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Results of Cementless and Cemented Bipolar Hemiarthroplasty in Proximal Femur Fractures with Dorr Type B Morphology

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ABSTRACT

Objective: Surgical outcomes of patients with Dorr type B femoral morphology operated for hip fracture with bipolar hemiarthroplasty were compared. **Materials and Methods:** This retrospective study included 255 patients with a follow-up of at least five years. Patients were divided into two groups: cementless (group 1; n=87) and cemented (group 2; n=168). The study focused on the following parameters: Admission cost, fracture type, gender, need for blood transfusion, Harris Hip Score (HHS), additional fracture, use of cement, mortality rate, revision surgery, the time between trauma and surgery, length of hospital stays, and surgery time. **Results:** The mean age of patients was similar in both groups. Group 2 had a significantly longer duration of surgery and a higher need for blood transfusions than group 1. The mean hemoglobin levels of patients were similar in both groups. Pertrochanteric femoral fractures were more common than femoral neck fractures in group 2. The two groups did not differ on the parameters of time between trauma and surgery, mortality rate, revision surgery, length of hospital stay, cost, and additional fractures. **Conclusion:** In patients aged 75 years or older who are scheduled for cemented bipolar hemiarthroplasty, erythrocyte suspension preparation should be performed before surgery if a hip fracture with Dorr type B femoral morphology is present.

Keywords: Elderly, Hemiarthroplasty, Hip, Hip Fractures.

Dorr Tip B Morfolojili Proksimal Femur Kırıklarında Çimentosuz ve Çimentolu Bipolar Hemiarthroplasti Sonuçları

ÖZ

Amaç: Bipolar hemiarthroplasti ile kalça kırığı nedeniyle ameliyat edilen Dorr tip B femur morfolojisine sahip hastaların cerrahi sonuçları karşılaştırıldı. **Gereç ve Yöntem:** Bu retrospektif çalışmada, en az 5-yıllık takibi olan 255 hasta değerlendirildi. Hastalar iki gruba ayrıldı: sementsiz (Grup 1; n=87) ve sementli (Grup 2; n=168). Çalışma şu parametrelere odaklandı: yatış maliyetleri, kırık tipi, cinsiyet, kan transfüzyonu ihtiyacı, Harris hip skoru (HHS), ek kırık, çimento kullanımı, ölüm oranı, revizyon cerrahisi, travma ile cerrahi arasındaki süre, hastanede kalış süresi ve ameliyat süresi. **Bulgular:** Gruplarda yer alan hastaların yaş ortalaması benzer idi. Grup 2, Grup 1'e göre anlamlı olarak daha uzun ameliyat süresine ve daha yüksek kan transfüzyonu oranına sahipti. Ortalama hemoglobina değerleri her iki grupta benzerdi. Grup 2'de pertrokanterik femur kırıkları, femur boyun kırıklarından daha yaygındı. Travma ve ameliyat arasındaki süre, ölüm oranı, revizyon cerrahisi, hastanede kalış süresi, yatış maliyeti ve ek kırık açısından iki grup arasında anlamlı bir fark yoktu. **Sonuç:** 75 yaş veya üzeri Dorr tip B femur morfolojisine sahip kalça kırığı olan hastalar çimentolu bipolar hemiarthroplasti planlanıyorsa ameliyat öncesi mutlaka eritrosit süspansiyonu hazırlığı yapılmalıdır.

Anahtar kelimeler: Yaşlı, Hemiarthroplasti, Kalça, Kalça Kırıkları.

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INTRODUCTION

Osteoporotic hip fractures are more common with increasing age. It is estimated that by 2050, a total of 63 million hip fractures will be identified worldwide (Melton III et al., 1999). These fractures are becoming increasingly critical due to high mortality and the cost of postoperative care. A patient with a hip fracture incurs three times the cost per year as a patient without a hip fracture (Haentjens et al., 2001).

The Dorr type, Singh index, cortical thickness index (CTI), and canal-to-calcus ratio (CCR) are classification systems for the quality of the proximal femur (Singh et al., 1970). The Dorr classification was developed by Dorr (1993). While Dorr type A indicates good bone quality, types B and C are more common indications of osteoporotic bone (Sah et al., 2007).

Hip fractures are treated in a variety of ways in older patients. Total hip arthroplasty (THA) and internal fixation (IF) are standard options in elderly patients or patients with osteoporotic hip fractures, but hemiarthroplasty (cemented or cementless) is still a treatment of choice. Hemiarthroplasty has been reported to be relatively superior to THA and IF (Fan et al., 2012; Kiran Kumar et al., 2013; Parker & Johansen, 2006; Sonar et al., 2014). Therefore, hemiarthroplasty is the primary procedure of choice in our clinic for the treatment of older hip fractures with low bone quality.

Some intraoperative and postoperative complications of hemiarthroplasty include periprosthetic fractures, dislocation, deep infection, venous thromboembolism, cardiopulmonary disease, and mortality (Weinrauch, 2006).

This retrospective study with a follow-up of five years compared the differences between cementless and cemented bipolar hemiarthroplasty in elderly patients with a Dorr B-type proximal femur fracture.

MATERIALS AND METHODS

Three hundred two patients aged 75 years or older with Dorr type B femoral morphology underwent bipolar hemiarthroplasty for proximal femoral fractures. Forty-seven patients were not included in the sample because we did not have access to their data. Eighty-seven (34.10%) patients underwent surgery with cementless bipolar hemiarthroplasty (group 1), whereas the remaining 168 (65.90%) underwent surgery with cemented bipolar hemiarthroplasty (group 2). Thirty-two (12.50%) patients died within the first five years. The remaining 223 patients (87.50%) were followed up for at least five years.

Parameters

The parameters were: Age (≥ 75), sex, duration of surgery, time between first admission and surgery, additional fracture, blood transfusion, hemoglobin (Hg), sodium (Na), potassium (K), creatinine,

glucose, thyroid-stimulating hormone (TSH), free thyroxine (T4), Dorr classification, fracture classification, Harris Hip Score (HHS), mortality, revision surgery, and admission cost. Blood tests were performed at initial admission.

The Dorr classification is used to determine bone quality and structure of the proximal femur (Dorr et al., 1993). Type A has a dense cortical bone beginning at the tip of the lesser trochanter, which looks like a "champagne flute" and a slender femoral canal. Type B has a wide diaphyseal canal and a thin cortex. Type C has a wide diaphyseal canal that looks like a "stovepipe."

William H. Harris developed the Harris Hip Score to assess the health consequences of hip surgery (Mahomed et al., 2001). It is a ten-item instrument used to assess postoperative recovery and compare health outcomes. The patient answers eight questions while the physician scores two items (deformity and range of motion). The highest score is 100, and the worst score is < 70 .

The total cost was the sum of the cost of all procedures performed from admission to discharge. During the 5-year follow-up, patients who underwent reoperation for infection, periprosthetic fracture, or dislocation were documented.

Statistical analysis

The calculation of the values of skewness and kurtosis is a method for analyzing the normal distribution of the data. The values for kurtosis and skewness of the measurements were between -3 and $+3$, so the normality test could be considered valid (DeCarlo, 1997; Groeneveld & Meeden, 1984; Hopkins & Weeks, 1990; Moors, 1986). The data and results all conformed to the range of normal distribution. Statistical analyzes were performed using parametric tools.

The independent-samples t-test for numerical data was used to examine differences between groups. We evaluated categorical data and descriptive statistical methods (mean, standard deviation) using Pearson chi square and Fisher's exact tests. SPSS® version 20.00 for Windows (SPSS, Armonk, NY, USA) was used for statistical analysis. The significance threshold was chosen at $p < 0.05$.

Ethical considerations

Informed consent was obtained from all patients who participated in the study during their first hospitalization. The study was conducted in accordance with the principles of the Declaration of Helsinki. We obtained ethical approval from the Ethics Committee of Erzurum Regional Training and Research Hospital (approval date/number: 01.03.2021/ 05-89).

RESULTS

The mean age of the patients was 83.03 years. While the mean age of patients in group 1 was 82.34 years, the mean age of patients in group 2 was 83.38 years. There was no statistically

significant difference between the groups in terms of age ($p=0.142$). The mean operation time was 92.28 min in group 1 and 109.03 min in group 2,

respectively. We found a statistically significant difference between the two groups ($p=0.002$) (Table 1).

Table 1. Demographic data of the patients.

Dorr type b	Cementless (n=87)	Cemented (n=168)	Total (n=255)	P
	X±SD (Min-Max)	X±SD (Min-Max)	X±SD (Min-Max)	
Age	82.34±5.26 (75-94)	83.38±5.36 (75-106)	83.03±5.34 (75-106)	0.142
Surgery time/minutes	92.28±43.05 (29-240)	109.03±38.51 (35-245)	103.31±40.82 (29-245)	0.002*
Total cost / USD	1769±443 (471-3025)	1783±528 (507-3227)	1778±500 (471-3227)	0.839
Hospitalization time / day	8.86±4.37 (1.70-22.90)	8.44±3.21 (2.30-19.40)	8.58±3.64 (1.70-22.90)	0.431
Time between trauma and surgery / day	2.94±1.85 (0.30-8.10)	2.95±1.76 (0.40-9.60)	2.95±1.79 (0.30-9.60)	0.970
Hemoglobin (g/dL)	12.90±1.86 (8.00-17.90)	12.55±1.96 (7.50-17.60)	12.67±1.93 (7.50-17.90)	0.173
Glucose (mg/dL)	127.26±33.33 (65-221)	131.51±31.46 (57-229)	130.06±32.11 (57-229)	0.317
Creatinine (mg/dL)	1.01±0.43 (0.30-2.40)	0.97±0.37 (0.50-2.40)	0.99±0.39 (0.30-2.40)	0.477
TSH (mU/L)	1.49±0.99 (0-5)	1.49±1.16 (0-6)	1.49±1.10 (0-6)	0.967
T4 (ng/L)	1.11±0.22 (0.60-1.80)	1.10±0.23 (0.60-1.80)	1.10±0.23 (0.60-1.80)	0.641
Na (mmol/L)	137.83±3.78 (125.00-148.00)	137.25±3.62 (121.00-148.30)	137.45±3.68 (121-148.30)	0.236
K (mmol/L)	4.35±0.63 (3.10-7.30)	4.25±0.60 (3.10-6.50)	4.28±0.61 (3.10-7.30)	0.194

TSH: Tirotropin; T4: Tiroksin; Na: Sodium; K: Potassium. * Independent Samples t-test.

The patients who received blood transfusion in the postoperative period were 53 patients in group 1 and 138 patients in group 2 ($p<0.001$) (Table 2).

Trauma caused by the fracture was low-energy in 251 (98.40%) patients. Only 4 (1.60%) patients had fractures after high-energy trauma. These four patients underwent cementless bipolar hemiarthroplasty for a pertrochanteric femoral fracture.

In group 1, 25 (28.70%) patients had pertrochanteric femur fractures, while 62 (71.30%) patients had femoral neck fractures. In group 2, 123 (73.20%) patients had pertrochanteric femoral fractures, while the remaining 45 (26.80%) patients had femoral neck fractures. There was considerable variability in the type of fractures between the two groups ($p=0.017$) (Table 2).

Patients operated on with cementless bipolar hemiarthroplasty had HHS scores of 75.06±8.65 and 84.34±7.02 at six months and 12 months after surgery, respectively, and there was a statistically significant difference ($p<0.001$). In patients operated with cemented bipolar hemiarthroplasty, the HHS scores at six months and 12 months after surgery were 77.30±8.69 and 84.41±7.00, respectively, and there was a statistically significant difference ($p<0.001$). The mean HHS score at postoperative month 12 was significantly higher than the mean HHS score at postoperative month 6 in all patients ($p<0.001$). In contrast, there was no significant difference in postoperative HHS scores at six months ($p=0.052$) and at 12 months ($p=0.943$) between the two groups (Table 3).

Table 2. Surgical data of the patients.

Dorr type b		Cementless (n=87)	Cemented (n=168)	Total (n=255)	p
		n (%)	n (%)	n (%)	
Blood transfusion	None	34 (39.10%)	30 (17.90%)	64 (25.10%)	<0.001**
	Transfusion	53 (60.90%)	138 (82.10%)	191 (74.90%)	
Death	Live	74 (85.10%)	149 (88.70%)	223 (87.50%)	0.504
	Dead	13 (14.90%)	19 (11.30%)	32 (12.50%)	
Gender	Male	46 (52.90%)	86 (51.20%)	132 (51.80%)	0.801
	Female	41 (47.10%)	82 (48.80%)	123 (48.20%)	
Revision surgery	None	80 (92.00%)	157 (93.50%)	237 (92.90%)	0.124
	Revised	7 (8.00%)	11 (6.50%)	18 (7.10%)	
Additional fractures	None	85 (97.70%)	161 (95.80%)	246 (96.50%)	0.402
	Fractures	2 (2.30%)	7 (4.20%)	9 (3.50%)	
Trauma	Low	83 (95.40%)	168 (100.00%)	251 (98.40%)	0.004*
	High	4 (4.60%)	0	4 (1.60%)	
Fracture type	Petrochanteric	25 (28.70%)	123 (73.20%)	148 (58.00%)	0.017**
	Femoral Neck	62 (71.30%)	45 (26.80%)	107 (42.00%)	

* Fisher's Exact Test (1-sided), ** Pearson Chi-Square.

Table 3. Harris Hip Score in the postoperative 6th and 12th months.

Dorr Type B	Cementless N: 87	Cemented N: 168	Total N: 255	p
	X±SD (Min-Max)	X±SD (Min-Max)	X±SD (Min-Max)	
HHS- 6 th month	75.06 ± 8.65 (63-90)	77.30 ± 8.69 (63-90)	76.53 ± 8.73 (63-90)	0.052
HHS- 12 th month	84.34 ± 7.02 (70-95)	84.41 ± 7.00 (70-95)	84.39 ± 6.99 (70-95)	0.943
p-value	<0.001*	<0.001*	<0.001*	

HHS: Harris Hip Score

* Related-Samples Test

There was no significant difference between the two groups in total cost (p=0.839), length of hospital stays (p=0.431), and time from trauma to surgery (p=0.970). There was no significant difference in hemoglobin (p=0.173), creatine (p=0.477), glucose (p=0.317), TSH (p=0.967), T4 (p=0.641), Na (p=0.236) and K (p=0.194). There was also no significant difference in death (p=0.504), sex

(p=0.801), revision surgery (p=0.124), and additional fractures (p=0.402).

DISCUSSION

One of the most striking results was that petrochanteric femoral fractures were significantly more common in group 2 than in group 1. The petrochanteric fractures are more complicated to treat than femoral neck fractures. The fact that the operative time was longer and the need for blood

transfusion was higher in group 2 also supports this contention.

Hip fractures, which increase with age, are more common in women than in men. After menopause, estrogen levels in women decrease, increasing the risk of fractures in women (Anderson et al., 1964; Ong et al., 2002; Seckin, 2003). In contrast, we found that the number was slightly higher in men.

There is an ongoing debate about the ideal treatment for hip fractures caused by osteoporosis in the elderly. The most common complications are avascular necrosis after internal fixation, nonunion and implant failure, and hip dislocation and reoperation for total hip arthroplasty (Guyen, 2019; McKinley & Robinson, 2002). Therefore, hemiarthroplasty appears to be the ideal treatment for such patients. Initially, the equipment for arthroplasty may be expensive, but given the high reoperation rates and complications from internal fixation, we think hemiarthroplasty will cost less (Lu-Yao et al., 1994; Rogmark et al., 2003).

Current research, which includes national registries of joint replacements, recommends cemented stems for femoral neck fractures because they offer immediate full weight-bearing, less postoperative discomfort in the mid-thigh, lower risk of intraoperative fractures, and fewer late fractures requiring revision (Song et al., 2019).

Complications and revision surgery can also drive up costs. Dorr et al. (1993) reported that patients with femur type C have a higher risk of intraoperative fractures than patients with femur types A and B (Dorr et al., 1993). Cement may reduce the risk of intraoperative fractures (Nash & Harris, 2014). We did not find a significant difference in revision surgery and intraoperative fracture rates between the two groups.

Some studies reported higher blood transfusion rates, longer operative time, and more cardiovascular complications in patients with cemented hemiarthroplasty than in patients with cementless hemiarthroplasty (Barenus et al., 2018; Frenken et al., 2018). According to some authors, there is no hemodynamically significant difference between cemented and cementless hemiarthroplasty (Inngul et al., 2015; Miyamoto et al., 2018). We found that group 2 required more blood transfusions in the postoperative period than group 1.

Most studies show that the mortality rate in the postoperative period is higher in patients with cemented hemiarthroplasty than in patients with cementless hemiarthroplasty (Holt et al., 1994; Muirhead-Allwood et al., 1983). However, some other studies reported similar mortality rates in both groups (Frenken et al., 2018). A delay of more than four days between admission and surgery increases mortality rates in the first year (Moran et al., 2005). We found that both groups 1 and 2 had a mean delay of 72 hours between admission and surgery and

similar mortality rates in the first five years (14.90% and 11.30%, respectively).

This study had some limitations. First, we did not include postoperative hemoglobin levels in the analysis because the blood tests were performed on different days. Second, we did not compare pain scores between the two groups. Third, the tension band technique with K-wire and cerclage was used to fix fractures in the greater trochanter in some patients. However, no differential grouping was performed for these patients.

This study had three strengths. First, the sample size was large. Second, we followed the patients over a long period of time. Third, a comparative approach was used, which is rare in the literature. Therefore, we believe our results will contribute to the literature.

CONCLUSION

Surgical time was longer in patients operated on with cemented bipolar hemiarthroplasty. The need for blood transfusion was higher in patients operated on with cemented bipolar hemiarthroplasty. While femoral neck fractures were more common in patients operated on with cementless bipolar hemiarthroplasty, petrochanteric femoral fractures were more common in patients operated on with cemented bipolar hemiarthroplasty. The postoperative recovery and health outcomes of patients operated on with cemented or cementless bipolar hemiarthroplasty were similar.

Therefore, in patients aged 75 years or older who are scheduled for cemented bipolar hemiarthroplasty, the erythrocyte suspension preparation should be performed before surgery if a hip fracture with Dorr type B femoral morphology is present.

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Conflict of Interest

The authors declare that there are no potential conflicts of interest related to the research, authorship, and/or publication of this article.

Author Contributions

Plan, design: MÇE, ST, KZ; **Material, Methods, and data collection:** KZ, MÇE, MCT; **Data analysis and comments:** ST, MCT; **Writing and corrections:** MÇE, ST, MCT, KZ.

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