7%) at the 3rd postoperative year. One patient (0.7%) developed a superficial infection and intravenous antibiotics were administered and another (0.7%) a deep infection, treated by a revision. There were no dislocations.

All femoral components showed osseointegration and no aseptic loosening or osteolysis occurred (Fig. 1a-c). Stable reduction was determined in 107 patients and unstable in 36. There were no significant differences in terms of demographic data and clinical outcomes between patients with stable and unstable reductions. However, a greater frequency of subsided stems and greater subsidence were determined in patients with unstable reductions (Table 2 and Fig. 1d-f).

During the follow-up period, two reoperations were performed due to deep infection and periprosthetic fracture. Using revision for any reason as the endpoint, the 9-year rate of survival was 94.2% (95% CI: 93.5% to 94.9%) (Fig. 2).

Discussion

For several decades, the treatment of choice for unstable intertrochanteric fractures in elderly patients has been osteosynthesis with internal fixation. However, osteosynthesis of such fractures in the elderly requires a long period of non-weight-bearing and is associated with loss of fixation, nonunion and cut out of the lag screw.[17] As a result, the frequency of arthroplasty in these cases has increased and many authors have reported favorable outcomes (Table 3).[6,18-23]

Haentjens et al. investigated the clinical outcomes of internal fixation compared with bipolar hemiarthro-

Table 3. Outcomes of bipolar hemiarthroplasty for intertrochanteric fractures.

Study	No. of hips	Type of femoral stem	Mean age (years)	Mean follow-up (months)	Harris Hip Score	Survival rate - loosening of implant (%)	Survival rate - any reasons (%)	Mean stem subsidence (mm)	Dislo-cation (%)	Deep infection (%)
Fan et al.[22]	72	Cemented	76.5	39.7	74.6	95.8	–	–	0	–
Tang et al.[27]	96	Cemented	81.1	44.2	80.2	–	–	–	1.3	0.6
Lee et al.[3]	61	Cementless	81.1	38.4	–	100	96.7	–	3.3	3.3
Sancheti et al.[23]	37	Cemented	77.1	24.5	84.8	–	–	–	0	0
Choy et al.[28]	40	Cementless	78.8	40.5	80.6	100	100	–	0	0
Kayali et al.[20]	42	Cementless	75	24	–	–	–	10.7	0	0
Current study	143	Cementless	84.9	45.6	82	100	94.2	3.1	0	0.7

plasty and reported 75% satisfactory results and fewer postoperative complications in the arthroplasty group.[18] Kayali et al. compared the outcomes of 43 hemiarthroplasties and 45 internal fixations for unstable intertrochanteric fractures and concluded that, although the clinical outcomes were similar in the two groups, hemiarthroplasty patients had a lower postoperative complication rate and were able to bear weight sooner.[20] In our study, 81% of patients regained their pre-injury levels of ambulation. Moreover, despite the mild stem subsidence, all stems were stable at the final follow-up and there was no loosening or dislocation. Consequently, our results were similar to those of other studies.[3,18,20]

The posteromedial fragment in unstable intertrochanteric fractures has been emphasized as a key factor

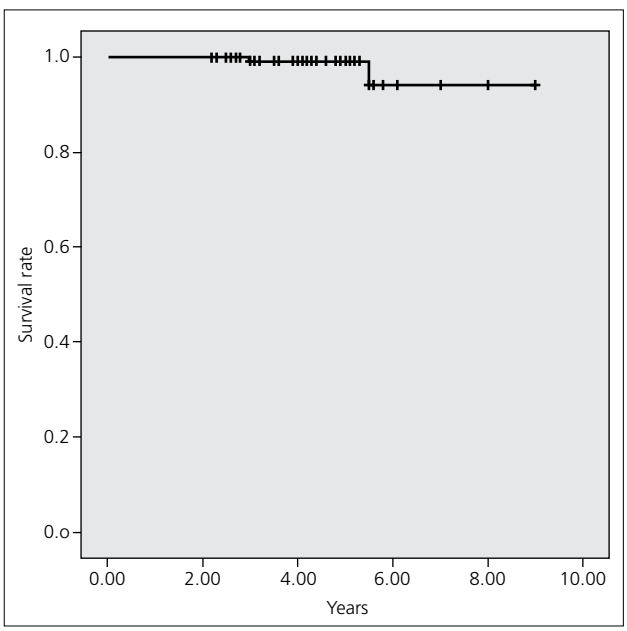

Fig. 2. Kaplan-Meier survivorship analysis. The 9-year survivorship rate was 94.2% (95% CI: 93.5% to 94.9%) using revision for any reason as the endpoint.

responsible for mechanical stability. In a study by Apel et al.,[24] the maximum load prior to loss of reduction was compared between different fixation methods. Anatomical reduction and fixation of the posteromedial fragment allowed the femur to resist an average maximum load 57% greater than when the fragment was excluded. As a result, the posteromedial fragment has been described as the keystone to mechanical stability in intertrochanteric femoral fractures. Our results were similar in that stability of the posteromedial reduction had a significant impact on the incidence of femoral stem subsidence, and instability was associated with larger subsidence. The posteromedial fragment in unstable intertrochanteric fractures, thus, seems to play an important role in achieving stability of fracture reduction and of the stem.

Subsidence of the femoral stem in intertrochanteric fractures has been previously reported. In a study by Bohm and Bischel, the average distance of stem migration was 5.9 mm and there was a positive correlation between migration and osteoporosis as well as and proximal femoral defects.[21] Weber et al. observed migration only in the first year and not after osseointegration.[25] In order to reduce stem subsidence, two possible methods should be considered. One involves using calcar replacement prosthesis to fill the calcar defect. Stern and Angerman reported that 95 out of 105 patients were able to walk following bipolar hemiarthroplasty with calcar replacement for the treatment of intertrochanteric fractures, without subsidence of the femoral stem.[26] However, calcar replacement is a technically demanding procedure, calcar stems are not readily available and surgeons tend to be unfamiliar with them.[5] The other method is to reconstruct the calcar, with secure fixation of the posteromedial fragment. The advantages of this method include anatomical restoration of the fractured bone, familiarity to surgeons and secure fixation of the stem. Because the posteromedial fragment provides es-

sential resistance to axial loading and stem migration during osseointegration, the stem can migrate distally if the fragment is not stably fixed around the stem with cerclage wiring.

The retrospective design and the short follow-up period can be considered limitations of our study. However, long follow-ups are rarely possible in octogenarians and have limited clinical relevance considering the remaining life expectancy. Additionally, the current study does not compare internal fixation with hemiarthroplasty, or cemented with cementless stems. Due to the risk of fixation failure or nonunion in octogenarians and the subsequent need to revise to hemiarthroplasty and the risk of cement-related fatal cardiovascular complications, only cementless hemiarthroplasty was performed in our hospital for unstable intertrochanteric fractures in octogenarians.

In conclusion, bipolar hemiarthroplasty can be recommended for the treatment of intertrochanteric fractures in octogenarians. However, stable fixation of posteromedial fragment is necessary to avoid the femoral stem subsidence.

Conflicts of Interest: No conflicts declared.

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