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Functional results of patients with femoral intertrochanteric fractures who underwent surgery of proximal femoral nail or bipolar hemiarthroplasty: A comparative study

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Abstract

Aim: In this study, the functional results of patients with femoral intertrochanteric fractures who underwent surgery were compared with their clinical features in terms of proximal femoral nail (PFN) and bipolar hemiarthroplasty (BPH).

Materials and Methods: PFN (Group 1) was implanted in 40 of 89 patients (44 female, 45 male) aged between 51-80 (mean 68,16 ± 6,78) whereas BPH (Group 2) was used with 49 patients. Age, gender, fracture mechanism, additional disease, Body mass index (BMI), Albumin level, Hemoglobin (Hb) decrease level, T-score, American Society of Anesthesiologists (ASA) classification, type of anesthesia, surgery type, operation time, hospital stay and full weight-bearing time, the scores of Harris Hip Function (HHS), the social function of Jensen (JSF), Parker-Palmer mobility (PPMS) in preoperative and postoperative periods, and postoperative complications were all recorded.

Results: In group 1; patients were younger, operation time was 46.78 ± 5.29 minutes and hospital stay was 2.48±0.75 days, which were shorter compared with group 2. For group 1, most surgery types were closed, T-score was -2.49±0.59 and better, the time of full weight-bearing was 3.48±0.78 months, Hb decrease was 1.17±0.37 and less, and Albumin level was 3.11±0.4 g/dL and higher compared to group 2 ($p<0.05$). HHS was better in the BPH group at the sixth month ($p<0.05$). In group 1, the 12th, and 24th months scores of JSF were better, PPMS was higher in all evaluations ($p<0.05$). Operation time, ASA, T-score, and albumin levels correlate with functional scores, while BMI and Hb did not.

Conclusion: Many factors are important for progressing patients with intertrochanteric femur fractures toward a functional level. Considering these parameters in patients with femoral intertrochanteric fracture, PFN or BPH can both be used for treatment according to the surgeon's preference.

Level of evidence: Therapeutic Level III, retrospective cohort study.

Introduction

Hip fractures cause dysfunction disorders which limits a person's mobility. More than half of hip fracture patients cannot return to premorbid mobility levels [1]. Millions of people experience major problems due to these fractures, which put a heavy burden on health-care systems [2]. Intertrochanteric femur fractures constitute 61% of the hip fractures, also with high rates of mortality [3]. These patients suffer from many morbidities such as diabetes, lung, heart, hypertension, and poor general health [4].

Biomechanical studies have shown that intramedullary implants are suitable for trochanteric fractures due to their load-bearing and high mechanical resistance properties [5]. However; some patient-related features may prevent using these implants. Bipolar hip prostheses are widely used in trochanteric region fractures, especially in unstable fractures [6]. Osteosynthesis in the correct position provided by the implant can procure a good union and minimize mechanical complications [7].

In this study, we aimed to compare the functional results of proximal femoral nail (PFN) and bipolar hemiarthroplasty (BPH) surgeries performed on patients with an intertrochanteric femur fracture, and evaluate the risk factors that might affect these results.

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Materials and Methods

This study was designed as retrospective cohort and approved by the local ethics committee. We conducted the research in compliance within the principles of the Declaration of Helsinki. Between January-2017 and November-2019, 103 intertrochanteric femur fracture patients who had either PFN or BPH surgery were recorded and analyzed in our hospital. Patients with pathological fractures, multiple fractures, who did not satisfy with controls and the patients who we could not reach were excluded from the study. 89 patients constituted the study group. Age, gender, fracture mechanism (low-high energy), additional disease, Body mass index (BMI), Albumin level, Hemoglobin (Hb) decrease level (Hb level difference before and after the operation without blood transfusion), T-score for osteoporosis, American Society of Anesthesiologists (ASA) classification, type of anesthesia used for surgery, surgery type (open-closed), operation time, hospital stay and full weight-bearing time, the scores of Harris Hip Function (HHS), Social function of Jensen (JSF), Parker-Palmer mobility (PPMS) in preoperative (before fracture) and postoperative periods, and postoperative complications were recorded using the hospital archive and patient controls (Table 1, 2).

The patients were divided into three age groups; 50 - 60, 61-70, 71-80. Some of the patients also reported diabetes mellitus (DM), cardiac – hypertension, pulmonary, and neurologic disease. Patients with a BMI $\geq$ 25 kg /m^2 were classed as overweight, albumin level between 3,4-5,4 g/dl was normal, and patients with a T-score $\leq$ -2.5 had osteoporosis. Postoperative complications were recorded regarding wound infection, deep vein thrombosis (DVT), urinary-pulmonary infection, bedsore, and implant-related complications.

HHS score has four components that are deformity, range of motion, function, and pain [8]. Patient function is categorized by the ability to perform everyday activities and gait. The meanings of the scores: excellent 90–100, good 80–89, fair 70–79, and poor <70. It was evaluated preoperatively and at 6th and 12th months postoperatively.

JSF score has four components; completely dependent - 4 points, moderately dependent - 3 points, slightly dependent - 2 points, independent - 1 point [9]. It was evaluated preoperatively and at 3rd, 6th, 12th, and 24th months postoperatively.

PPMS evaluates a) the ability to walk within the home, b) the ability to go outside the house and c) the ability to go to a restaurant, shopping, or to see relatives and these were scored as 3 points able, 2 points if alone with an assistive device, 1 point with assistance from another person, and 0 points if the patient was unable at all [10]. It was evaluated preoperatively and at 3rd, 6th, 12th, and 24th months postoperatively.

Statistical analysis

All analyses were conducted using SPSS statistical package software (version 21.0; IBM, Armonk, NY, USA).Within the scope of the study; power analysis was performed to determine the number of samples. For the power analysis, the effect level was 0.80 and α value was 0.05, while the power value (1- β) was calculated as 0.80. Qualitative and quantitative data were summarized depending on whether the variable was categorical or numeric, respectively. The Chi-squared test was used to examine the association among categorical variables. The correlation test was used tfor the analysis of numerical variables. The difference between numerical variables according to categorical variables with two groups was analyzed with the t-test. The difference between categorical variables with three or more groups was analyzed with the ANOVA test. The statistical significance level was set at p <0.05.

Results

The mean follow-up time of 89 patients (44 female, 45 male) aged between 51-80 (mean 68,16 $\pm$ 6,78) was 28.6 (range 24-33) months. PFN (Group 1) was performed on 40 of 89 patients and BPH (Group 2) was performed on 49 patients. Patients with PFN were younger with an average age of 64.55 $\pm$ 6.23 compared to those who underwent BPH (p <0.05). There was no significant difference between the two groups concerning gender (p> 0.05). Most fractures were the result of low energy (p>0.05). In both groups spinal anesthesia was applied to most of the patients, and most of the patients had more than one additional disease. Although postoperative complications were higher in Group 1, there was no significant difference between the two groups in terms of these parameters (p>0.05) (Table 1).

In group 1, average operation time was 46.78 $\pm$ 5.29 minutes and hospital stay was 2.48$\pm$0.75 days, which were shorter than group 2. Most surgery types were closed, T-score was -2.49$\pm$0.59 and better, the time of full weight-bearing was 3.48$\pm$0.78 months, Hb decrease was 1.17$\pm$0.37 and lower, and albumin level was 3.11$\pm$0.4 g/dL and higher (p<0.05) in group 1 compared with group 2. There was no significant difference between the two groups concerning BMI and ASA (p>0.05) (Table 1).

In the postoperative period and from a functional perspective, at 6th month, the BPH group had a higher HHS than the PFN group (p<0.05), but there was no difference between the two groups at the end of one year (p>0.05) (Table 2). Also, there was no difference between the two groups concerning preoperative HHS (p>0.05). While there was no difference between the two groups for JSF at 3rd and 6th months (p>0.05), 12th and 24th months scores were better in the PFN group than that of the BPH group (p<0.05). For PPMS, the scores were higher in all evalu-

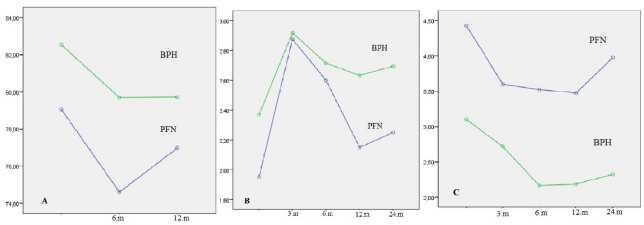

Figure 1. In two groups, comparison of preoperative and postoperative three scoring systems; A) HHS B) JSF C) PPMS.

Table 1. The relationship of implant types and clinical features of the patients.

		PFN		BPH		
		N	%	N	%	p value
Age (years)	50-60	13	32.5	5	10.2	.015*
	61-70	14	35.0	16	32.7	
	71-80	13	32.5	28	57.1	
	Mean±Sd	64.55±6.23		71.12±5.74		
Gender	Female	21	52.5	23	46.9	.602
	Male	19	47.5	26	53.1	
Anesthesia	Spinal	35	87.5	42	85.7	.806
	General	5	12.5	7	14.3	
Fracture mechanism	Low energy	30	75	39	79,6	.606
	High energy	10	25.0	10	20.4	
Surgery type	Open	3	7.5	49	100	.001*
	Closed	37	92.5	-	-	
Additional illness	Only one	8	30.8	12	36.4	.652
	>1	18	69.2	21	63.6	
Postoperative complication	Wound site	4	30.8	1	20.0	.636
	DVT	2	15.4	2	40.0	
	Urinary-pulmonary infection	1	7.7	1	20.0	
	Bedsore	4	30.8	1	20.0	
	Implant related	2	15.4	-	-	
		Mean ±Sd		Mean ±Sd		
Operation time (minutes)		46.78 ±5.29		58.73±7.01		.001*
Hospital stay (day)		2.48±0.75		4.59±1.0		.001*
BMI		26.5±4.14		26.94±4.29		.627
ASA		2.63±0.63		2.84±0.59		.105
T-score		-2.49±0.59		-2.83±0.5		.004*
Full weight-bearing (month)		3.48±0.78		postoperative day		.001*
Hb decrease (g/dL)		1.17±0.37		2.05±0.45		.001*
Albumin (g/dL)		3.11±0.4		2.84±0.33		.001*

PFN: proximal femoral nail BPH: bipolar hemiarthroplasty BMI: body mass index ASA: American Society of Anesthesiologists classification Hb: hemoglobin Sd: Standard deviation *Significance; p<0.05.

ations for the PFN group ($p<0.05$) whereas preoperative PPMS and JSF were worse in the BPH group ($p<0.05$) (Table 2). When comparing the scorings made in the postoperative period to the preoperative period, although it was seen that there was a positive relationship within them, the patient scores did not reach the preoperative levels (Figure 1) (Table 3).

When we evaluated the three types of scoring in both groups together with operation time, BMI, ASA, T score, Hb decrease, and albumin level, the albumin level shows a positive correlation with PPMS and HHS while there was a negative correlation with JSF evaluation. T-score and ASA score values showed a negative correlation with PPMS and HHS but a positive correlation with JSF scores. In terms of BMI and Hb decrease level, no correlation could be established with the scores in the two groups. In the PFN group, operation time negatively correlated with PPMS and HHS but correlated positively with JSF evaluation. In the BPH group, no correlation could be established between the operation time and the scores (Table 4).

Discussion

Most hip fractures are observed in people older than 65, and half of these fractures are in the intertrochanteric region. Hip fractures are also more common in women. This type of injury usually develops as a result of high-energy events such as falling from a height or traffic accidents in the younger age groups, and as a result of low-energy injuries such as simple falls in the elderly [11, 12]. In this study, the mean age of all patients was above 65 years, but the average age of the PFN group was younger than BPH, and the fracture mechanism was mostly due to low energy, which consistent with the literature. We believe that the almost equal distribution of gender in this type of fracture in our region, to the fact that men take a less active role in work activities but face more injury risks, and low functional mobility are all factors that increase the susceptibility to hip fracture [13].

It was shown that advanced age and low socioeconomic level negatively affected mobility [14]. Patients over 75 years of age generally have osteoporosis, slow fracture healing, are bedridden, have complications, and high mortal-

Table 2. The assessment of the implant types according to the three scoring systems; HHS, JSF, and PPMS.

		PFN	BPH	p value
	Month	Mean ± Sd	Mean ± Sd	
Harris Hip function score	6.	74.6 ± 6.05	79.69 ± 5.99	.001*
	12.	76.98 ± 6.22	79.71 ± 7.18	.061
Jensen Social function score	3.	2.88 ± 0.46	2.92 ± 0.40	.637
	6.	2.60 ± 0.55	2.71 ± 0.50	.306
	12.	2.15 ± 0.66	2.63 ± 0.70	.001*
	24.	2.25 ± 0.93	2.69 ± 0.87	.022*
Parker-Palmer mobility score	3.	3.60 ± 1.17	2.71 ± 0.82	.001*
	6.	3.53 ± 1.20	2.16 ± 1.16	.001*
	12.	3.48 ± 1.71	2.18 ± 1.50	.001*
	24.	3.98 ± 1.93	2.33 ± 1.71	.001*
Preoperative	Harris Hip Function Score	79.05 ± 6.16	82.53 ± 5.53	.188
	Jensen Social function score	1.95 ± 0.68	2.37 ± 0.64	.015*
	Parker-Palmer mobility score	4.43 ± 1.97	3.10 ± 1.16	.001*

*Significance; p<0.05.

Table 3. The correlation of preoperative and postoperative three scoring systems (HHS, JSF, and PPMS) with patient groups.

	Month		Preoperative Harris hip function score	
			PFN	BPH
Harris hip function score	6.	r	.960*	.873*
	12.	r	.968*	.946*
			Preoperative Jensen social function score	
			PFN	BPH
Jensen social function score	3.	r	.470*	.202
	6.	r	.569*	.468*
	12.	r	.817*	.592*
	24.	r	.796*	.697*
			Preoperative Parker-Palmer mobility score	
			PFN	BPH
Parker-Palmer mobility score	3.	r	.929*	.890*
	6.	r	.869*	.901*
	12.	r	.927*	.902*
	24.	r	.953*	.927*

*Significance; p<0.05 r ; correlation.

ity rates [4]. Most of the patients in this study had more than one additional disease. Wound site, DVT, urinary-pulmonary infection, bed sores, and implant-related postoperative complications were observed. It is possible that the absence of distinction between the two groups in these areas is attributed to the specific properties of this region's fractures.

The osteoporosis incidence rate has been growing rapidly due to the increasing life expectancy [15]. Some studies have shown that osteoporosis has negative consequences in intertrochanteric fractures [16].The important points in this type of fracture are full-weight bearing, early mobilization, and secure fixation. However, the fact that most of the patients are older-aged and osteoporosis has a major impact on implant complications and morbidity [17, 18]. Failure to attain early weight-bearing is well documented, especially in cases of this fracture type, which affects older patients [19, 20]. It was reported that early administration of intravenous bisphosphonate therapy was a safe treatment option for people with intertrochanteric fractures who also had osteoporosis. In impoverished nations, osteoporosis care is frequently overlooked due to reasons such as insufficient awareness and financial constraints [21]. In this study, while full weight-bearing was allowed on the first postoperative day in the BPH group, weight-bearing occurred in the next months in the PFN group. Our BPH application in the group with a lower T-score and complications related to implants and bedsores in the PFN group are consistent with the literature and show that we consider early mobilization.

High BMI was found to be a protective factor against hip fractures, whereas limited functional mobility was found to be a risk factor [13, 22]. Patients with intracapsular fractures had lower BMI levels than those with intertrochanteric fractures, according to another study. Compared to almost half of patients with intracapsular fractures, only one-fifth of patients with intertrochanteric fractures had BMIs below 18 kg/m^2 [23]. Our study found that the mean BMI was >25 kg/m^2 in both groups, which indicates that there might be other risk factors in fractures of this region within the scope of protection.

An increased risk of fracture at any location is linked to poor nutritional status, as characterized by the Mini Nutritional Assessment (MNA) [24]. The advantages of a healthy nutritional status regarding function, comorbidity, and outcome, were also observed in another study which was related to hip fractures [25]. Good nutrition has been linked to a faster recovery of hip fractures and a lower fracture incidence. Albumin is a good marker of malnutrition [26]. It has also been shown that albumin levels did not indicate improved functional results [27]. Here, albumin values were below the average in both groups, but we attribute the higher albumin level in the PFN group to the BPH group, to the lower mean age of the patients in this group.

In a study about PFN and hemiarthroplasty in the elderly, it was found that the PFN group's surgery time was lengthier [28]. In contrast, according to Özkayın et.al, the surgery time in PFN patients was less than that of the hemiarthroplasty group [11]. These differences in the literature may be due to reasons such as fracture reduction, implant differences or surgical ability. The operation duration and volume of intraoperative blood loss in the PFN group were considerably lower than those in the hemiarthroplasty group, with no significant difference related to average hospital stay between the two groups [6].

Table 4. Comparison of clinical parameters in two groups with three scoring systems; HHS, JSF, and PPMS.

		PFN						BPH					
		O.time	BMI	ASA	T score	Hb dec.	Alb.	O.time	BMI	ASA	T score	Hb dec.	Alb.
HARRİS 6.m	r	-.254*	.107	-.236*	-.668*	-.249	.506*	-.067	-.003	-.315*	-.645*	-.098	.553*
HARRİS 12.m	r	-.291*	.105	-.245*	-.709*	-.250	.507*	-.044	.079	-.393*	-.701*	-.095	.533*
JENSEN 3.m	r	.061	.113	.277*	.338*	.309	-.036	.059	.167	.146	.108	.059	-.022
JENSEN 6.m	r	.377*	-.295	.325*	.527*	.156	-.127	.049	-.105	.250*	.530*	.022	-.469*
JENSEN 12.m	r	.393*	-.140	.339*	.625*	.135	-.499*	.095	-.063	.298*	.573*	.174	-.484*
JENSEN 24.m	r	.321*	-.227	.121	.687*	.068	-.531*	.191	-.106	.063	.670*	.247	-.635*
PARKER 3.m	r	-.242*	.153	-.139	-.768*	-.214	.625*	.041	.048	-.358*	-.682*	-.087	.630*
PARKER 6.m	r	-.230*	.106	-.375*	-.630*	-.208	.640*	.044	.002	-.325*	-.699*	-.072	.590*
PARKER12.m	r	-.203*	.089	-.360*	-.794*	-.198	.629*	-.011	.044	-.343*	-.692*	-.214	.599*
PARKER24.m	r	-.156	.043	-.368*	-.751*	-.150	.556*	.039	.000	-.256	-.731*	-.135	.575*

O.time; Operation time Hb dec.; Hb decrease Alb.; Albumin m; month r ; correlation *Significance; p<0.05.

In another study, despite the reduced surgery duration, the quantity of postoperative and intraoperative early bleeding was greater in hemiarthroplasty patients. It has been suggested that controlling hemodynamics in patients with a high ASA score and a requirement for postoperative intensive care might be problematic [29]. In this study, the PFN group had lower levels of Hb decrease, shorter hospital stay, and operation time, compared to the other group. Although there was no disparity between the two groups in terms of ASA scores and anesthesia type used, it is possible that the closed method of most of the surgeries in the PFN group affects the results.

In a study, it was reported that DVT and pulmonary embolism rates were much greater in BHA, according to PFN [29]. In another research, no significant differences were found between the two groups regarding postoperative problems like bedsores, DVT, lung infection, and urinary tract infection [4]. The study found that no late postoperative infections in either of the BHA or PFN patients. Nevertheless, it has also been shown that the incidence rates of early postoperative wound infections were comparable [30]. Although, wound site, bedsore, and implant-related problems were more common in the PFN group in this study, there was no difference between the two groups in terms of postoperative complications in general. Therefore, the surgeon's knowledge and opinion can be used to evaluate each case and choose the best treatment technique.

It has been shown that at 6th month in the hemiarthroplasty group, there was a higher HHS score and at 12^{th} month in the PFN group, a higher HHS score [11]. Although both groups' scores increased by 18^{th} month, the PFN group growth was larger. In a study, at the final patient follow-up, activities of daily living at discharge, higher albumin level, and younger age were all linked to greater hip function, as measured by HHS [31]. According to certain studies, pre-injury function and functional recovery correlated positively [32]. Tang et al. [20] showed that as people aged, their HHS scores decreased. Hip function was linked to older age, which was a non-modifiable and independent health concern [31]. In this study, the mean age was higher in the BPH group. Although in the two groups there was no difference among the preoperative HHS, the HHS was better at 6th month in the BPH group than in the PFN group, but there was no difference among the two groups at the end of one year. There was a positive correlation between the preoperative and postoperative HHS. Since this scoring includes many parameters in itself, it provided better scores in the BPH patients with regard to the PFN patients in the early period and showed that other factors should be considered in the evaluations.

No functionally significant difference was found among the PFN and cementless BPH groups in a research performed in elderly patients with trochanteric fractures at the end of two years [28]. The hemiarthroplasty patients exhibited better social functionality in the third month, but the groups' values were identical at 12^{th} month. Despite the fact that there was rise in both groups at 24^{th} month, the PFN group showed somewhat better social functioning. It was reported that there was no significant change in their evaluation of life quality. In this study, no difference was observed among the two groups regarding JSF at 3^{rd} and 6^{th} months, while the 12^{th} and 24^{th} months, the scores were better in PFN patients compared with BPH patients. Regarding PPMS, the scores were higher in all evaluations in the PFN group. This result could be due to sociocultural factors such as patients struggling with living conditions in the postoperative period which is associated with the higher average age in the BPH group. The evaluation of PPMS on a single parameter such as mobility may have affected the results. In this study, the fact that preoperative PPMS and JSF were worse in the BPH group showed that the preoperative function levels of patients may also be reflected in the postoperative levels [33]. In addition, when we compared these three types of scoring criteria with the preoperative periods, although it was seen that each evaluation had a positive relationship within itself, the patient scores could not reach the preoperative levels.

A systematic review related to the health status of patients after hip fractures proved that in pre-fracture situations, comorbidity that affects ASA score, mental status, nutritional status including BMI and albumin, length of hospital stay, female gender, postoperative pain, and additional disorders were strongly linked to health-related life quality [33]. Anemia on arrival was linked to poor re-

covery, according to a meta-analysis of research on factors related to hip joint performance [34]. According to several researches, individuals with anemia at the time of admission did not have a higher risk of ambulatory capacity deterioration after they were discharged from rehabilitation centers [35, 36]. Blood transfusion, on the other hand, did not result in greater recovery of daily activities, according to a randomized controlled study [37]. In this study, albumin, T-score, and ASA values showed various correlations with patient function. However, BMI and Hb decrease were not correlated with both groups, and the operation time correlated only with the PFN group.

Limitations

The limitations of this study were that it was carried out in a single-centre, the small sample size, and the retrospective nature of the research. Also because of the advanced age of some patients, communication difficulties might have been effective in reflecting the functional scores.

Conclusion

There are no prognostic predictive markers for treatment outcomes in individuals with intertrochanteric fractures. It is therefore, vital to determine factors that will contribute to the long-term functional improvement in these patients. Considering these parameters in patients with this type of fracture, PFN or BPH can be used in the treatment according to the surgeon's preference. This study presents a different perspective in terms of showing the functional levels of the patients with intertrochanteric femur fractures after either PFN or BPH surgeries.

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Ethics approval

This study was approved by Istinye University Clinical Research Ethics Committee (Date: 03/03/2022-No; 3/2022.K-21).

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