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Comparison of Intraoperative and Postoperative Outcomes of Proximal Femoral Nailing and Bipolar Hemiarthroplasty Techniques in Intertrochanteric Femur Fracture Treatment

İntertrokanterik Femur Kırığı Tedavisinde Proksimal Femoral Çivileme ve Bipolar Hemiartroplasti Tekniklerinin İntraoperatif ve Postoperatif Sonuçlarının Karşılaştırılması

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ABSTRACT

Aim: This study was undertaken with the purpose of comparing the short and long term surgical, clinical, and functional results between bipolar hemiarthroplasty and proximal femoral nailing in the same cohort of patients.

Material and Methods: The retrospective scanning of two-year data of a tertiary care hospital has been carried out for patients with hip fractures undergoing proximal femoral nailing and bipolar hemiarthroplasty. 67 patients underwent proximal femoral nailing and 74 patients underwent bipolar hemiarthroplasty were included in the study. Each patient's short and long term outcomes were documented as well as their preoperative, intraoperative, and postoperative features.

Results: There were no significant differences in the demographic features of both groups. The median intraoperative blood loss was significantly higher in the group who underwent bipolar hemiarthroplasty compared to the group who underwent proximal femoral nailing (450 cc vs 300 cc, respectively, $p<0.001$). It was found that the bipolar hemiarthroplasty procedure was associated with a greater need for intraoperative transfusion than the proximal femoral nailing procedure ($p=0.007$). Intraoperative complications were reported only in patients who underwent bipolar hemiarthroplasty. The need for intensive care unit was significantly higher in the bipolar hemiarthroplasty group than in the proximal femoral nailing group, with the rate of 86.5% (n=64) and 68.7% (n=46), respectively ($p=0.011$).

Conclusion: According to the results of this study, the proximal femoral nailing procedure appears to be a more reliable surgical technique in patients with hip fractures in terms of both intraoperative complications and the postoperative need for an intensive care unit.

Keywords: Elderly; hemiarthroplasty; intertrochanteric fracture; proximal femur nailing; surgery outcomes.

ÖZ

Amaç: Bu çalışma, benzer özelliklere sahip hasta grubunda bipolar hemiartroplasti ile proksimal femoral çivileme arasında kısa ve uzun dönem cerrahi, klinik ve fonksiyonel sonuçları karşılaştırmak amacıyla yapılmıştır.

Gereç ve Yöntemler: Proksimal femur çivileme ve bipolar hemiartroplasti uygulanan kalça kırığı olan hastalar için, üçüncü basamak bir hastanenin iki yıllık verilerinin geriye dönük taraması yapıldı. 67 proksimal femoral çivileme uygulanan hasta ve 74 bipolar hemiartroplasti uygulanan hasta çalışmaya dahil edildi. Her bir hastanın kısa ve uzun vadeli sonuçları ile ameliyat öncesi, ameliyat sırasındaki ve ameliyat sonrası özellikleri kayda alındı.

Bulgular: Her iki grubun demografik özelliklerinde istatistiksel olarak anlamlı bir farklılık yoktu. Bipolar hemiartroplasti uygulanan grupta ameliyat sırasındaki ortanca kan kayıp miktarı proksimal femoral çivileme uygulanan gruba göre anlamlı derecede daha yüksekti (sırasıyla 450 cc'ye karşı 350 cc; $p<0,001$). Bipolar hemiartroplasti prosedürünün, proksimal femoral çivileme prosedüründen daha fazla ameliyat sırasında transfüzyon ihtiyacı ile ilişkili olduğu saptandı ($p=0,007$). Sadece bipolar hemiartroplasti yapılan hastalarda ameliyat sırasında komplikasyon varlığı rapor edilmiştir. Yoğun bakım ihtiyacı bipolar hemiartroplasti grubunda, proksimal femoral çivileme grubuna göre, sırasıyla %86,5 (n=64) ve %68,7 (n=46) oranları ile anlamlı derecede daha yüksekti ($p=0,011$).

Sonuç: Bu çalışmanın sonuçlarına göre, kalça kırığı olan hastalarda proksimal femoral çivileme prosedürü hem ameliyat sırasındaki komplikasyonlar ve hem de ameliyat sonrası yoğun bakım ihtiyacı açısından daha güvenilir bir cerrahi teknik olarak görünmektedir.

Anahtar kelimeler: Yaşlılar; hemiartroplasti; intertrokanterik kırık; proksimal femur çivileme; cerrahi sonuçlar.

INTRODUCTION

As a consequence of increased life expanse, complications related to aging increase, one of the most common complications of aging is hip fractures. The approximate rate of hip fractures is predicted to reach 4.5 million by 2050 worldwide (1,2). The unstable intertrochanteric fractures can only be treated surgically; therefore, choosing the optimal medical innervation with minimal complications is essential for quality aging. Stabil fixation, early mobilization, and weight-bearing are the expectations from surgical treatment. However, underlying diseases and comorbidities of the patients and the low surgical tolerance of the under-risk population make it hard to achieve the ideal result. Therefore, exhaustive studies and reports on surgical techniques always are required. The most common surgical technics in femur neck and trochanteric fractures are the proximal femoral nailing (PFN) technique, uni and bipolar hemiarthroplasty (BHA), and external fixation. Unfortunately, there is no consensus regarding the most reliable method for elderly patients to avoid complications and gain maximum benefit. This study aimed to compare the complications and the clinical and functional outcomes of patients with intertrochanteric fractures of the femur treated with PFN and BHA.

MATERIAL AND METHODS

Study Design

This is a retrospective study analyzing patients admitted to the orthopedic clinics of Ahi Evran University Faculty of Medicine with unstable trochanteric fractures and treated with PFN or BHA from January 2018 to December 2020. The medical records were collected from the hospital database. Ethical approval was obtained for the study from the Ethics Committee of Ahi Evran University Faculty of Medicine numbered 2021-03/30, date 09/02/2021. The recommendations of the Declaration of Helsinki for biomedical research involving human subjects were followed. The authors have provided contributions to data collection, manuscript preparation, and literature review.

Patients and Data

The patients admitted with unstable intertrochanteric fractures according to Evans's classification were studied. The patients were included if the fracture occurred after low or minor energy trauma and if they were followed up at least two years after the surgery. The patients were excluded if the fracture occurred after multi-trauma, on pathologic or malignant baseline, and stable fractures, patients with previous immobility, patients with a preexisting femoral implant, and severe infection or sepsis were also excluded.

A total of 213 cases of unstable femur fractures were accepted into our clinic between January 2018 and December 2020. Among them, a total of 72 cases were excluded from the study because they did not meet the study criteria, were multi-trauma cases or emergency cases, or had insufficient follow-up data.

Patients' demographic and clinical information such as age, gender, concomitant comorbid disease status, and the American Society of Anesthesiologists (ASA) score were recorded. Information regarding trauma, such as side and etiology of injury, preoperative Arbeitsgemeinschaft für Osteosynthesefragen (AO) evaluation of fracture, was also noted. The preoperative and postoperative information of the patients such as the length and type of surgery, the length of hospital stay, the intensity and duration of intensive care, the length of fat storage, the need for intraoperative blood supplementation, and any intra- and postoperative complications were collected.

Treatment and Follow-up

All the patients were operated on by a surgeon with at least a 5-year of experience. In addition, all the patients included were evaluated with the ASA classification for the preoperative health status, and the fractures were classified using the AO classification. All the patients were followed up at least one year after the operation; the short-term (the first-month follow-up) and the long-term (the 12 months follow-up) complications were recorded. Intraoperative blood loss, duration of the procedure, and complications were recorded. In addition, the postoperative mobilization, complication, and mortality status were detected.

Surgical Technique

After supine positioning on the orthopedic table, the surgical area was prepared following the closed reduction, and an appropriate incision was made to reach the trochanter major. Using the trochanteric reamer over the K-wire after being seen on both planes on the scopy, the proximal femur was reamed. Nails of appropriate diameter and length were placed with the placement guide. After the nail was placed over the guide wire, the K-wire was removed. After the nail was sent, the tissue saver system (A-PFN Blade Drill & Prox. Screw K-Wire Guide) was placed to deliver the proximal neck screw and antirotation wedge. A-PFN (Antirot.-Prox. Fem. Nail) model from TST Orthopedic Implants was used for the surgery. Preoperative images of two proximal femur fractures and their postoperative images after placement of PFN were presented in Figure 1. Preoperative images of a femur fracture and the postoperative image after repairing with BHA were presented in Figure 2.

Statistical Analysis

All analyses were performed on SPSS v.21. Normality assumption was examined by the Kolmogorov-Smirnov test, and the Levene test was used to examine the homogeneity of variances. Descriptive statistics were given as mean±standard deviation or median, 25^{th}-75^{th} percentile, and minimum-maximum for continuous variables, as appropriate. Categorical variables were summarized as frequency and percentage. Independent samples t, Welch, or Mann-Whitney U test were used to compare groups if the assumptions were met. The Pearson chi-square or Fisher-Freeman-Halton tests were performed for categorical comparisons. A p value of <0.05 was defined as the significance level for all statistical analyses.

RESULTS

A total of 141 patients, 67 patients who underwent PFN and 74 patients who underwent BHA were included. The general demographic characteristics of the patients were similar and homogenous. The mean age was similar between the groups. The age range of the patients in the PFN group started from 26 years of age. It was the youngest patient in the group; the next patient's age was 54 years. When evaluating the patients according to comorbidities, we found out that another four patients and the present young had no comorbidities, and those

patients' ages ranged from 62-84 years of age. Therefore, we did not exclude the young patient from the study, considering it differed from the study population environment. The side of the fracture (p=0.558), and the median interval between the trauma and surgery (p=0.070) were similar. All patients with existing comorbid diseases were homogenous (p=0.245). The general features of the patients were shown in Table 1.

Pre- and Intraoperative Data Comparison

According to AO classification, the fracture types were similarly proximal and diaphyseal femoral fractures in all the patients. The patients had similar operative risks with similar preoperative ASA scores. There was no significant difference between the groups according to the duration of the procedure; the median duration for both techniques were approximately 60 minutes (p=0.205). However, intraoperative bleeding was significantly higher in the BHA group (p<0.001), and there was a significantly more need for transfusion in the BHA group (p=0.007). The intraoperative complications were reported only in the BHA group (periprosthetic fracture, trochanter major fracture, trochanter minor fracture). The intraoperative data of the PFN and BHA groups were shown in Table 2.

Postoperative Data Comparison

There was no significant difference in hospital stay days between the groups; the patients who underwent PFN were hospitalized for a median of 7 (range, 2-17) days, and the patients who underwent BHA for 6 (range, 3-28) days after the surgery. 68.7% (n=46) of the patients in PFN and 86.5% (n=64) of the patients in the BHA group needed intensive care unit follow-up after the surgery, and the difference was statistically significant (p=0.011). Only two patients in the PFN group and only four patients in the BHA group were unable to mobilize (p=0.683). Both short-term and long-term complications were similar in both groups (p=0.668). The mortality rate was similar between the BHA group and the PFN group (p=0.683). Table 2 presents the postoperative data in detail.

Figure 1. A pre- and post-operative image of proximal femur fractures; the proximal femur nailing

Figure 2. A female patient with a proximal femur fracture was repaired with bipolar hemiarthroplasty

Table 1. Comparison of the baseline features of the patients

	PFN (n=67)	BHA (n=74)	p
Age (years), mean±SD	77.99±12.67	80.12±7.04	0.225
BMI (kg/m^2), mean±SD	27.55±3.25	26.71±4.45	0.197
Gender, n (%)			
Female	36 (53.7)	45 (60.8)	0.396
Male	31 (46.3)	29 (39.2)	
Side, n (%)			
Right	32 (47.8)	39 (52.7)	0.558
Left	35 (52.2)	35 (47.3)	
Comorbidity, n (%)	62 (92.5)	64 (86.5)	0.245
Time before surgery (hours)$^{\#}$	2 (1-3) [1-6]	2 (2-4) [1-8]	0.070

PFN: proximal femoral nailing, BHA: bipolar hemiarthroplasty, SD: standard deviation, $^{\#}$: median (25^{th}-75^{th} percentile) [minimum-maximum]

Table 2. Comparison of pre-, intra-, and postoperative features of the patients

		PFN (n=67)	BHA (n=74)	p
Preoperative features	**AO classification of the fracture**, n (%)			
	A1	37 (55.2)	36 (48.6)	0.592
	A2	27 (40.3)	32 (43.2)	
	A3	3 (4.5)	6 (8.1)	
	ASA score, n (%)			
	1	1 (1.5)	0 (0.0)	0.121
	2	18 (26.9)	29 (39.2)	
	3	47 (70.1)	41 (55.4)	
	4	1 (1.5)	4 (5.4)	
Intraoperative features	**Duration of operation** (minutes)$^{\#}$	60 (55-70) [45-95]	60 (50-65) [40-85]	0.205
	Intraoperative blood loss (cc)$^{\#}$	300 (200-350) [100-600]	450 (385-500) [250-650]	**<0.001**
	Need for transfusion, n (%)	34 (50.7)	54 (73.0)	**0.007**
	Intraoperative complication, n (%)	0 (0.0)	1 (1.4)	1.000
Postoperative features	**Hospitalization time** (days)$^{\#}$	7 (6-9) [2-17]	6 (5-8) [3-28]	0.095
	Need for intensive care unit, n (%)	46 (68.7)	64 (86.5)	**0.011**
	Postoperative complications*, n (%)	4 (6.0)	3 (4.1)	0.708
	Long term complications**, n (%)	3 (4.5)	2 (2.7)	0.668
	Lack of mobilization, n (%)	2 (3.0)	4 (5.4)	0.683
	Mortality, n (%)	2 (3.0)	4 (5.4)	0.683

PFN: proximal femoral nailing, BHA: bipolar hemiarthroplasty, AO: Arbeitsgemeinschaft für Osteosynthesefragen, ASA: American Society of Anesthesiologists, $^{\#}$: median (25^{th}-75^{th} percentile) [minimum-maximum], *: delirium, superficial infection, deep tissue infection, deep vein thrombosis, pulmonary embolism, **: coxarthrosis, revision surgery, devise loosening

DISCUSSION

Hip fractures are a significant cause of morbidity and mortality in the elderly, and surgery is indicated for most cases. Nevertheless, comorbidities, osteoporotic, and poor bone structure of the elderly make it challenging to obtain an ideal treatment for hip fractures. A large number of studies suggested surgical repair. According to study reports performed after 1971, when primary arthroplasty was performed first, most surgical intervention patients were mobilized earlier. Mortality in patients who underwent surgical intervention was reported to be fourfold lower at one year and threefold lower at two-year follow-up compared to those with chose non-operative treatment (3,4). Furthermore, surgical repair provides better pain control and more rapidly improves mobility, even in bed (5).

The baseline composition of patients in this study showed a typical prototype of femoral trochanteric fracture due to minor trauma population: senile, female dominate population with coexisting diseases in leading of the patients. Therefore, the average demographics, fracture types, and preoperative ASA scores were coequal between the groups.

Several studies have evaluated the association of preoperative duration with some postoperative outcomes in the literature (6-8). It was found that delayed operative intervention results in a deferral of full weight-bearing and leads to delayed functional recovery. In addition, operating the hip within 24 hours was found to be associated with reduced pain and a decreased hospitalization stay compared with delayed (>24 hours) surgery (9). Consequently, surgical intervention is recommended within 24 hours in medically stable patients without significant comorbidities. And for all patients, it is recommended to avoid delaying surgery beyond 72 hours. In this study, the median trauma to surgery time was 2 hours both in PFN and BHA groups. The widely accessible healthcare and experienced consensus of surgeons on early intervention may be the reason for the algorithmic standardization in such early intervention.

Comparing the surgical techniques, we investigated the duration of operation, intraoperative blood loss, need for transfusion, and intraoperative complications. It took a similar time (approximately 60 minutes) to repair the injured hip in both methods. However, the remaining features were privileged to PFN surgery. Intraoperative blood loss, need for transfusion and need for intensive care unit were reported to be significantly higher in BHA. The complications were periprosthetic and trochanteric fractures. Some studies reported either PFN or BHA techniques benefit in either operation time. Ekinci et al. (10) reported that BHA surgery is advantageous in terms of operating time, allowing early weight bearing, on the contrary, Özkayın et al. (11) have reported a shorter time for the PFN method, or intraoperative bleeding amount. Several studies report that both methods as equally safe for the patients (12). There is no single ideal method according to operative outcomes.

Interestingly, this study found that more patients who underwent BHA needed intensive care unit hospitalization after the surgery. It may be a consequence of BHA intraoperative disadvantages. Again, there were many mortalities and especially long-term mortality after the BHA surgery. So, we may say that the BHA method is a disadvantageous technique for hip fracture repair in general. Tan et al. (13) have also reported significantly high postoperative complication and mortality rates in patients who underwent BHA and therefore suggested not to select BHA as a primary option in trochanteric fractures in the elderly. In their systematic review, Kumar et al. (14) also suggested the PFN method in elderly patients as a safer surgical technique.

Literature reports that mortality of hip fracture surgery range from approximately 1 to 10 percent, depending on patient characteristics (15,16). The mortality rate arises over time, one-year mortality rates have ranged from 12 to 37 percent (17). The mortality rate in this study was approximately 3.0% for PFN and 5.4% for the BHA group. Like as LeBlanc et al. (17) reported no increased risk of mortality after the first-year follow-up in their large prospective case-control study, we found out that long-term mortality is similar between the groups.

Considering that many studies comparing the PFN and BHA techniques have been performed, and the data reported still gives no consensus on the ideal approach, as a suggestion for further studies, we would offer to collect all the previous reports in a single detailed meta-analysis.

As a limitation of the study, it is a single-center study with a comparatively low number of patients. Nevertheless, the clear and close follow-up data of the patients increases the value of the study.

CONCLUSION

Intraoperative and some long term postoperative outcomes of BHA treated to give a negative impression on this technique. Patients with hip fractures treated with BHA have more intraoperative blood loss, have more need for transfusion during the surgery, have more intraoperative complications, and have a higher rate of need for intensive care unit. Therefore, PFN techniques seem to be a safer surgery method for patients with hip fractures.

Ethics Committee Approval: The study was approved by the Clinical Researches Ethics Committee of Ahi Evran University (09.02.2021, 03-30).

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