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Is the number of dislocations after bipolar hemiarthroplasty affected by anatomical parameters?

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Abstract

The aim of this study was to evaluate the relationship between the number of dislocations and anatomical parameters after bipolar hemiarthroplasty (BHA) in femoral neck fracture (FNF) treatment. 'A total of 240 consecutive patients (157 females, 83 males) with FNFs who were treated with BHA were evaluated retrospectively. Of these 24 patients with dislocations divided into two main groups according to the number of dislocations: Single-dislocation (Group 1, n=15) and multiple-dislocation groups (Group 2, n=9). Surgery-related and anatomical morphologic features as well as patient factors and clinical outcomes were comparatively analyzed between the groups. Pre and postoperative standard anteroposterior (AP) and lateral radiographs were used to evaluate for surgical and anatomical parameters. Harris and Modified Harris Scores were used to evaluate postoperative clinical outcomes. The mean follow-up period was 30.2±11.7 months (range, 12-56 months). Mean age was 80.1±6.4 years (range, 71-98 years). Dislocation incidence was 10.0% (24/240). Mean time to first dislocation was 2.3±1.4 months (range, 1-6 months). Mean number of dislocations was 2.1±1.0 (range, 1-4). There was significant difference in surgical factors and anatomical parameters between groups including nonoperated side offset (ON), nonoperated side femoral offset (FO), residual femoral neck length (RFNL), major trochanter upper end and femoral head center distance (TEFHCD) of nonoperated side, height of hip center (HHC) of operated and nonoperated side, femoral neck-shaft angle (FNSA) of operated side and pelvic obliqity (PO) between the groups ($p<0.05$). However, patient related factors, time between injury to operation, operative time, prothesis type and clinical scores did not differ between single-dislocation and multiple-dislocation groups ($p>0.05$). Surgery-related and anatomical morphologic features were found to be effective in the number of dislocations (re-dislocation) after BHA. Patients who experienced the first-time dislocation after BHA with anatomical and surgical risk factors should be carefully monitored and more controlled physiotherapy may be recommended in terms of re-dislocation risk.

Keywords: Hemiarthroplasty, dislocation, risk factor, pelvic morphology, anatomical features

Introduction

Hip fracture incidence increases proportionally in elderly patients with the increase in the average life span. Mobilization and return to normal life are of utmost importance in order to prevent possible complications in these patients [1]. Bipolar hemiarthroplasty (BHA) offers a good alternative for displaced femoral neck fracture (FNF) in elderly to other treatment options (e.g. total hip arthroplasty, internal fixation) considering complications, mobilization time, revision rates and health-related quality of life [2,3]. Furthermore, it takes shorter time, causes less blood loss and has lower dislocation rates than total arthroplasty [4,5]. However, dislocation is a well-known complication that can lead to serious mortality and morbidity after BHA [6]. In the literature up to 16% BHA dislocation rates have been reported [7–10]. Several patient and surgery-related factors were found to be associated with dislocation after BHA in the literature such as weakness of abductor muscle, neurological problems, deformities of hip joint, surgical approaches, prosthetic problems and other [9,11–14]. Also, some other studies evaluated the association of pelvic and anatomical parameters and BHA dislocation [9,13,14]. However, a comparative analysis of re-dislocation in terms of anatomical and surgical factors are limited. Our hypothesis was that these factors may differ from each other in single and re-dislocation patient groups. Therefore, in this study, our aim was to investigate the surgical and anatomical factors as well as the patient factors and clinical outcomes in terms of number of dislocations after the treatment of BHA in elderly patients with FNFs.

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Materials and Methods

We reviewed 280 patients who were operated for FNFs between 2013 - 2019 retrospectively. 240 patients (157 females, 83 males, mean age of 80.1 + 6.4 years (range, 71-98 years) who met the inclusion criteria were included in the study. Posterolateral approach, BHA due to displaced FNF and at least 1-year regular follow-up, unilateral dislocations were the inclusion criteria. Pathological fractures (4 patients), other surgical approaches or implants (22 patients), lower than 1-year follow-up (8 patients), and history of previous hip surgery (4 patients) were excluded. Operations were performed under general or regional anesthesia with lateral decubitus position. After the skin incision was made, the subcutaneous tissue and fascia were passed. Short external rotator tendons were separated including the piriformis muscles and also the quadratus femoris muscles when needed. All the separated tissues were repaired with the joint capsule at the end of surgery. On the first postoperative day, immediate weight bearing allowed by using crutches. A rehabilitation program was given to all patients by a physiotherapist advising to avoid more than 90 degrees of flexion, 45 degrees of rotation and excessive hip adduction in hip movements. Pre- and postoperative standard anteroposterior (AP) and lateral radiographs of femur and hip joint and also pelvis were evaluated. Then, the measurements were recorded. Number of dislocations were investigated. Between single and multiple dislocation groups, a comparative analysis was performed including operation side, gender, age, body mass index (BMI), American Society of Anesthesiologists (ASA) Score and comorbidities (diabetes, thyroid disease, dementia, hypercholesterolemia, delirium) as patient factors. A blinded surgeon performed radiological measurements of the patients. Surgical and anatomical parameters were examined using Center edge angle (CE) [15], high of the pelvis (PH) [15], difference between the leg length following surgery (LLD) [16], offset of the prosthesis (OP) [15], femoral offset (FO) [15], femoral head extrusion index (FHEI) [17], residual femoral neck length (RFNL) [15] , upper end of trochanter major to center distance of femoral head (TEFHCD) [15], hip height center (HHC) [15], body weight lever arm (BWLA) [15], acetabular index (Sharp's angle) (AI) [18], Tönnis angle (TA) [19], femoral neck-shaft angle (FNSA) [15] and pelvic obliquity (PO) [20] as previously described and type of femoral stem (cementless square, modular, cemented calcar replacement) was recorded. Both healthy and affected sides were evaluated. Harris [21] and Modified Harris Scores [22) were used to evaluate postoperative clinical outcomes between the groups. Local Ethics Committee of Ordu University approved the study (protocol no: 2018/217) and participants approved the informed consent.

A SPSS, version 22.0, for Windows (SPSS Inc., Chicago, IL) was used in the statistical analysis of the data'. Median (range), mean±standard deviation (SD) and frequency ratio were used in descriptive statistics. Shapiro–Wilk test was used to test normality. Since the variables were not fit the normal distribution of nonparametric tests were used. The quantitative independent data were analyzed using independent sample t-test and Mann-Whitney U test. The comparison of qualitative independent data was performed using the Chi-squared test or Fischer exact test (when the Chi-square test conditions were not met). A <0.05 p-value was considered statistically significant for all tests.

Results

Dislocation (all posterior) occurred in 24 of 240 cases (10%) during follow up: Fifteen patients in single-dislocation group and nine patients in multiple-dislocation group. The mean follow-up period was 30.2±11.7 months (range, 12-56 months). Mean age was 80.1±6.4 years (range, 71-98 years). Mean time to first dislocation was 2.3±1.4 months (range, 1-6 months). Mean number of dislocations was 2.1±1.0 (range, 1-4). There was no significant difference between single-dislocation and multiple-dislocation group according to patient related factors (Table 1).

The parameters of non-operated side offset (ON), non-operated side FO, RFNL, TEFHCD of non-operated side, HHC of operated and non-operated side, FNSA of operated side and PO were significantly different between the single and multiple dislocation groups ($p<0.05$). Surgical factors and anatomical parameters are summarized in Table 2. No significant difference was observed in terms of clinical outcomes and type of prosthesis between the groups, the outcomes are summarized in Table 3 and Table 4.

Discussion

This comparative study reveals that number of dislocations following BHA is affected by anatomical and surgical factors. Decrease in the non-operated side of ON, FO, TEFHCD, HHC and operated side of HHC and also increase in RFNL, FNSA of operated side and higher PO towards the non-operated side had a negative effect in preventing dislocation and increased the number of dislocations. However patient factors and clinical outcomes did not differ in terms of number of dislocations after the treatment of BHA in elderly patients with FNFs.

Dislocation is a well-known complication that can lead to serious mortality and morbidity after BHA [6]. In the literature, up to 16% BHA dislocation rates have been reported [7–10]. Ko et al. [13] reported a dislocation rate of 1.9% after BHA using posterior approach where Mukka et al. [9] reported 10.7% revealing that most of these dislocations occurred in the first 6 months. Similar to the literature we found our dislocation rate as 10% and, we observed our first dislocations within 6 months.

Several patient and surgery-related factors were found to be associated with dislocation after BHA in the literature such as weakness of abductor muscles, neurological problems, deformities of hip joint, surgical approaches, prosthetic problems and other [9,11–14]. However, some other studies found no difference in the incidence of dislocation between patients with or without neuromuscular disease [16,23]. In our study, we found no significant difference between single-dislocation and multiple-dislocation groups. Comorbidities, age, sex, side of operation, BMI, ASA had no effect on re-dislocation.

Table 1. Patient characteristics according to the dislocation status.

		Total (n=240)	Dislocation (-) (n=216)	Single Dislocation (+) Group (n=15)	Multiple Dislocations (+) Group (n=9)	P value
Age (year)		80.1 ± 6.4	80.3 ± 6.4	79.4 ± 7.8	77.7 ± 2.0	0.454
BMI (kg/m2)		24.2 ± 2.7	24.3 ± 2.8	23.2 ± 2.1	23.5 ± 2.1	0.223
Sex	Female	157 (65.4)	143 (66.2)	9 (60.0)	5 (55.6)	0.726
	Male	83 (35.6)	73 (33.8)	6 (40.0)	4 (44.4)	
ASA	I	35 (14.6)	32 (14.8)	3(20.0)	0 (0.0)	0.347
	II	62 (25.)	56 (25.9)	2 (13.3)	4 (44.4)	
	III	122 (50.8)	111 (51.4)	8 (53.3)	3 (33.3)	
	IV	21 (8.8)	17 (7.9)	2 (13.3)	2 (22.2)	
Side	Right	101 (42.1)	94 (43.5)	4 (26.7)	3 (33.3)	0.381
	Left	139 (57.9)	122 (56.5)	11 (73.3)	6 (66.7)	
Diabetes	(-)	49 (20.4)	42 (19.4)	6 (40)	1 (11.1)	0.126
	(+)	191 (79.6)	174 (80.6)	9 (60)	8 (88.9)	
Hypercholestromia	(-)	72 (30.0)	62 (28.7)	7 (46.7)	3 (33.3)	0.332
	(+)	168 (70.0)	154 (71.3)	8 (53.3)	6 (66.7)	
Thyroid disease	(-)	10 (4.2)	10 (4.6)	0 (0.0)	0 (0.0)	0.560
	(+)	230 (95.8)	206 (95.4)	100 (100.0)	100 (100.0)	
Delirium	(-)	39 (16.3)	37 (17.1)	1 (6.7)	1 (11.1)	0.520
	(+)	201 (83.8)	179 (82.9)	14 (93.3)	8 (88.9)	
Dementia	(-)	47 (19.6)	44 (20.4)	1 (6.7)	2 (22.2)	0.424
	(+)	193 (80.4)	172 (79.6)	14 (93.3)	7 (77.8)	
Time injury to operation (days)	≤2	80 (69.4)	70 (32.4)	5 (33.3)	5 (55.6)	0.353
	>2	160 (30.6)	146 (67.6)	10 (66.7)	4 (44.4)	
Anesthesia type	Regional	136 (56.7)	90 (41.7)	7 (46.7)	7 (77.8)	0.097
	General	104 (43.3)	126 (58.3)	8 (53.3)	2 (22.2)	
Operative time (minutes)		65.3 ± 7.9	65.0 ± 7.2	68.0 ± 10.3	68.8 ± 8.2	0.156
Follow-up period (month)		30.2 ± 11.7	30.7 ± 11.8	27.2 ± 12.3	33.3 ± 10.0	0.414

BMI, Body mass index

Table 2. Surgery-related and pelvic morphologic features according to the dislocation status

	Total Dislocations (n=24)		Single Dislocation Group (n=15)		Multiple Dislocations Group (n=9)		p value
	Mean+sd/n-%	Median(min-max)	Mean+sd/n-%	Median(min-max)	Mean+sd/n-%	Median(min-max)	
(CE) angle(os)	44.2 ± 7.7	43.0 (32.0-58.0)	43.4 ± 1.4	44.0(42.0-45.0)	44.6 ± 9.8	43.0 (32.0-58.0)	0.718
(CE) anglex(ns)	41.4 ± 3.1	41.0 (36.0-47.0)	40.8 ± 1.5	41.0 (38.0-43.0)	41.8 ± 3.8	42.0 (36.0-47.0)	0.599
PH (cm)	21.6 ± 1.1	21.4 (20.0-24.0)	21.9 ± 1.6	21.0(20.2-24.2)	21.4 ± 0.7	21.6 (20.1-22.5)	0.278
LLD (cm)	0.21 ± 0.9	0.0 ([-1]-2)	0.06 ± 1.2	-0.5 ([-1.0]-2.0)	0.3 ± 0.8	0.0 ([-1.0] – 2.0)	0.347
OP (Offset Protesis)(cm)	5.0 ± 0.6	5.0 (4.0-6.0)	4.7 ± 0.7	5.1 (4.0-6.0)	5.2 ± 0.4	5.0 (5.0-6.0)	0.230
ON (Offset- ns) (cm)	4.8 ± 0.9	4.9 (3.3-6.5)	5.6 ± 0.8	5.3 (4.6-6.5)	4.4 ± 0.6	4.6 (3.3-4.9)	0.011
FO (os)(cm)	3.6 ± 0.7	3.9 (2.2-4.4)	3.8 ± 0.3	3.9 (3.5-4.3)	3.4 ± 0.8	3.9 (2.2-4.4)	0.953
FO (ns)(cm)	3.5 ± 0.9	3.6 (2.0-4.9)	4.1 ± 0.5	3.9 (3.6-4.9)	3.1 ± 0.8	2.8 (2.0-4.6)	0.009
FHEI (os)	0.4 ± 0.2	0.4 (0.2-0.8)	0.5 ± 0.2	0.4 (0.2-0.8)	0.4 ± 0.1	0.4 (0.2-0.7)	0.482
FHEI (ns)	0.12 ± 0.01	0.13 (0.09-0.15)	0.12 ± 0.01	0.13 (0.09-0.14)	0.12 ± 0.01	0.12 (0.10-0.15)	0.370
RFNL (os) (cm)	1.4 ± 0.6	1.2 (0.5-3.2)	1.1 ± 0.45	1.2 (0.5-2.1)	1.6 ± 0.6	1.4 (0.9-3.2)	0.018
TEFHCD (os)(cm)	4.3 ± 0.3	4.5 (3.7-5.0)	4.2 ± 0.5	4.5 (3.7-5.0)	4.3 ± 0.2	4.5 (3.9-4.6)	0.482
TEFHCD (ns)(cm)	4.9 ± 0.5	4.8 (4.2-6.1)	5.4 ± 0.5	5.3 (4.8-6.1)	4.7 ± 0.2	4.8 (4.2-4.9)	0.000
HHC (os)(cm)	6.6 ± 0.7	6.3 (5.9-8.1)	6.9 ± 0.5	6.9 (6.3-7.4)	6.5 ± 0.8	6.3 (5.9-8.1)	0.048
HHC (ns)(cm)	6.5 ± 0.7	6.5 (5.5-7.9)	7.2 ± 0.6	6.8 (6.6-7.9)	6.2 ± 0.5	6.1 (5.5-7.1)	0.001
BWLA (os) (cm)	9.3 ± 0.5	9.1 (8.2-11.0)	9.4 ± 0.4	9.7 (9.0-10.1)	9.2 ± 1.1	8.8 (8.2-11.0)	0.641
BWLA (ns) (cm)	9.4 ± 0.8	9.7 (7.8-10.8)	9.8 ± 0.1	9.8 (9.7-10.0)	9.2 ± 1.0	8.9 (7.8-10.8)	0.143
AI (os)	34.0 ± 4.5	33.0 (28.0-44.0)	34.5 ± 1.6	35.0 (33.0-37.0)	33.6 ± 5.7	32.0 (28.0-44.0)	0.656
AI (ns)	33.2 ± 3.6	34.0 (27.0-38.0)	34.0 ± 3.2	35.0 (30.0-38.0)	32.7 ± 3.9	34.0 (27.0-38.0)	0.424
TA (os)	7.5 ± 4.1	8.0 (2.0-14.0)	9.5 ± 5.7	12.0 (2.0-14.0)	6.3 ± 2.2	6.0 (3.0-9.0)	0.062
TA (ns)	11.0 ± 3.9	13.0 (5.0-16.0)	10.6 ± 3.5	13.0 (6.0-13.0)	11.2 ± 4.2	12.0 (5.0-16.0)	0.953
FNSA (os)	143.3 ± 6.5	145.0 (135.0-150.0)	137.2 ± 2.6	135.0 (135.0-140.0)	147.0 ± 5.2	150.0 (135.0-150.0)	0.001
FNSA (ns)	143.2 ± 5.9	145.0 (132.0-151.0)	145.3 ± 2.3	145.0 (142.0-148.0)	142.0 ± 7.0	140.0 (132.0-151.0)	0.347
PO	-0.6 ± 3.4	-2.0 ([-6.0]-5.0)	0.8 ± 2.2	2.0 ([-2.0]-3.0)	-1.6 ± 3.8	-3.0 ([-6.0]-5.0)	0.041

CE: Center Edge, PH: Pelvic High, LLD: Leg Length Difference, FHEI: Femoral Head Extrusion Index, RFNL: Residual Femoral Neck Length, TEFHCD: Major Trochanter Upper End and Prosthetic Head Center Distance, FO: Femoral Offset, HHC: Height of Hip Center, BWLA: Body Weight Lever Arm, AI: Acetabular Index, TA: Tönnis Angle, FNSA: Femoral Neck-Shaft Angle, PO: Pelvik Obliqity. (os): Operated Side, (ns): Non-operated Side. Bolded p indicates a statistically significant difference between groups ($p < 0.05$).

Table 3. Comparison of dislocation status according to prothesis type.

		Total Dislocation	Single Dislocation	Multiple Dislocations	p value
		n-%	n-%	n-%	
	Cementless squared	18-75.0	9-60.0	9-100.0	
	Modular	3-12.5	3-20.0	0-0.0	
Prothesis type	Cemented calcar replacement	3-12.5	3-20.0	0-0.0	0.100

Table 4. Comparison of clinical outcomes according to dislocation status.

	Total Dislocation		Single Dislocation		Multiple Dislocations		p value
	Mean+sd	Median(min-max)	Mean+sd	Median(min-max)	Mean+sd	Median(min-max)	
Harris Score	64.7+ 19.3	64.0 (21.0-100.0)	66.8 + 15.1	60.5 (58.0-93.0)	59.5 + 21.6	60.2 (24.0-82.0)	0.726
Modified Harris Score	58.8+ 18.2	58.0 (18.0-91.0)	62.6 + 14.0	56.0 (52.0-87.0)	54.0 + 19.7	54.0 (20.0-75.0)	0.726

Also, some other studies evaluated the association of pelvic and anatomical parameters and BHA dislocation [9,13,14]. Several studies found that CE angle, FO, LLD, RFNL affected dislocation rates after BHA [9,10,13,14]. However, a comparative analysis of re-dislocation with single dislocation in terms of anatomical and surgical factors are limited. In this study, we investigated the surgical and anatomical factors in detail. In the literature, small CE angle, shortening of FO and leg length was found to increase the dislocation after BHA [9,16]. Besides smaller cup size, higher offset difference and higher LLD were found to be associated with higher dislocation risk [24]. Also, higher RFNL was found to be associated with higher dislocation risk [10]. In the current study, we found that lower ON, FO, TEFHCD and HHC on the non-operated side and lower HHC on the operated side, besides higher RFNL and FNSA on the operated side. Also, a higher inclination of PO towards the operated side increased the number of dislocations. Increase in HHC and TEFHCD increases the lever arm length. Therefore, we thought that decrease in these parameters facilitated dislocation by causing impingement.

Confusing results have been reported in the literature on stem type and cement use [7,16,25-27]. Where some studies declared that BHA was associated with lower dislocation [7], some reported no effect of stem type [26]. Varley et al. [26]. found that cemented BHA increased the dislocation risk compared to non-cemented BHAs. In contrast Salem et al. [25] declared that cemented prostheses reduced the dislocation risk. In our study, we found no effect of cement use or stem type on re-dislocation status.

When a dislocation occurs after BHA, there may be a serious concern about the experience a re-dislocation. Therefore, patients in the high-risk group should be well monitored and more protective measures should be taken. In order to minimize dislocation risk, instead of closed reduction, which is the first choice after the first dislocation, more protective methods such as revision with dual mobility cups may be considered due to the higher risk of re-dislocation. Although it is difficult to perform randomized controlled studies in this patient group, studies evaluating anatomical and surgical risk factors are needed in larger and more homogeneous patient groups.

The limited number of patients in the groups and the retrospective nature of the study may be the limitations of our study. We did not have enough data about social and mobilization status of the patients. However, we examined the subgroups as dislocation and multiple dislocation.

Conclusion

Surgery-related and anatomical morphologic features were found to be effective on the number of dislocations after BHA. Patients who experienced the first-time dislocation after BHA with anatomical and surgical risk factors should be carefully monitored and more controlled physiotherapy and treatment modalities may be recommended in terms of re-dislocation risk.

Conflict of interests
The authors declare that they have no conflict of interest.

Financial Disclosure
The financial support for this study was provided by the investigators themselves.

Ethical approval
Local Ethics Committee of Ordu University approved the study (protocol no: 2018/217)

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