Int J Burn Trauma 2023;13(3):126-135
www.IJBT.org /ISSN:2160-2026/IJBT0149351

Original Article

Uncemented hemiarthroplasty may have a role in the treatment of unstable intertrochanteric fractures in elderly patient. A survival complications and functional outcomes analysis

Luca Andriollo[1,2], Rudy Sangaletti[1,3], Lorenzo Are[1,2], Loris Perticarini[3], Francesco Benazzo[3,4], Stefano Marco Paolo Rossi[3]

[1]U.O.C Ortopedia e Traumatologia, Fondazione Poliambulanza, Via Bissolati 57, 25124, Brescia, Italy; [2]Università Cattolica del Sacro Cuore, 00185, Roma, Italy; [3]Sezione di Chirurgia Protesica ad Indirizzo Robotico - Unità di Traumatologia dello Sport, U.O.C Ortopedia e Traumatologia, Fondazione Poliambulanza, Via Bissolati 57, 25124, Brescia, Italy; [4]IUSS Istituto Universitario di Studi Superiori, 27100, Pavia, Italy

Received January 28, 2023; Accepted June 6, 2023; Epub June 15, 2023; Published June 30, 2023

Abstract: Background: Fractures of the proximal femur account for 30% of all fractures requiring surgical treatment. The optimal treatment for per- and intertrochanteric fractures, particularly associated with trochanter instability, is still open to debate. For these reasons, some authors have recently supported the use of bipolar arthroplasty or hemiarthroplasty as a treatment capable of reducing the risk of complications and obtaining a better functional result. The purpose of this study was to evaluate the functional and clinical outcomes at minimum six months of follow up of bipolar hemiarthroplasty as the primary treatment for intertrochanteric fracture in older patients. A secondary objective was to study the risk of early and intraoperative complications. Methods: From November 2020 to April 2022, 102 patients with lateral proximal femur fracture underwent surgical operation with implant of a long-stemmed bipolar hemiarthroplasty. 86 patients were enrolled. The average age at the time of fracture was 87.4 ± 4.6 (range 77-98) years. Of the patients, 76.7% were female. For all patients intra- and perioperative data were extracted. All available patients were evaluated at a minimum 6-months follow-up to investigate: Charlson Comorbidity Index, autonomy (Barthel Index), use of walking aids (Koval Grade), memory quality or dementia (Mental Score), subsequent hospitalizations for surgical operations relating to the operated hip. Results: The average time from trauma to surgery was 1 ± 0.7 days. The surgical time was 78.9 ± 21.9 minutes. At least one cerclage was used in 73.3% of patients. 87.5% of patients were verticalized on the first day. The average hospitalization time was 5.5 ± 2.9 days. During follow-up 20 deaths occurred, with a distance to surgery of 6.6 ± 7.2 (range 0.3-22.7) months. Six months after surgery, out of 86 patients, 12 deaths occurred, corresponding to 13.95%. 12 months after surgery, out of 57 patients, 15 deaths occurred, corresponding to 26.31%. Conclusions: Long stemmed bipolar hemiarthroplasty following intertrochanteric fracture can be considered a safe procedure, especially in patients over 80 with associated comorbidities and short life expectancy.

Keywords: Intertrochanteric fracture, proximal femur fracture, trochanter instability, bipolar hemiarthroplasty

Introduction

Fractures of the proximal femur account for 30% of all fractures requiring surgical treatment [1].

The general population is ageing, leading to an increase in osteopenic-associated fractures, primarily proximal femur fractures requiring urgent treatment [1]. Although there is widespread consensus on the treatment of medial femur fractures in elderly patients, the optimal treatment for per- and intertrochanteric fractures, particularly associated with trochanter instability, is still open to debate [2-5]. The goal of surgical treatment in all fractures of the proximal femur in the elderly is the achievement of a stable osteosynthesis that allows complete early mobilization of the patient and walking with full weight bearing; prolonged immobiliza-

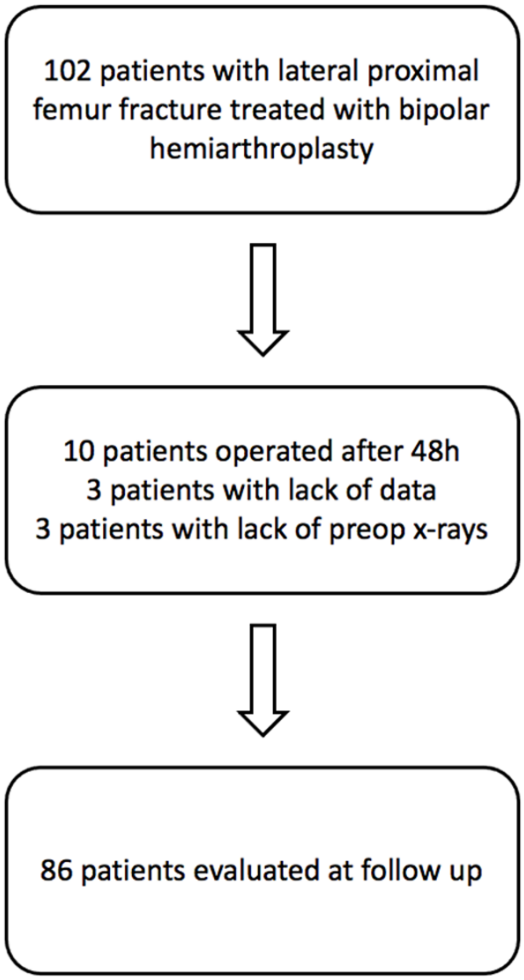

Figure 1. Patients flow chart.

tion has been shown to be correlated with increased mortality [6].

Closed reduction and osteosynthesis is the solution most frequently chosen by orthopedic surgeons. The choice of fixation devices is generally limited to the use of cephalomedullary nails or sliding hip screws, the former representing the most widely used in the treatment of lateral fractures of the femoral neck, although not all authors agree in their superiority over sliding hip screws in terms of fixation failure rate [1].

The treatment of intertrochanteric fractures, AO/ASIF 31-A1 or 31-A2, in the elderly patient is still controversial [7], especially for comminuted fractures in patients with advanced osteoporosis. Another issue is represented by the coexisting presence of hip osteoarthritis, which affects recovery times and functional results of the joints treated by osteosynthesis. The conditions illustrated make it difficult to obtain a stable fixation and a good reduction of the fracture, and are therefore risk factors for failure which in the literature approaches 50% [8]. For these reasons, some authors have recently supported the use of bipolar arthroplasty or hemiarthroplasty as a treatment capable of reducing the risk of complications and obtaining a better functional result [8, 9].

However, prosthetic replacement for lateral (extracapsular) femoral fractures is rarely performed, especially when compared to femoral neck (intracapsular) fractures. The vascular supply of the femoral head is not compromised and the prosthetic replacement for these fractures is often technically a challenge [3, 10, 11]. Long stemmed implants are often required, and restitution of soft tissue tension and limb length is particularly challenging. In addition, increased intraoperative blood loss, postoperative morbidity and mortality can be expected. Despite these premises, several authors have found a low complication rate and an excellent functional recovery [9, 10, 12, 13].

The purpose of this study was to evaluate the functional and clinical outcomes at minimum six months of follow up of bipolar hemiarthroplasty as the primary treatment for intertrochanteric fracture in older patients. A secondary objective was to study the risk of early and intraoperative complications.

Materials and methods

This retrospective study was conducted Considering only patients with at least 6 months of follow up, from November 2020 to April 2022 102 patients with lateral proximal femur fracture were treated. Inclusion criteria: lateral fracture of proximal femur (AO/ASIF 31-A1 or 31-A2), treated with bipolar hemiarthroplasty implantation, age greater than 75 years. Patients with periprosthetic fracture, pathological fractures, lack of data, lack of preoperative x-rays or operated after 48 h from trauma were excluded. 86 patients were enrolled (**Figure 1**).

For all patients, data on transfusion, postoperative complications, days of hospitalization, hemoglobin were evaluated, through a search from the medical record server.

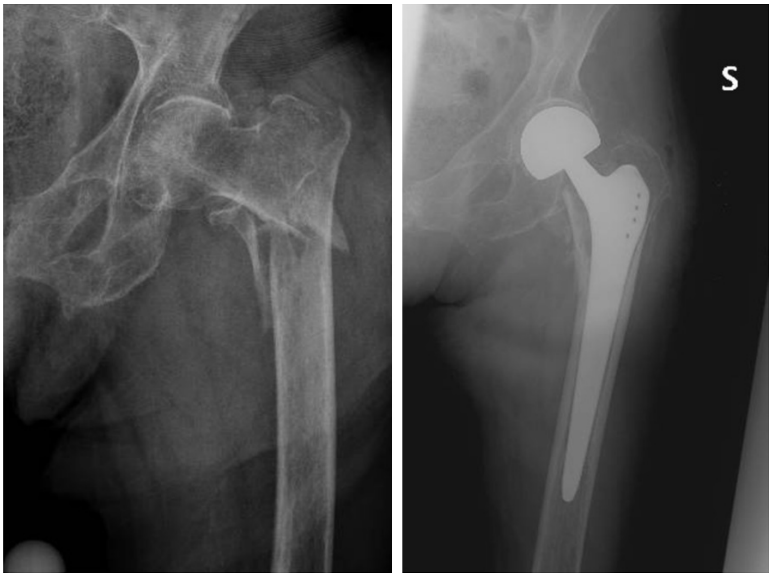

Figure 2. Bipolar hemiarthroplasty after trochanteric region fracture.

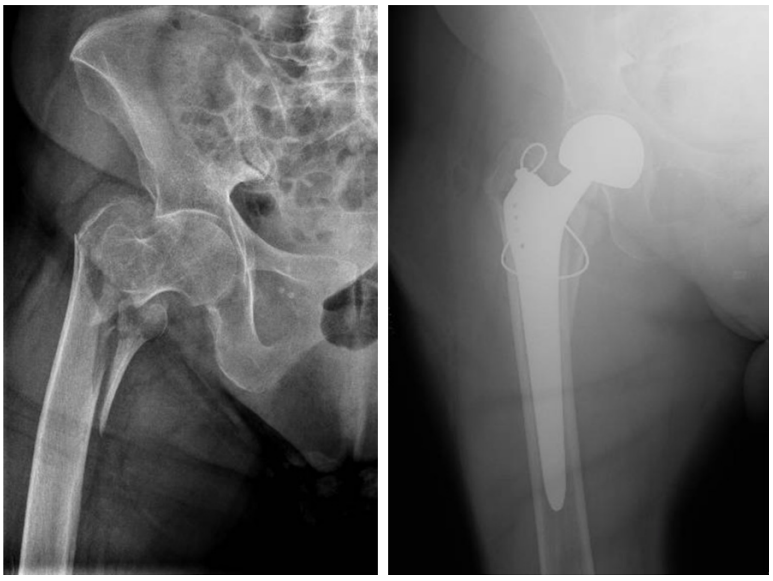

Figure 3. Bipolar hemiarthroplasty with cerclage after trochanteric region fracture.

Operative technique

The patient is positioned in decubitus contralateral to the fractured femur, with a posterior support positioned at the level of the sacrum and an anterior support at the level of the anterior superior iliac spine (ASIS). Skin disinfection is performed using 2% chlorhexidine digluconate and subsequently the sterile field is set up with disposable towels. The surgical approach performed is the posterolateral hip one with a longitudinal skin incision at the level of the posterior two-thirds of the trochanter and recovery of the piriformis tendon, of the triceps coxae and sparing of the joint capsule, when not injured in the traumatic act. Hip dislocation is performed with the aid of a corkscrew extractor. We proceed with the osteotomy, the preparation of the femoral canal with special broaches and the positioning of a trial implant with which we perform the articulation tests and establish the metry of the limbs. The implanted stem, Alloclassic® Zweymüller® SLL (Zimmer Biomet, Warsaw, IN), must be stable to ensure primary stability during fracture healing. The implant is completed by the use of a bipolar head with metal/polyethylene coupling. The next step is to obtain a satisfactory reduction of the trochanteric massif and to stabilize it, when deemed appropriate, trough cerclages Cable-Ready® Cable Grip System (Zimmer Biomet, Warsaw, IN), possibly positioned over the lesser trochanter in the medial region of the femoral neck and/or with a "figure eight" shape around to the greater trochanter. Capsulorrhaphy and reinsertion of the external rotators are performed if possible at the end of the procedure.

All patients received routine venous thromboembolism (VTE) prophylaxis with low-molecular-weight heparin for 4 weeks after surgery. Routine prophylactic antibiotics (cefazolin) was used perioperatively. In **Figure 2**, fracture treated using bipolar hemiarthroplasty. In **Figure 3**, fracture treated using bipolar hemiarthroplasty and cerclage.

Rehabilitation protocol

Postoperative rehabilitation protocols included immediate full weight-bearing protected by crutches during the first 4 weeks. Exercises were focused on immediate active flexion and extension. According to the routine of our

Table 1. Anamnestic data, ASA score and pre-trauma functional score

Patients (N)	86
Age (Y)	87.4 ± 4.6 (77-98)
BMI (Kg/m^2)	23.7 ± 4.27 (16.5-31.2)
Follow-up (M)	16.6 ± 5.5 (7.7-25.3)
Subject gender summarized by n (%)	
Female	66 (76.7)
Male	20 (23.3)
High demands on pre-trauma home care n (%)	49 (57.0)
ASA	2.8 ± 0.5 (2-4)
ASA 1 n (%)	0 (0)
ASA 2 n (%)	17 (19.8)
ASA 3 n (%)	62 (72.1)
ASA 4 n (%)	7 (8.1)
Hypertension N (%)	48 (55.8)
Chronic Respiratory Syndrome N (%)	14 (16.3)
History of Tumors N (%)	28 (32.6)
Neurological Strokes N (%)	11 (12.8)
Heart Attack N (%)	8 (9.3)
Depression N (%)	12 (14)
Dementia N (%)	26 (30.2)
Neurodegenerative Diseases N (%)	7 (8.1)
Chronic Renal Failure N (%)	14 (16.3)
Atrial Fibrillation N (%)	18 (20.9)
Diabetes Mellitus N (%)	16 (18.6)
Charlson Comorbidity Index	5.9 ± 1.7 (1-11)
Barthel Index	76 ± 20.04 (15-100)
Koval's walking ability grade	1.7 ± 1.16 (0-5)
Mental Score	0.7 ± 0.6 (0-2)

department, no movement restrictions were applied to patients operated using the PL approach.

Postoperative assessment

According to our protocol patients were evaluated at 3 months and at 1 year postoperative.

Anteroposterior radiographs of the pelvis and hip and a lateral radiograph were made at each follow-up visit. Stem subsidence and femoral component loosening were evaluated according to the criteria of Engh et al. [14]. All available patients were assessed to investigate: days of hospitalization in rehabilitation facilities, return to home, Charlson Comorbidity Index, Barthel Index, Koval's walking ability grade, Mental Score, hospitalizations for surgical operations relating to the operated hip. Charlson Comorbidity Index predicts the ten-year mortality for a patient who may have a range of comorbid conditions. The Barthel Index measures functional disability in 10 activities of daily living (ADLs) by quantifying patient performance. 5-point increments are used in scoring, with a maximal score of 100 indicating full independence in physical functioning whilst a lowest score of 0 indicating a patient with a complete bed-bound state. The Koval's walking ability grade is used to evaluate walking dependency according to seven categories: (1) independent community ambulator, (2) community ambulator with cane, (3) community ambulator with walker/crutches, (4) independent household ambulator, (5) household ambulator with cane, (6) household ambulator with walker/crutches, and (7) nonfunctional ambulator. The Mental Score for assessing elderly patients for the possibility of dementia. If a revision procedure or complication occurred, all relevant information on the revision procedure were collected. The scores were evaluated by our team of clinical doctors at the time of admission and reported in the medical record. At follow-up they were evaluated by telephone call, also with the collaboration of the patients family members.

Statistical analysis

Statistical analysis was performed with SPSS v18.0 (Chicago, IL, USA) by an independent statistician. Continuous variables were described using arithmetic mean and SD (standard deviation). Categorical variables were described using frequency distributions and percentages. Survival was analysed using the Kaplan-Meier methodology according to different end points with the associated 95% confidence intervals. The test of independence between the mortality and risk factors was analyzed using Chi-square. Biserial correlations were performed

Table 2. Intrahospitalization results

Time from trauma to surgery (day)	1 ± 0.7 (0-2)
0 day	21 (24.4)
1 day	47 (54.7)
2 days	18 (20.9)
Surgical time (min)	78.9 ± 21.9 (45-169)
Cerclage summarized by n (%)	
Yes	63 (73.3)
No	23 (26.7)
Anesthesia summarized by n (%)	
Spinal Anesthesia	79 (91.9)
General Anesthesia	7 (8.1)
Hb preoperative (g/L)	11.8 ± 1.4 (8.4-14.7)
Hb day 1 (g/L)	9.4 ± 1.1 (6.9-12.2)
Hb at discharge (g/L)	9.2 ± 0.7 (7.3-11.8)
Transfusion of Packed Red Cells n (%)	52 (60.5)
Assisted verticalization n (%)	83 (96.5)
1st day	75 (87.2)
2nd day	7 (8.1)
3rd day	1 (1.2)
No verticalization	3 (3.5)
Days of hospitalization	5.5 ± 2.9 (2-22)

using Two-tailed test. P<0.05 was considered with significant difference.

The study was performed in accordance with the ethical standards in the 1964 Declaration of Helsinki and with the HIPAA regulation. The Institutional Review Board (IRB) of the author's institution defined this study as exempt from IRB approval (prospective study on a well-established surgical procedure and commercialized insert).

Level of Evidence IV: cohort studies.

Results

Anamnestic data

In this study, 86 patients were analysed, including 66 women (76.7%) and 20 men (23.3%). The average age was 87.4 ± 4.6 (range 77-98) years. The average follow-up was 16.6 ± 5.5 (range 7.7-25.3) months. Of these patients, 49 (57%) had high demands on pre-trauma home care.

The main pathologies present in the anamnesis were investigated, summarized in **Table 1**. The ASA score was also evaluated, which presented an average value of 2.8 ± 0.5 (range 2-4), with complete data represented in **Table 1**. The Charlson Comorbidity Index had an average score of 5.9 ± 1.7 (range 1-11). **Table 1** also reports data of the preoperative scores investigated: Barthel Index, Koval's walking ability grade and mental score.

Perioperative results

The average time from trauma to surgery was 1 ± 0.7 (range 0-2) days. The surgical time was 78.9 ± 21.9 (range 45-169) minutes. At least one cerclage was used in 63 (73.3%) patients. 79 (91.9%) patients underwent spinal anesthesia. Preoperative hemoglobin was 11.8 ± 1.4 (range 8.4-14.7) g/L, first day postoperative hemoglobin was 9.4 ± 1.1 (range 6.9-12.2) g/L and discharge hemoglobin was 9.2 ± 0.7 (range 7.3-11.8) g/L. 52 (60.5%) patients were transfused with Packed Red Cells.

75 (87.5%) patients were verticalized on the first day. The average hospitalization time was 5.5 ± 2.9 (range 2-22) days. Complete results are summarized in **Table 2**.

Postoperative results

Postoperative results, including clinical outcomes, are presented in **Table 3**. During hospitalization, 7 (8.1%) patients presented complications: 1 (1.16%) death, 1 (1.16%) dislocation, 2 (2.3%) Sars-CoV-2 positive test, 1 (1.16%) common peroneal nerve dysfunction, 1 (1.16%) bowel obstruction and 2 (2.3%) urinary tract infection (UTI). After discharge, 74 (86.1%) were transferred to community-based rehabilitation, with a stay of 24.8 ± 16.6 (range 3-90) days.

During the follow-up, 16 (18.6%) patients were readmitted to hospital, only in 3 (3.48%) cases due to orthopedic complications: 1 (1.16%) luxation, 1 (1.16%) local hematoma and 1 (1.16%) prosthetic joint infection (PJI). During follow-up 20 (23.3%) deaths occurred, with a distance to surgery of 6.6 ± 7.2 (range 0.3-22.7) months.

Comparing the investigated scores (Barthel, Koval and Mental) between pre-operative and at the time of follow-up, a statistically significant difference emerged with *p* value <0.05 in all scores, with: 1) decrease of Barthel Index,

Table 3. Post-operative data and outcome

Complication rate during hospitalization N (%)	7 (8.1)		
Death N (%)	1 (1.16)		
Disclocation N (%)	1 (1.16)		
Covid N (%)	2 (2.32)		
Common peroneal nerve dysfunction N (%)	1 (1.16)		
Bowel obstruction N (%)	1 (1.16)		
UTI N (%)	2 (2.32)		
Community-based rehabilitation N (%)	74 (86.1)		
Community-based rehabilitation (days)	24.8 ± 16.6 (3-90)		
Reospitalization rate N (%)	16 (18.6)		
Reospitalization rate for orthopedic complications N (%)	3 (3.48)		
Dislocation N (%)	1 (1.16)		
Local hematoma N (%)	1 (1.16)		
PJI N (%)	1 (1.16)		
Death N (%)	20 (23.3)		
Death (time) months	6.6 ± 7.2 (0.3-22.7)		
Death N (%) - 6 months	12/86 (13.95)		
Death N (%) - 12 months	15/57 (26.31)		
Death N (%) - 18 months	8/27 (29.62)		
	Pre-Op	Post-Op	*p* value
Barthel Index	76 ± 20.04 (15-100)	54.1 ± 23.7 (10-95)	<0.05
Koval's walking ability grade	1.7 ± 1.16 (0-5)	3.2 ± 2.1 (1-7)	<0.05
Mental Score	0.7 ± 0.6 (0-2)	0.9 ± 0.8 (0-2)	<0.05

Table 4. Risk factors analyzed using Chi-square test

	Hypertension		Chronic respiratory sindrome		History of tumors		Neurological strokes	
	No (N)	Yes (N)	No (N)	Yes (N)	No (N)	Yes (N)	No (N)	Yes (N)
Alive (N)	30	36	56	10	44	22	58	8
Dead (N)	8	12	16	4	14	6	17	3
p value	0.705		0.710		0.719		0.858	
	Depression		Dementia		Chronic renal failure		Atrial fibrillation	
	No (N)	Yes (N)	No (N)	Yes (N)	No (N)	Yes (N)	No (N)	Yes (N)
Alive (N)	56	10	47	19	57	10	55	11
Dead (N)	18	2	13	7	15	4	13	7
p value	0.479871209		0.569		0.295		0.105	
	Diabetes mellitus		Male		Heart attack		Neurodegenerative disease	
	No (N)	Yes (N)	No (N)	Yes (N)	No (N)	Yes (N)	No (N)	Yes (N)
Alive (N)	52	14	56	10	61	5	61	5
Dead (N)	18	2	10	10	17	3	18	2
p value	0.270		0.001		0.306		0.681	

meaning a less autonomy in daily life actions, 2) increase of Koval's walking ability grade, meaning a greater need for walking aids, 3) increase of Mental Score, meaning worsening memory/dementia.

Table 4 shows the tests of independence between the mortality and risk factors. **Table 5** shows biserial correlations. A statistically significant difference was found only in males, with *p* value 0.001. Six months after surgery,

Table 5. Correlations analyzed using two-tailed test

	p value
Time from trauma to surgery	0.940
Mental Score pre-op	0.780
Koval's walking ability grade pre-op	0.321
Barthel Index pre-op	0.366
Charlson Comorbidity Index	0.109
Community-based rehabilitation (days)	0.446
Surgical time (min)	0.641
Hb at discharge	0.537
Hb preoperative	0.277
Hb day 1	0.716
Age (Y)	0.958

out of 86 patients, 12 deaths occurred, corresponding to 13.95%. 12 months after surgery, out of 57 patients, 15 deaths occurred, corresponding to 26.31%. 18 months after surgery, out of 27 patients, 8 deaths occurred, corresponding to 29.62% (**Table 3**).

With permanence alive as an endpoint Kaplan-Meier survival estimate shows a survival rate of 82.6% at 8 months (**Figure 4**).

Discussion

Internal fixation with an intramedullary nail remains today the treatment of choice in undisplaced lateral fractures of the proximal femur. The treatment of displaced fractures is still currently debated in the literature. The use of intramedullary nails or dynamic hip screws may require long periods of non-weight-bearing and complications such as loss of fixation, nonunion, and lag screw cutout [15-18]. The use of hemiarthroplasty has been suggested in order to allow early loading and to prevent complications due to proximal femur collapse [19-22].

In this study, the use of bipolar hemiarthroplasty in displaced lateral femoral fractures of elderly patients was investigated. This type of treatment was effective and reproducible in our cohort of patients, with a low rate of short-term intra- and post-operative complications related to surgery. The main advantage in clinical practice was the possibility of verticalizing patients quickly and with low number of complications and postoperative morbidity, regardless of the level of comminution or displacement of the fracture, especially in patients with low pre-fracture functional levels.

In the authors' clinical experience, hemiarthroplasty in lateral femoral neck fractures can be performed by expert surgeons or younger surgeons with experience in hip replacement, suitably supported, with a relatively short learning curve. The surgeon's skill consists in obtaining a satisfactory reduction of the trochanteric massif, particularly of the postero-medial cortex and in placing, if necessary, one or more cerclages in the most suitable position for maintaining the reduction during the subsequent broaching.

The use of one or more cerclages in 73.3% of patients accounts for the need to use additional fixation devices to obtain an acceptable reduction of the trochanteric massif in displaced fractures. Anatomical reduction and fixation of the posteromedial fragment are in fact fundamental to guarantee the mechanical stability of the femur following a pertrochanteric fracture [23]. The use of transverse cerclages, preceeding femoral stem placement, may also help to prevent intraoperative periprosthetic fractures in some intertrochanteric fracture patterns [24].

The use of cemented stems in elderly osteoporotic patients is associated with increased cardiopulmonary complications, increased blood loss, and increased operative times compared to uncemented stems [25]. Lee et al. [26], in a study of 2019 on 234 patients undergoing HA with uncemented stems on intertrochanteric fracture, reported a 4.3% postoperative orthopedic complication rate. Intraoperatively they reported 10 periprosthetic fractures caused by distal extension of the trochanteric fracture. No intraoperative periprosthetic fractures was reported in our series. The orthopedic complications that occurred during hospitalization were dislocation (non-surgically reduced) and dysfunction of the common peroneal nerve.

In this series, the rehospitalization rate was 18.6% (16 patients). Of these, 3 (3.48%) were readmitted due to orthopaedic complications: 1 dislocation, 1 local hematoma and 1 deep infection. These numbers look comparable to those reported in the literature for both intertrochanteric fractures followed by HA and femoral nailing [26-28]. In contrast, in a 2015 com-

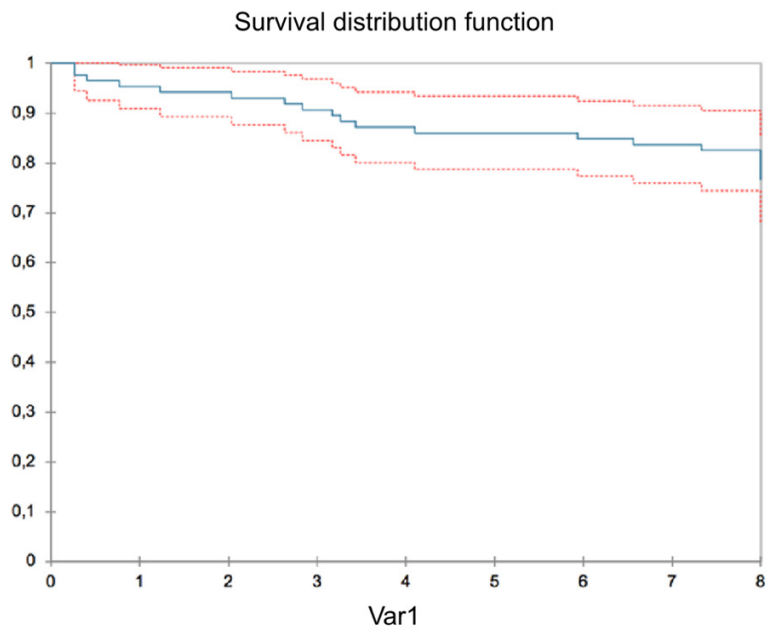

Figure 4. Kaplan-Meier survival estimate shows a survival rate of 82.6% at 8 months with permanence alive as an endpoint.

parative study by Fichman et al. [29], the rate of major complications was significantly increased in the group of patients undergoing osteosynthesis, with 20.7% compared to 3.4% in the case of HA.

The use of a long femoral stem allowed 95.3% of the patients to be verticalized in the first two post-operative days (87.2% in the first day, 8.1% in the second post-op day), while in only 3 cases it was not possible to verticalize the patient during hospitalization. Also, thanks to the efficiency of rehabilitation and pharmacological protocol, the average post-operative hospital stay was 5.5 ± 2.9 days.

Postoperative mortality following hip fracture surgery in elderly people is high [30, 31]. In a study by Lee et al. [26] on 234 HA following intertrochanteric fractures, the authors reported 7 deaths (2.9%) within 30 days, 18 deaths (7.7%) within 90 days and 30 (12.82%) within a year from the fracture. In our series, the 6-months mortality was 13, 95% and the 12-months mortality 26, 31%. The only statistically significant association for an increased risk of mortality following fracture was male sex.

Social functioning and mobility after surgery in intertrochanteric fractures are a matter of debate in the literature. In this cohort of patients, the mean Barthel score decreased from 76 ± 20.04 preoperatively to 54.1 ± 23.7 at the postoperative follow-up, while the Koval's walking ability grade increased from 1.7 ± 1.16 to 3.2 ± 2.1, thus indicating a reduction in autonomy in daily activities and in the patients' independence in walking. Kim et al. [27] in their series, reported a return to preoperative ambulation levels in 81% of 143 patients undergoing HA.

In a previous study by the same authors, no statistically significant differences in terms of functional outcomes between hemiarthroplasty and femural nailing were reported [16].

Ozkayin et al. [28] in a prospective randomized study compared functional outcomes in two groups of patients older than 75 with intertrochanteric fractures, undergoing femoral nailing and HA, reporting a recovery increase rate highest between 3 and 6 months for the first group and between 1.5 and 3 month post-op for the second group, respectively, with better function at 18 months follow-up in the nailing group.

Similar results were reported by Desteli et al. [32], with better social functioning and mobility scores for patients undergoing hemiarthroplasty within the first 3 months and a trend reversal at 12-24 months in favor of patients undergoing intramedullary nailing.

This study has several limitations. First, the relatively short follow-up can be considered a limitation, but in the context of over-80-year-old patients with limited life expectancy, this finding appears to be of less clinical relevance. Secondarily, the absence of a comparison group and the retrospective design of the study.

Conclusions

In conclusion, long stemmed bipolar hemiarthroplasty following displaced intertrochanteric fracture can be considered a safe procedure, especially in patients over 80 with associated comorbidities and short life expectancy. Fur-

ther studies will be needed to compare the complication and mortality rates and functional outcomes, with patients treated by osteosynthesis.

Disclosure of conflict of interest

None.

Address correspondence to: Dr. Stefano Marco Paolo Rossi, Sezione di Chirurgia Protesica ad Indirizzo Robotico - Unità di Traumatologia dello Sport, U.O.C Ortopedia e Traumatologia, Fondazione Poliambulanza Istituto Ospedaliero, Via Bissolati 57, 25124, Brescia, Italy. Tel: +39-030-3518976; E-mail: rossi.smp@gmail.com

References

[1] Mittal R and Banerjee S. Proximal femoral fractures: principles of management and review of literature. J Clin Orthop Trauma 2012; 3: 15-23.

[2] Geiger F, Schreiner K, Schneider S, Pauschert R and Thomsen M. Proximal fracture of the femur in elderly patients. The influence of surgical care and patient characteristics on postoperative mortality. Orthopade 2006; 35: 651-657.

[3] Giannotti S, Bottai V, Dell'Osso G, De Paola G, Bugelli G and Guido G. The hip prosthesis in lateral femur fracture: current concepts and surgical technique. Clin Cases Miner Bone Metab 2014; 11: 196-200.

[4] Hoskins W, Corfield S, Lorimer M, Peng Y, Bingham R, Graves SE and Vince KG. Is the revision rate for femoral neck fracture lower for total hip arthroplasty than for hemiarthroplasty?: a comparison of registry data for contemporary surgical options. J Bone Joint Surg Am 2022; 104: 1530-1541.

[5] Pass B, Nowak L, Eschbach D, Volland R, Knauf T, Knobe M, Oberkircher L, Lendemans S and Schoeneberg C; Registry for Geriatric Trauma DGU. Differences of hemiarthroplasty and total hip replacement in orthogeriatric treated elderly patients: a retrospective analysis of the Registry for Geriatric Trauma DGU®. Eur J Trauma Emerg Surg 2022; 48: 1841-1850.

[6] Dimitriou R, Calori GM and Giannoudis PV. Improving patients' outcomes after osteoporotic fractures. Int J Clin Rheumatol 2012; 7: 109-124.

[7] Schütz M and Bühler M. Classification of proximal femoral fractures. Helv Chir Acta 1993; 59: 947-954.

[8] Sinno K, Sakr M, Girard J and Khatib H. The effectiveness of primary bipolar arthroplasty in treatment of unstable intertrochanteric fractures in elderly patients. N Am J Med Sci 2010; 2: 561-568.

[9] Blomfeldt R, Törnkvist H, Ponzer S, Söderqvist A and Tidermark J. Comparison of internal fixation with total hip replacement for displaced femoral neck fractures. Randomized, controlled trial performed at four years. J Bone Joint Surg Am 2005; 87: 1680-1688.

[10] Pho RW, Nather A, Tong GO and Korku CT. Endoprosthetic replacement of unstable, comminuted intertrochanteric fracture of the femur in the elderly, osteoporotic patient. J Trauma 1981; 21: 792-797.

[11] Tronzo RG. The use of an endoprosthesis for severely comminuted trochanteric fractures. Orthop Clin North Am 1974; 5: 679-681.

[12] Haentjens P and Lamraski G. Endoprosthetic replacement of unstable, comminuted intertrochanteric fracture of the femur in the elderly, osteoporotic patient: a review. Disabil Rehabil 2005; 27: 1167-1180.

[13] Stern MB and Goldstein TB. The use of the Leinbach prosthesis in intertrochanteric fractures of the hip. Clin Orthop Relat Res 1977; 325-331.

[14] Engh GA and Ammeen DJ. Unicondylar arthroplasty in knees with deficient anterior cruciate ligaments. Clin Orthop Relat Res 2014; 472: 73-77.

[15] Kregor PJ, Obremskey WT, Kreder HJ and Swiontkowski MF; Evidence-Based Orthopaedic Trauma Working Group. Unstable pertrochanteric femoral fractures. J Orthop Trauma 2005; 19: 63-66.

[16] Kim SY, Kim YG and Hwang JK. Cementless calcar-replacement hemiarthroplasty compared with intramedullary fixation of unstable intertrochanteric fractures. A prospective, randomized study. J Bone Joint Surg Am 2005; 87: 2186-2192.

[17] Adams CI, Robinson CM, Court-Brown CM and McQueen MM. Prospective randomized controlled trial of an intramedullary nail versus dynamic screw and plate for intertrochanteric fractures of the femur. J Orthop Trauma 2001; 15: 394-400.

[18] Bojan AJ, Beimel C, Speitling A, Taglang G, Ekholm C and Jönsson A. 3066 consecutive Gamma Nails. 12 years experience at a single centre. BMC Musculoskelet Disord 2010; 11: 133.

[19] Broos PL, Rommens PM, Geens VR and Stappaerts KH. Pertrochanteric fractures in the elderly. Is the Belgian VDP prosthesis the best treatment for unstable fractures with severe comminution? Acta Chir Belg 1991; 91: 242-249.

[20] Harwin SF, Stern RE and Kulick RG. Primary Bateman-Leinbach bipolar prosthetic replace-

ment of the hip in the treatment of unstable intertrochanteric fractures in the elderly. Orthopedics 1990; 13: 1131-1136.
[21] Green S, Moore T and Proano F. Bipolar prosthetic replacement for the management of unstable intertrochanteric hip fractures in the elderly. Clin Orthop Relat Res 1987; 169-177.
[22] Rodop O, Kiral A, Kaplan H and Akmaz I. Primary bipolar hemiprosthesis for unstable intertrochanteric fractures. Int Orthop 2002; 26: 233-237.
[23] Apel DM, Patwardhan A, Pinzur MS and Dobozi WR. Axial loading studies of unstable intertrochanteric fractures of the femur. Clin Orthop Relat Res 1989; 156-164.
[24] Lee YK, Park CH and Koo KH. Fixation of trochanteric fragments in cementless bipolar hemiarthroplasty of unstable intertrochanteric fracture: cerclage wiring. Hip Pelvis 2017; 29: 262-269.
[25] Qi X, Zhang Y, Pan J, Ma L, Wang L and Wang J. Effect of bone cement implantation on haemodynamics in elderly patients and preventive measure in cemented hemiarthroplasty. Biomed Res Int 2015; 2015: 568019.
[26] Lee YK, Won H, Roa KRU, Ha YC and Koo KH. Bipolar hemiarthroplasty using microarc oxidation-coated cementless stem in patients with unstable intertrochanteric fracture. J Orthop Surg (Hong Kong) 2019; 27: 230949901984781.
[27] Kim Y, Moon JK, Hwang KT, Choi IY and Kim YH. Cementless bipolar hemiarthroplasty for unstable intertrochanteric fractures in octogenarians. Acta Orthop Traumatol Turc 2014; 48: 424-430.
[28] Özkayın N, Okçu G and Aktuğlu K. Intertrochanteric femur fractures in the elderly treated with either proximal femur nailing or hemiarthroplasty: a prospective randomised clinical study. Injury 2015; 46 Suppl 2: S3-S8.
[29] Fichman SG, Mäkinen TJ, Safir O, Vincent A, Lozano B, Kashigar A and Kuzyk PR. Arthroplasty for unstable pertrochanteric hip fractures may offer a lower re-operation rate as compared to cephalomedullary nailing. Int Orthop 2016; 40: 15-20.
[30] Choi JY, Cho KJ, Kim S, Yoon SJ, Kang M, Kim K, Lee YK, Koo KH and Kim CH. Prediction of mortality and postoperative complications using the hip-multidimensional frailty score in elderly patients with hip fracture. Sci Rep 2017; 7: 42966.
[31] Lee YK, Lee YJ, Ha YC and Koo KH. Five-year relative survival of patients with osteoporotic hip fracture. J Clin Endocrinol Metab 2014; 99: 97-100.
[32] Desteli EE, İmren Y, Erdoğan M and Aydagün Ö. Quality of life following treatment of trochanteric fractures with proximal femoral nail versus cementless bipolar hemiarthroplasty in elderly. Clin Invest Med 2015; 38: E63-72.