



# A multicenter intertrochanteric fracture study in the elderly: Hemiarthroplasty versus proximal femoral nailing

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With the aging population, the incidence rate of osteoporosis has been rapidly increasing.<sup>[1]</sup> These fractures are predicted to reach 2.6 million in 2025 and 4.5 million in 2050 worldwide.<sup>[2]</sup> The incidence of these fractures, which frequently occur due to falls, is two-three times higher in females than in males.<sup>[3]</sup> Intertrochanteric fractures, which are usually unstable, can only be treated surgically.<sup>[4]</sup>

The key point of the surgical treatment is stable fixation and early mobilization with full-weight bearing. However, this is not always as easy as it seems. Most of the patients are elderly, osteoporotic, with additional morbidity and limited mobilization, and prone to complications.<sup>[5,6]</sup> Therefore, there is no consensus regarding the treatment of

## ABSTRACT

**Objectives:** This study aims to compare the clinical and functional results of intertrochanteric femoral fractures treated with bipolar hemiarthroplasty (BHA) or proximal femoral nailing (PFN) in elderly patients.

**Patients and methods:** This multicenter, prospectively followed-up, retrospectively compared cohort-type study included 308 patients (81 males, 227 females; mean age 78.4±7.2 years; range, 65 to 95 years) who were treated with BHA or PFN for intertrochanteric fractures by five orthopedic surgeons in four provinces and seven clinics between January 2014 and May 2018. Clinical follow-up was performed at third week, third and sixth months, and at the end of the first and second years. The American Society of Anesthesiologists for preoperative status, Singh index for bone quality, and Harris Hip Score (HHS) for functional outcomes were evaluated.

**Results:** While 156 patients (38 males, 118 females; mean age 77.7±5.9) were treated with BHA, 152 patients (43 males, 109 females; mean age 79±6.1) were treated with PFN. While there was no significant difference between the two groups in terms of total HHS, a significant difference was found in the sub-parameters ( $p<0.001$ ). Good and excellent results were found in 78.2% of BHA and 86.2% of PFN patients. Mortality rates were similar at the end of two years (14% and 13.6%, respectively).

**Conclusion:** In general, clinical and functional outcomes of BHA and PFN are similar. The rates of pulmonary embolism and deep vein thrombosis are significantly higher in BHA. However, BHA is advantageous in terms of operation time and early weight bearing compared to PFN.

**Keywords:** Harris Hip Score, hemiarthroplasty, intertrochanteric fracture, proximal femur nail.

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intertrochanteric fractures and the most appropriate treatment according to the patient's age and fracture type is still not clear. To date, treatment methods such as dynamic hip screw (DHS), proximal femoral

nail (PFN) antirotation, unipolar and bipolar hemiarthroplasty (BHA), total arthroplasty, and external fixation have been used.<sup>[2,4,6-8]</sup>

Although the research of biomechanical properties has shown that intramedullary nails are more stable due to the shorter lever arm, it is known that failure to achieve early weight bearing is an important problem particularly in this type of fracture in which elderly and osteoporotic patients are affected.<sup>[9,10]</sup> Hemiarthroplasty, which has been used frequently in the treatment of intertrochanteric fractures since the 1970s, cannot be considered an ideal treatment.<sup>[10]</sup> Despite the many studies on this subject, large case series comparing PFN versus BHA are rarely seen in the literature. Therefore, in this study, we aimed to compare the clinical and functional results of intertrochanteric femoral fractures treated with BHA or PFN in elderly patients.

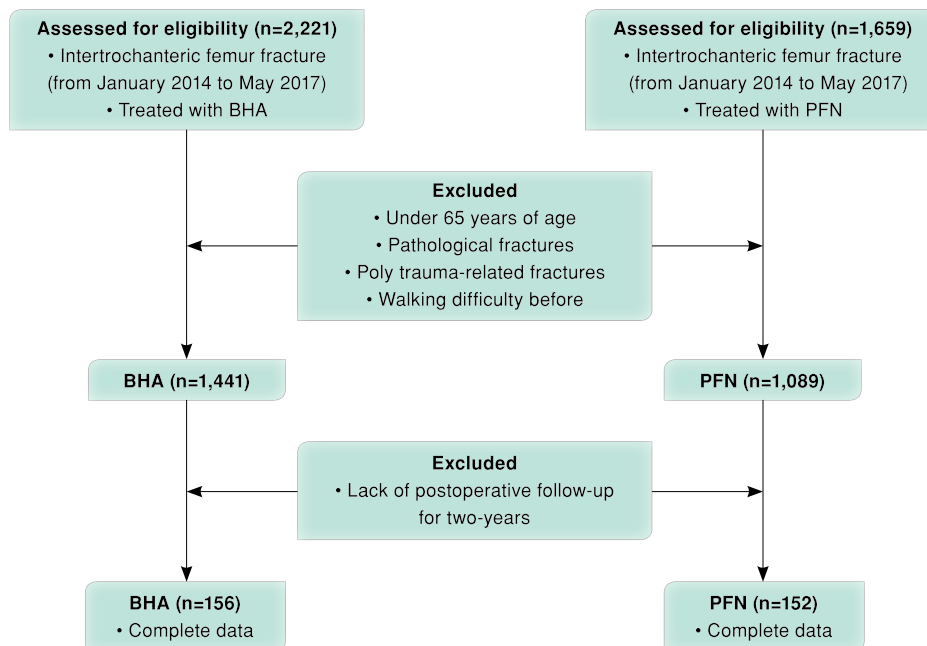
## PATIENTS AND METHODS

This multi-center, prospectively followed up, retrospectively compared cohort-type study was conducted by five orthopedic surgeons in four provinces and seven hospitals. Between January 2014 and May 2018, 2,221 patients underwent hemiarthroplasty and 1,659 patients underwent PFN

for intertrochanteric femoral fractures. The study protocol was approved by the Erciyes University Ethics Committee (numbered 2018/545). A written informed consent was obtained from each patient. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patients over 65 years of age and treated with BHA and PFN for intertrochanteric fractures were included in the study. Patients under 65 years of age; with pathological fractures, poly trauma-related fractures, or walking difficulties before immobility or fracture; or that had not been followed-up for two years postoperatively were excluded. As a result of the power analysis, the sample size was found to be 92 for each group. Thus a total of 308 patients (81 males, 227 females; mean age  $78.4 \pm 7.2$  years; range, 65 to 95 years) were included, 156 patients (38 males, 118 females; mean age  $77.7 \pm 5.9$ ) constituting the BHA group and 152 patients (43 males, 109 females; mean age  $79 \pm 6.1$ ) constituting the PFN group (Figure 1).

The medical records of the patients included in the study were collected from patient files and the Hospital Information Management System. The questionnaires were administered during the patients' check-ups in the outpatient polyclinic. The American Society of Anesthesiologists (ASA) classification was used to evaluate the preoperative health status of the



**FIGURE 1.** Flow diagram of study inclusion and exclusion criteria.

BHA: Bipolar hemiarthroplasty; PFN: Proximal femoral nailing.

patients and bone quality was evaluated using the Singh index. Fracture classification was performed by two orthopedic surgeons on an intraobserver basis and one radiologist on an interobserver basis using the Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association (AO/OTA) classification (Table I). Clinical follow-up was performed at the third week, third and sixth months, and at the end of the first and second years. ASA score for preoperative status, Singh index for bone quality, and Harris Hip Score (HHS) for functional outcomes

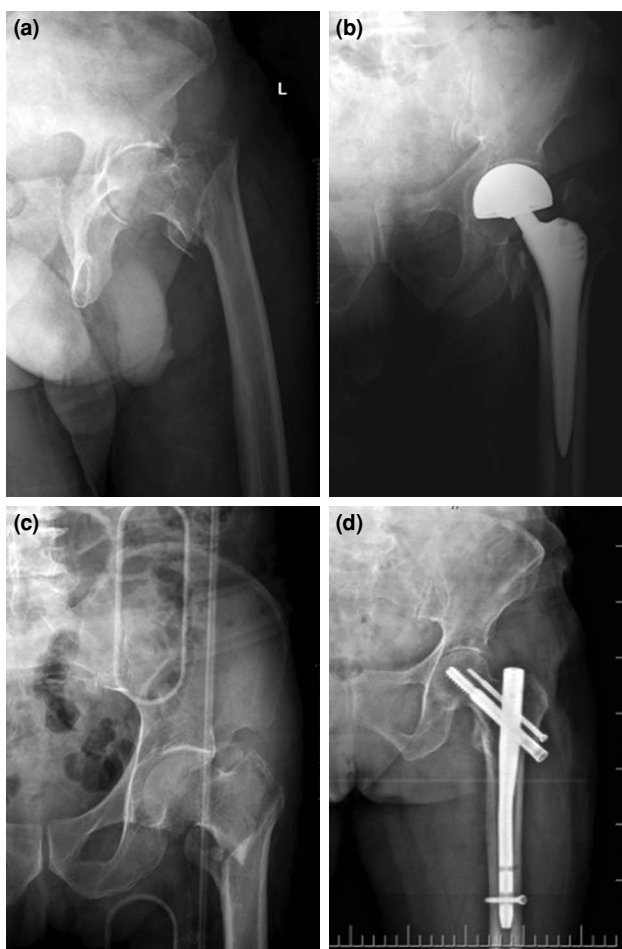
were evaluated. The final postoperative follow-up of the patients was performed using anteroposterior and lateral X-rays, while the functional evaluation was performed by the HHS questionnaire.

Bipolar hemiarthroplasty was performed under general or spinal anesthesia or sacral plexus block according to the decision of the anesthesiologist, with the fracture side up in the lateral decubitus position by a posterolateral approach. In patients with intertrochanteric fracture after insertion of a

**TABLE I**  
Comparison of baseline characteristics between bipolar hemiarthroplasty and proximal femoral nailing

Characteristics	BHA group (n=156)				PFN group (n=152)				Statistics	p
	n	%	Mean±SD	Median	n	%	Mean±SD	Median		
Age (year)			77.7±5.9				79±6.1		-0.411*	0.510
Gender									1.799**	0.431
Female	118	75.6			109	71.7				
Male	38	24.4			43	28.3				
Side									0.006**	0.955
Left	94	60.3			87	57.2				
Right	62	39.7			65	42.8				
Etiology										
Fallen from the standing height	17	10.9			13	8.5			1.202**	0.039
Fallen from high height	30	19.2			65	42.8			33.7**	<0.001
Road accident	38	24.4			42	27.6			4.531**	0.745
Assault	27	17.3			11	7.2			6.003**	0.143
Others	44	28.2			21	13.8			22.6**	<0.001
ASA score									5.346**	0.342
1	3	1.9			7	4.6				
2	87	55.8			75	49.3				
3	59	37.8			64	42.1				
4	7	4.5			6	3.9				
AO/OTA classification									2.314**	0.068
31A1.2	5	3.2			3	2				
31A1.3	26	16.7			36	23.7				
31A2.2	38	24.4			42	27.6				
31A2.3	84	53.8			62	40.8				
31A3.1	1	0.6			2	1.3				
31A3.2	-	-			5	3.3				
31A3.3	2	1.3			2	1.3				
Singh index				3.0				3.0		
Comorbidities										
Hypertension	89	57			69	45.4			6.879**	0.005
Cardiovascular disease	48	30.8			63	41.4			0.803**	0.346
Diabetes mellitus	97	62.2			102	67.1			7.456**	0.005
Pulmonary disease	34	21.8			29	19.1			1.211**	0.563
Cerebrovascular disease	18	11.5			23	15.1			2.832**	0.27
Others	49	31.4			19	12.5			0.398**	0.732

BHA: Bipolar hemiarthroplasty; PFN: Proximal femoral nailing; SD: Standard deviation; ASA: American Society of Anesthesiologists; AO/OTA: Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association; \* T test. \*\* Chi-Square test.



**FIGURE 2.** (a) Anteroposterior radiograph showing an unstable intertrochanteric fracture of left hip in a 76-year-old male patient who fell at home. (b) Radiograph two years after hemiarthroplasty. (c) Anteroposterior radiograph showing an unstable intertrochanteric fracture of left hip in a 77-year-old female patient who fell at home. (d) Radiograph 15 months after fixation with a proximal femoral nail.

prosthesis, fixation was achieved by reduction with cable and/or cable plate (Figure 2).

Proximal femoral nail was performed under general or spinal anesthesia or sacral plexus block on a traction table with G-arm fluoroscopy by the standard surgical method (Figure 2).

In all patients, 1 g of intramuscular cefazolin sodium (Sefazol®; M. Nevzat İlaç Sanayi, Istanbul, Turkey) was administered as antibiotic prophylaxis two hours before surgery. The patients were mobilized on postoperative day one or two under the guidance of an orthopedic surgeon. Bipolar hemiarthroplasty patients were mobilized with full weight bearing on the first day. The use of a walker was terminated at four weeks. In PFN patients,

partial weight bearing was started after one month. At six weeks postoperatively, full load was allowed. The use of crutches was terminated at 10 weeks. After discharge, the patient was followed-up at the outpatient clinic after three weeks, three months, six months, one year, and two years.

#### Statistical analysis

The statistics were analyzed using the PASW version 17.0 software (SPSS Inc., Chicago, IL, USA). Kolmogorov–Smirnov tests were used to check the continuous variables for Gaussian distribution. T-tests were used for all the continuous variables with a Gaussian distribution. For the continuous variables without a Gaussian distribution, Wilcoxon statistics (Mann-Whitney U test) were used. For the ranking variables, Pearson chi-square tests were used to evaluate significance. The level of statistical significance was set at a two-sided  $p$  value of 0.05.

#### RESULTS

The age distributions of the BHA and PFN groups were similar ( $p>0.05$ ) (Table I). The mean follow-up period was  $27.6\pm 7.3$  months (range, 24.1 to 39.5 months). Follow-up time was  $24.2\pm 6.3$  months (range, 24.1 to 39.4 months) in the BHA group and  $31.6\pm 11.2$  months (range, 24.5 to 39.5 months) in the PFN group. The difference between the two groups was statistically significant ( $p=0.034$ , t-test).

The main characteristics of the patients in the groups are shown in Table I. Accordingly, gender, age at the time of fracture, age at the last follow-up, fracture side, fracture etiology, previous fracture prior to hip fracture, ASA score, AO/OTA fracture classification, Singh index, and comorbidity parameters of the patients did not differ significantly between the groups (Table I and II).

Although the PFN group had higher HHSs, no significant difference was found between the two groups (Figures 3 and 4). However, when the sub-headings of the scoring system were evaluated separately, arthroplasty was significantly superior in terms of the pain, walking distance, and stairs parameters ( $p<0.001$ ).

As shown in Figures 3, HHS decreased with age. This is due to the negative effect of aging on physical activity. While the mean score of patients under 70 years of age was 84.7, it decreased to 78.5 in the 85-89 age range and to 61.9 in patients older than 90 years.

Complications were seen in a total of 79 patients (Table III). Complications of the patients that died

**TABLE II**  
Comparison of perioperative variables between bipolar hemiarthroplasty and proximal femoral nailing

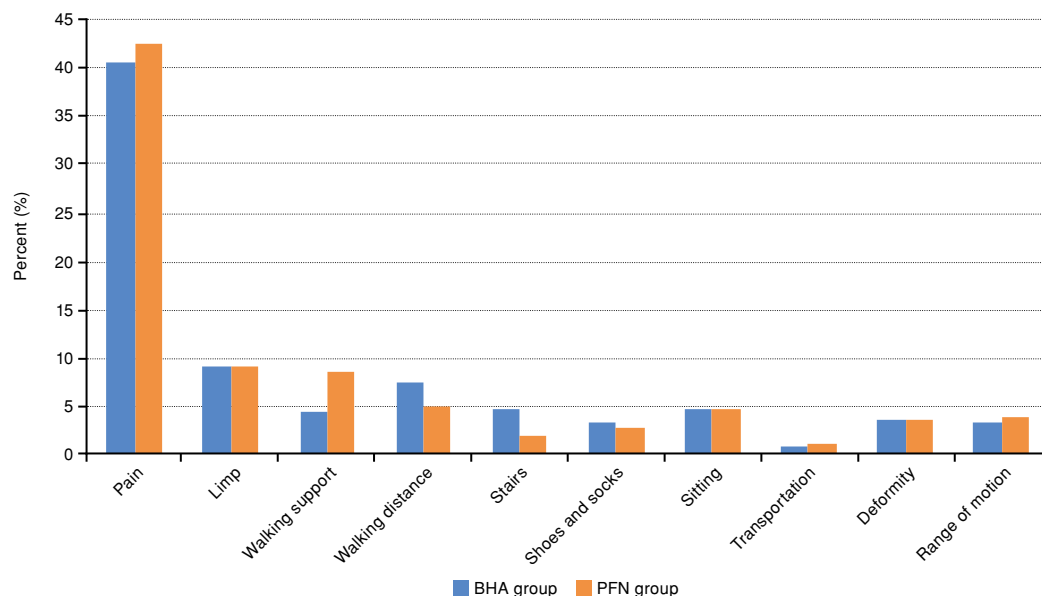
Characteristics	BHA group (n=156)				PFN group (n=152)				Statistics	p
	n	%	Mean±SD	Median	n	%	Mean±SD	Median		
Anesthesia									50.7*	<0.001
General	72	46.2			14	9.2				
Spinal	69	44.2			94	61.8				
Sacral plexus block	15	9.6			44	28.9				
Time from injury to admission (hour)				17.2				20.3	1,657.7†	0.537
Time from injury to operation (hour)				10.3				11.7	2,089.3†	0.453
Operation time (hour)				0,63				0,88	6,678.9†	<0.001
Blood loss during operation (mL)				321.4				78.9	6,487.5†	<0.001
Drainage volume from hemovac (mL)				248.8				102.7	5,345.2†	<0.001
Blood transfusion during hospital stay (mL)				614.4				326.8	4,567.9†	<0.001
Partial weight bearing and/or walking (day)				1.8				3.4	4,785.3†	<0.001
Hospital stay (day)				6.6				5.9	8,567.6†	0.703
Hemoglobin descending (g/dL)			8.3±2.7				3.5±1.1		3.7‡	<0.001
Albumin descending (g)			5.92±4.3				3.7±2.94		-1.453‡	0.002

BHA: Bipolar hemiarthroplasty; PFN: Proximal femoral nailing; \* Chi-Square test; † Wilcoxon signed-rank test; ‡ T test.

were not evaluated. Complication rates were higher in the BHA group, but the difference was not significant compared with the PFN group ( $p=0.203$ ,  $\chi^2=1.645$ ).

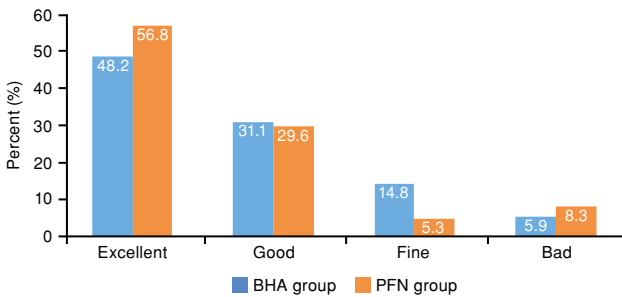
The types of complications varied between the groups. For the PFN group, cut-out/migration was seen in five patients, malrotation in seven patients, and inadequate fixation requiring revision surgery in four patients. Nonunion or delayed union was not

found radiologically. In the BHA group, malrotation was detected in two patients and the lower extremity length difference was more than 3 cm in four patients. In addition, symptomatic deep vein thrombosis (DVT) including pulmonary embolism was detected clinically and radiologically in 17 patients. However, this was seen only in three patients in the PFN group and was significantly higher when compared with the BHA



**FIGURE 3.** Distribution of Harris Hip Score in study groups.

BHA: Bipolar hemiarthroplasty; PFN: Proximal femoral nailing.



**FIGURE 4.** Ratio of Harris grade distribution in both groups.

BHA: Bipolar hemiarthroplasty; PFN: Proximal femoral nailing.

group ( $p < 0.001$ ,  $\chi^2 = 23.6$ ). Secondary revision surgery was performed in 15 patients for two dislocations, six deep infections, and seven periprosthetic fractures in the BHA group. Secondary revision surgery was performed in 22 patients including five with cut-out/migration, two with deep infections, 11 with periprosthetic fractures, and four with insufficient primary osteosynthesis in the PFN group. When the two groups were compared in terms of complications requiring revision surgery, no statistically significant difference was found ( $p = 0.554$ ,  $\chi^2 = 4.505$ ).

The comparison of fracture types according to AO/OTA classification and Singh index grades between the BHA and PFN groups with complications is shown in (Figure 4).

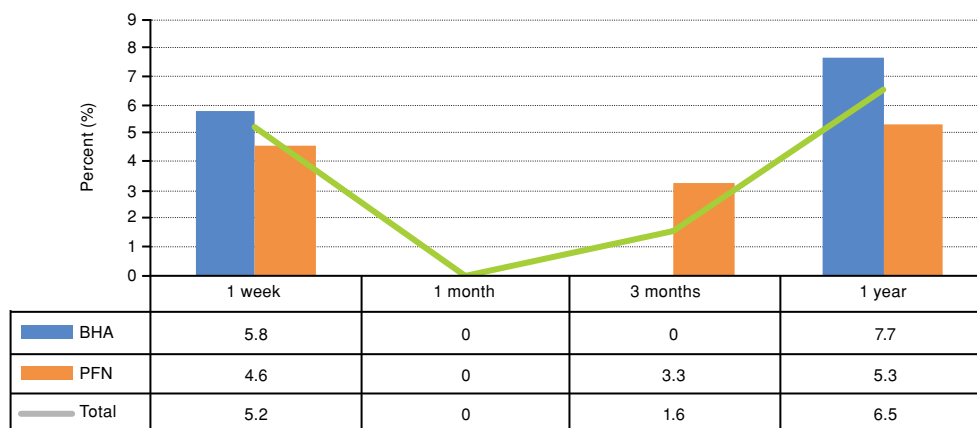
According to the fracture types, the number of complications and Singh index values were not significantly different between the groups ( $p > 0.05$ ). A total of 41 patients (21 in the BHA group and 20 in the PFN group) died during the entire follow-up period. There was no statistically significant difference in the mortality rate between the two groups ( $p = 0.039$ ,  $\chi^2$ -test). The mortality rates were also not significantly different between the groups at first week, first month, third month, first year, or the last follow-up. However, although there was no significant difference at the end of the first year, the mortality rate in the PFN group was lower than that in the BHA group (Figure 5).

## DISCUSSION

As with all fractures in elderly patients, it is difficult to obtain ideal treatment results because of low bone quality, additional morbidities, and mobilization problems in intertrochanteric femoral fractures. Although there are some differences in complications and mortality rates, there is no significant difference between BHA and PFN in elderly patients with intertrochanteric fractures in a great number of parameters during treatment.

There are many methods that can be used for intertrochanteric fractures and there are many reports comparing them in the literature. The use of

TABLE III				
Comparison between bipolar hemiarthroplasty and proximal femoral nailing with complications				
Characteristics	BHA (n=135)	PFN (n=132)	Statistics*	<i>p</i>
AO/OTA fracture classification				
31A1.2	2/5	-/3	0.789	0.456
31A1.3	1/26	5/36	1.724	0.061
31A2.2	3/38	9/42	0.0645	0.076
31A2.3	35/84	15/62	0.3389	0.686
31A3.1	1/1	1/2	1.512	0.093
31A3.2	-/-	4/5	0.409	0.198
31A3.3	1/2	2/2	1.086	0.251
Singh index (n)				
Grade I	2/7	1/11	0.5784	0.234
Grade II	5/13	5/27	0.0987	0.768
Grade III	23/79	19/65	2.8976	0.078
Grade IV	11/34	8/23	3.0098	0.045
Grade V	2/2	4/6	0.6754	0.384
BHA: Bipolar hemiarthroplasty; PFN: Proximal femoral nailing; AO/OTA: Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association; * Final number of patients in each group at end of two years; 41 exitus patients (21 in bipolar hemiarthroplasty group and 20 in proximal femoral nailing group) were excluded; * Chi-Square test.				



**FIGURE 5.** Distribution of mortality in study groups.  
BHA: Bipolar hemiarthroplasty; PFN: Proximal femoral nailing.

DHS, which is one of these methods, has decreased considerably in elderly patients due to insufficient functional results, external rotation deformity, and high amount of shortness.<sup>[3,11-13]</sup> Broos et al.<sup>[14]</sup> reported that hemiarthroplasty patients had less mortality, shorter operative time, and better functional results than DHS and angled plate patients.

The hemiarthroplasty method, which has been popular for almost 50 years and the design of which has developed over time, is still used as the first choice by many orthopedic surgeons. On the other hand, osteosynthesis with proximal hip nailing is more effective in biomechanical studies due to its lower deformity rate in elderly patients. The number of surgeons advocating that it should be considered primarily increases with each passing day.<sup>[15,16]</sup>

Özkayın et al.<sup>[3]</sup> reported higher HHSs in their hemiarthroplasty group for up to six months and higher values in their PFN group at 12 months. While these values increased in both groups at 18 months, the increase was greater in the PFN group. In addition, in contrast to our study, they reported that the operation time was shorter in PFN patients.<sup>[3]</sup> In the literature, different results have been reported in terms of operation time, which we think is due to the inability to standardize the surgical time due to the uncertainty in the reduction of unstable fractures.

In their study involving 50 patients, Hari Prasad et al.<sup>[6]</sup> reported that the amount of bleeding and the surgical time were lower in favor of PFN. Also, HHS was higher after hemiarthroplasty until the end of 12 months. However, we conclude that the low mean age of the patients is the most important factor affecting these results.

In their study including 86 patients, Desteli et al.<sup>[17]</sup> stated that there was no significant difference between the two groups in their two-year follow-up. Similarly, the length of hospital stay was correlative to that in our study; they reported that the operation time was longer in the PFN group. In addition, according to social functioning measurements, the hemiarthroplasty group had more social functionality at three months, while the values of the groups were equal at 12 months. The PFN group had slightly higher social functioning despite the increase in both groups at 24 months. In their evaluation of the quality of life, they reported no significant difference, while scores never returned to preoperative levels after either surgical technique.<sup>[17]</sup>

Luo et al.<sup>[18]</sup> reported that the mortality rate was 21.2% in the BHA group and 11.3% in the PFN group at one year. However, they also emphasized that PFN should not be abandoned due to minimal fixation failures.

Internal fixation causes further problems like cut-out and collapse in elderly patients. The extent of this problem is so great that some surgeons prefer to use hemiarthroplasty.<sup>[3,19]</sup> Kim et al.<sup>[7]</sup> reported that the mortality rates of their hemiarthroplasty and PFN groups were 20.6% and 13.8% at one year and 55% and 17% at three years, respectively, in their study of 58 patients.

In our study, the complication rate was slightly higher in the hemiarthroplasty group. However, the rate of symptomatic DVT, including pulmonary embolism, was significantly higher in the hemiarthroplasty group. We can say that the most important disadvantage of hemiarthroplasty

compared to PFN is the development of DVT despite pharmacological and mechanical measures. Our mortality rate was 5.33% in the first week and it increased to 13.66% after two years.

The amount of intra- and postoperative early bleeding was significantly higher in patients undergoing hemiarthroplasty despite the shorter operative time. It may be difficult to regulate hemodynamics in patients with a high ASA score and in need of postoperative intensive care. Therefore, it would be more appropriate to use PFN with a much lower rate of both intra- and postoperative bleeding by evaluating such patients carefully. However, the mean operation time is longer in PFN applications and problems such as postoperative early weight-bearing loss are encountered. In the elderly patient group, the short duration of surgery and intensive care unit stay, and early weight bearing are important in preventing mortality and morbidity.

Although the methods are similar in elderly patients in many respects in the long-term, early mobilization of the patient in the short-term will contribute to the patient's self-care, which will provide significant convenience particularly for the family. In addition, the necessity of using fluoroscopy in surgery seems to be a disadvantage for orthopedists, who are frequently exposed to radiation. Therefore, planning new studies including families and surgeons will contribute to clarifying this controversial issue.

There were some limitations of our study. First, multicenter patients were not able to receive postoperative standardized physical therapy and rehabilitation or complication management. Secondly, some patients were excluded due to a lack of a one-year follow-up. This exclusion also procures the mortality and morbidity rates of the study decreased. Lastly, study groups could not be selected according to each fracture type in the AO/OTA classification.

In conclusion, the method allowing shorter duration of surgery, early weight bearing, and low bleeding, complication, and mortality rates is the most ideal method in elderly patients with intertrochanteric fractures. The rates of pulmonary embolism and DVT are significantly higher in BHA. However, BHA is advantageous in terms of operation time and allowing early weight bearing compared to PFN. Clinical and functional outcomes of BHA and PFN are similar. Therefore, the evaluation of each case and choice of the appropriate treatment method should be left to the surgeon's preference and experience.

#### Declaration of conflicting interests

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