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Original Article

RISK FACTORS FOR ACETABULAR EROSION AFTER BIPOLAR HEMIARTHROPLASTY: A RETROSPECTIVE COHORT STUDY

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ABSTRACT

Introduction: Acetabular erosion is a significant, late-stage complication in patients undergoing hemiarthroplasty. This study aimed to investigate the risk factors for acetabular erosion in patients undergoing bipolar hemiarthroplasty for proximal femoral fractures.

Methods: This single-center retrospective study was performed on 126 patients aged between 55-85 years who underwent bipolar hemiarthroplasty for proximal femoral fractures between January 2017 and November 2023 and had at least 2 years of radiological follow-up. The demographic data, femoral stem type, and bipolar femoral head diameter of patients were recorded. Femoral offset (FO) and leg length discrepancy (LLD) were measured from early postoperative anteroposterior pelvic radiographs. Acetabular erosion was graded based on the Baker classification on final follow-up radiographs. Statistical analyses were performed using the *t* test, Mann–Whitney *U* test, chi-square test, and Spearman correlation analysis.

Results: The mean age of patients was 78.10 ± 7.66 years. 74.6% were female, and the mean follow-up period was 38.67 ± 12.45 months. According to the Baker classification, 29.4% of patients had grade 0, 42.9% had grade 1, 18.3% had grade 2, and 9.5% had grade 3 erosion. Acetabular erosion was found to be significantly more common in female patients ($p = 0.025$). An increased risk of acetabular erosion was observed in patients with a femoral head diameter ≤48 mm ($p = 0.043$; odds ratio = 3.10; 95% confidence interval = 1.00–9.66). A significant correlation was noted between increased follow-up duration and increased degree of acetabular erosion ($p = 0.001$). No significant correlation was found between age, femoral stem type, LLD, FO discrepancy, osteoporosis grades (T-score), and acetabular erosion.

Conclusion: Female sex and a bipolar femoral head diameter ≤48 mm were the main risk factors for the development of acetabular erosion after hemiarthroplasty and should be considered in surgical decision-making.

Keywords: Acetabular erosion, bipolar hemiarthroplasty, femoral head diameter, femur fracture

INTRODUCTION

Arthroplasty is the most commonly used surgical method for treating proximal femoral fractures, especially in the elderly population (1). Hemiarthroplasty or total hip arthroplasty are common surgical options for these fractures (2). It offers advantages such as less intraoperative blood loss, shorter surgical time, faster rehabilitation, and lower risk of dislocation compared with total hip arthroplasty (2,3). However, acetabular erosion, which is a significant late complication, may develop in patients undergoing hemiarthroplasty (4). It is defined as the degeneration of the articular cartilage and progressive loss of subchondral bone over time due to continuous contact between the acetabular surface and the bipolar head of the prosthesis (3). A previous study showed that the rate of radiological wear associated with acetabular erosion ranged from 1.9% to 66% whereas the rates of conversion into total hip arthroplasty (THA) associated with this condition ranged from 0.6% to 16.7% (5). The Baker classification system (6) has been introduced to radiologically assess acetabular erosion. Based on this system, grade 0 is considered normal, grade 1 denotes thinning of articular cartilage without bone erosion, grade 2 denotes acetabular bone erosion with early migration, and grade 3 denotes acetabular protrusion. Many studies have investigated the mechanical and biological causes of acetabular erosion, but reported conflicting results (7,8,9).

This study aimed to examine the risk factors for acetabular erosion in patients who underwent hemiarthroplasty due to proximal femur fractures.

METHODS

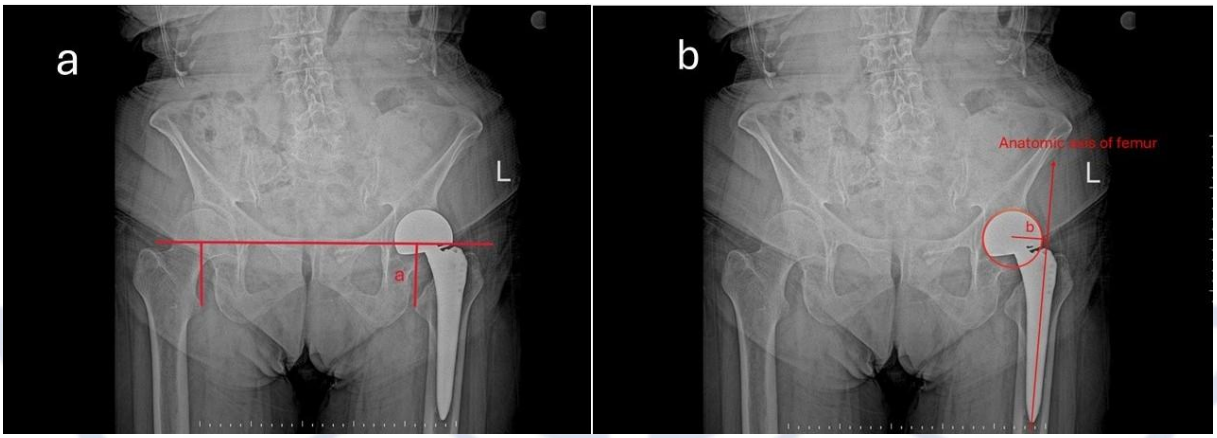
Study Design

This retrospective study evaluated patients who underwent hemiarthroplasty due to proximal femur fractures at the Orthopedics and Traumatology Clinic of Niğde Ömer Halisdemir University Education and Research Hospital. It was approved by the Non-Interventional Clinical Research Ethics Committee of Niğde Ömer Halisdemir University on November 19, 2025 (approval number 2025/121). The study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

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Figure 1. Radiographic measurements: a) leg length difference measurement, b) femoral offset difference measurement.



Patients who underwent hemiarthroplasty due to proximal femur fractures (femoral neck and intertrochanteric fractures) between January 2017 and November 2023 were included in the study. The inclusion criteria were as follows: a) patients aged 55–85, b) patients who had at least 2 years of radiographic images and follow-up, c) patients with appropriately taken radiographic images, d) patients with radiographs suitable for measuring femoral offset (FO) and leg length discrepancy (LLD), e) patients who did not undergo any revision surgery, f) patients with bone mineral density (BMD) measurements before or after surgery, and g) patients who underwent unilateral surgery during the follow-up period. The exclusion criteria for the study were as follows: a) patients younger than 55 or older than 85 years of age at the time of surgery, b) patients with a follow-up period shorter than 2 years due to mortality or other reasons, c) presence of pathological fracture, d) patients who developed intraoperative or postoperative periprosthetic fracture, e) history or presence of infection, and f) presence of alignment problems (varus or valgus) related to surgery.

The demographic data of patients, including age, sex, and surgery side, were recorded. Further, information on the type of femoral component and bipolar head diameter was collected. Additionally, FO and LLD were measured from the patient's early postoperative radiographic images (first 30 days). Radiographic measurements were taken from anteroposterior pelvic radiographs using the Sisoft PACS system (Republic of Türkiye Ministry of Health Picture Archiving and Communication System). All radiographic measurements were performed by a single observer (H.Y.) on standardized anteroposterior pelvic radiographs. Radiographs were considered eligible for measurement only if they showed no evident pelvic rotation or positioning error and allowed clear visualization of both teardrops and the proximal femur. The follow-up duration was defined as the interval from surgery to the final radiographic assessment. The LLD was calculated by measuring the difference between perpendicular lines drawn from the lesser trochanter of each femur to the reference line connecting both teardrops (10). FO discrepancy was calculated by measuring the difference between the perpendicular distances drawn from the center of the femoral head on both sides to the line representing the anatomical axis of the femur (11). The measurement of FO and LLD is shown in Figure 1. Acetabular erosion was classified based on the Baker classification (6), considering the most recent radiological image taken more than 2 years postoperatively. Acetabular erosion was graded according to the Baker classification using the final follow-up radiograph obtained more than 2 years after surgery. The Baker classification system is shown in Figure 2. Moreover, information on the T-score according to bone mineral

Table 1. Demographic and clinical data of patients

	Value/Distribution	Number of patients (n = 126)	Percentage (%)
Sex	Male	32	25.4
	Female	94	74.6
Side where surgery was performed	Left	68	54.0
	Right	58	46.0
Mean age	78.10 ± 7.66		
Average follow-up period (months)	38.67 ± 12.45 (range 25–73)		
Femoral head (mm)	46.95 ± 3.28 (range 42–56)		
Baker classification	Grade 0	37	29.37
	Grade 1	54	42.86
	Grade 2	23	18.25
	Grade 3	12	9.52

Table 2. Correlation between sex and acetabular erosion

	Grade 0–1	Grade 2–3	
Male	28 (87.5%)	4 (12.5%)	$p = 0.025^*$
Female	63 (67.0%)	31 (33.0%)	

*Chi-square test.

densitometry was collected, as well as the postoperative month of the most recent radiological image. Bone mineral density data were obtained from postoperative measurements, and the T-score of the contralateral femoral neck was recorded for analysis. All procedures were performed using a standardized surgical technique. Hemiarthroplasty was performed in the lateral decubitus position through a posterior approach, and all stems were cementless. The bipolar head diameter was selected intraoperatively using trial components and acetabular sizing to best match the native femoral head. Postoperative rehabilitation was standardized, and mobilization with weight bearing as tolerated was initiated on the first postoperative day unless otherwise contraindicated.

Statistical analysis

Continuous variables were expressed as mean ± standard deviation, minimum, and maximum values; categorical variables were expressed as counts and percentages. For comparisons, acetabular erosion (grades 0–1 and 2–3), age (≤75 and >75 years), and femoral head diameter (≤48 and >48 mm) were analyzed in two groups (3). The normality of continuous variables was examined using the Shapiro–Wilk test. The independent-samples *t* test was used for intergroup comparisons of variables with a normal distribution, whereas the Mann–Whitney *U* test was used for variables with no normal distribution. The chi-square test was used for comparing categorical variables. The effect size was indicated using the phi (ϕ) coefficient. The odds ratio (OR) and 95% confidence interval (CI) were calculated to observe the correlation between femoral head diameter and acetabular erosion (grades 0–1 and 2–3). The correlation between the patients' osteoporosis (T-score) and acetabular erosion degrees was evaluated using Spearman correlation analysis. The level of statistical significance was set at $p < 0.05$. All analyses were performed using IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp., NY, USA) software.

RESULTS

Patients ($n = 126$) meeting the study criteria were examined. The flowchart showing the patient selection criteria is presented in Figure 3. The mean age of the patients was 78.10 ± 7.66 years. Of the patients, 74.6% ($n = 94$) were female and 25.4% ($n = 32$) were male. The left and right hips were operated on in 54.0% ($n = 68$) and 46.0% ($n = 58$) of the patients. The postoperative follow-up period was 38.67 ± 12.45 months (range 25–73 months) on average. Based on the Baker classification, acetabular erosion was grade 0 in 37 patients (29.37%), grade 1 in 54 patients (42.86%), grade 2 in 23 patients (18.25%), and grade 3 in 12 patients (9.52%). The mean femoral head diameter used was 46.95 ± 3.28 mm (range 42–56 mm). The demographic and clinical data of the patients are presented in Table 1.

The evaluation of the correlation between acetabular erosion (Baker grades 0–1 and 2–3) and sex showed that grade 2–3 acetabular erosion was statistically significantly more common in female patients ($p = 0.025$). The correlation between sex and acetabular erosion is summarized in Table 2.

No statistically significant correlation was found between patients' age and acetabular erosion grades 0–1 and 2–3 ($t = 0.10$; $p = 0.918$). When age was divided into two groups as ≤75 and >75 years, no significant difference was observed between the acetabular erosion grades 0–1 and 2–3 ($p = 0.354$).

Figure 2. Baker classification system: a) grade 0: normal, b) grade 1: thinning of articular cartilage without bone erosion, c) grade 2: acetabular bone erosion–early migration, d) grade 3: acetabular protrusion.

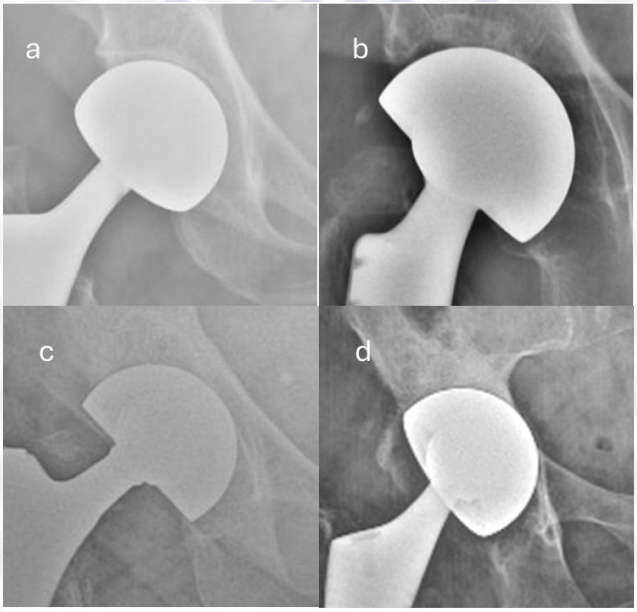


Table 3. Correlation between femoral head diameter and acetabular erosion

	Grade 0–1	Grade 2–3	
≤48 mm	65 (67.7%)	31 (32.3%)	$p = 0.043^{*}$
>48 mm	26 (86.7%)	4 (13.3%)	

*Chi-square test.

The chi-square test showed that the correlation between femoral head diameter (≤48 and >48 mm) and acetabular erosion (Baker grades 0–1 and 2–3) was statistically significant ($\chi^2[1] = 4.10$; $p = 0.043$; $\phi = 0.18$). Baker grade 2–3 acetabular erosion was more common in patients with a femoral head diameter ≤48 mm (OR = 3.10; 95% CI = 1.00–9.66). Correlation between femoral head diameter and acetabular erosion is summarized in Table 3.

A tapered rectangular cementless femoral stem was used in 68 patients (54%), whereas a fully porous-coated cementless modular femoral stem was used in 58 patients (46%). No significant correlation was found between prosthesis type (tapered rectangular cementless femoral stem and fully porous-coated modular femoral stem) and acetabular erosion (grades 0–1 and 2–3) ($p = 0.723$). Also, no statistically significant correlation was observed between radiological measurements (LLD and FO) and acetabular erosion (grades 0–1 and 2–3) (LLD: $U = 304$, $p = 0.235$, FO: $U = 299$, $p = 0.694$).

The examination of the correlation between postoperative follow-up duration and acetabular erosion revealed that Baker grade 2–3 acetabular erosion was significantly more common in patients with longer follow-up duration ($U = 979$; $p = 0.001$).

Spearman correlation analysis revealed no statistically significant correlation between the patients' osteoporosis grades (T-score) and the degree of acetabular erosion ($\rho = 0.07$; $p = 0.733$).

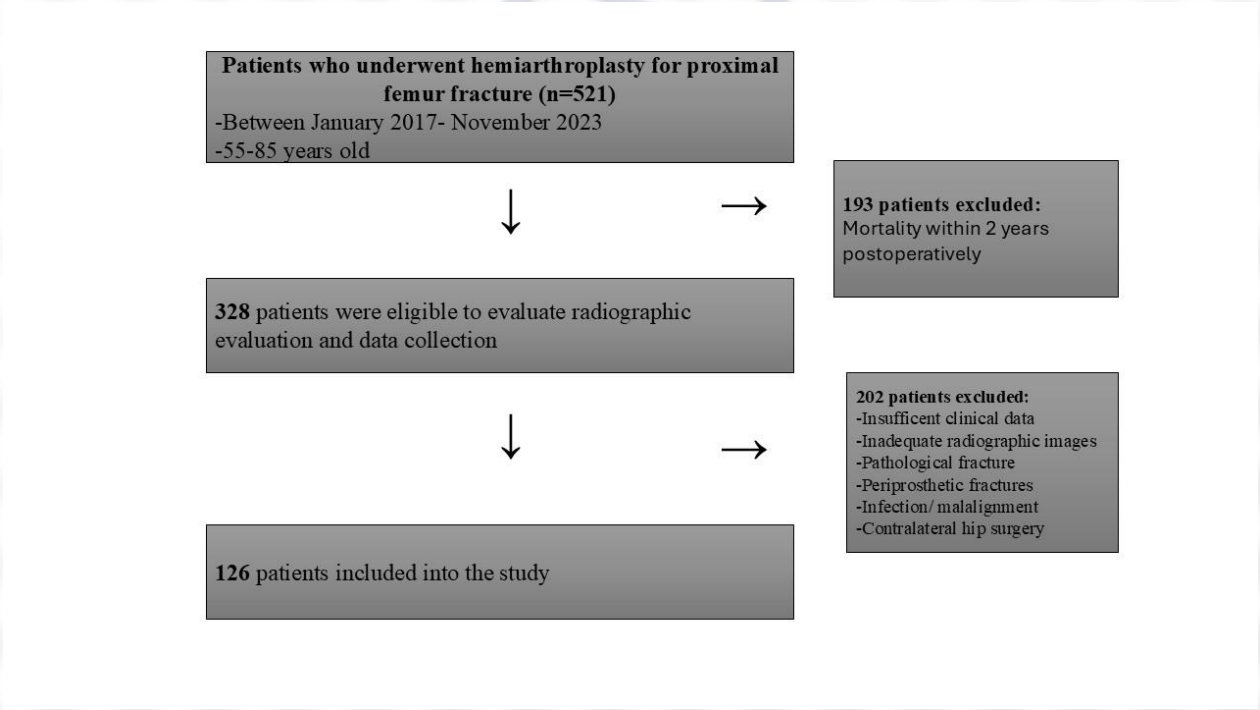
DISCUSSION

This study examined risk factors for mid-term acetabular erosion in patients who underwent hemiarthroplasty due to proximal femur fractures. The findings may contribute to individualized treatment strategies during surgical treatment and follow-up in proximal femur fractures.

Proximal femur fractures are common and clinically significant injuries in the geriatric population (12). Despite no regional differences reported in previous studies, the mean age of patients was reported to be 75 years in some studies and 84 years in others (13,14,15). A systematic review showed that the incidence of proximal femur fractures increased significantly after the age of 75 years (16). Besides demographic information, previous studies also showed that a majority of proximal femur fractures occurred in female patients and were more common in osteoporotic, postmenopausal women (15,17,18). Consistent with previous findings, the mean age of patients with proximal femur fractures was 78 years, and a majority of patients were women in the present study. This also suggested sufficient demographic homogeneity in the study population.

A previous study showed that sex was not a risk factor for acetabular erosion in 209 patients followed up for at least 10 years (3). Additionally, Rubio et al. reported no correlation between sex and acetabular erosion in patients undergoing hemiarthroplasty followed up for 10–13 years (19). Moon et al. showed that acetabular erosion was more common in men among patients younger than 60 years who underwent hemiarthroplasty (9). However, Emre et al. reported that acetabular erosion was more common in women (20). Despite current studies reporting different results regarding the correlation between sex and acetabular erosion, the present study discovered a correlation between female sex and

Figure 3. Flowchart of patient selection criteria



acetabular erosion in the cohort. This might be due to regional anatomical differences and changes in activity levels.

Age is an important criterion in deciding on the type of surgery to be performed. A retrospective study of 48 patients found no statistically significant correlation between acetabular erosion and age (21). Acetabular erosion is more common in patients aged less than 75 years undergoing hemiarthroplasty, and total hip replacement is more appropriate in these patients (22). Age was found to be an important risk factor for the development of acetabular erosion in patients younger than 60 years (9). The present study found no correlation of age with acetabular erosion in the early stages. The discrepancies in results might be due to regional variations in the activity levels of patients of varying ages. Therefore, hemiarthroplasty was more appropriate in older patients with low activity levels.

Schiavi et al. showed that a femoral head diameter ≤48 mm had a high risk of acetabular erosion, and not measuring the diameter was important in terms of polar wear (3). Moon et al. reported that the femoral head size was associated with acetabular erosion, emphasizing that selecting the correct femoral head size during surgery was important and represented a factor that should be considered based on preoperative measurements (9). A study conducted on a cadaver also demonstrated that selecting a large femoral head diameter was important for hip joint congruency and successful long-term results (23). Emre et al. indicated that using a bipolar head smaller than the native femoral head posed a risk for acetabular erosion (20). The present study showed that a bipolar head diameter smaller than 48 mm was a risk factor for acetabular erosion. This finding may help guide patient-specific preoperative planning.

Very few studies have investigated whether femoral stem types constitute a risk factor for acetabular erosion. Seyfettinoğlu et al. reported no difference in three different femoral stems in terms of acetabular erosion (8). The present study found no difference between the tapered rectangular cementless femoral stem and the fully porous-coated modular femoral stem. However, this needs further investigation.

A retrospective study found that the risk of acetabular erosion increased after the fourth postoperative year and was observed in 45% of cases (24). Similarly, another study reported a correlation between postoperative duration and acetabular erosion grade that increased over time (1). Similarly, the present study demonstrated that the acetabular erosion grade was more advanced in patients with longer postoperative follow-up periods. Therefore, performing hemiarthroplasty in younger patients with longer follow-up periods may have a negative impact in terms of acetabular erosion.

Hsu et al. reported that a LLD greater than 6 mm increased the risk of acetabular erosion 25 times, but FO discrepancy did not change the risk of acetabular erosion (21). In contrast, Mascheras et al. showed that LLD did not make any difference in terms of acetabular erosion (22). Another retrospective study demonstrated that postoperative LLD did not influence the risk of acetabular erosion (9). The present study showed that FO or LLD did not impact the formation of early-stage acetabular erosion. Large-scale prospective and biomechanical studies should be conducted in this regard.

BMD plays an important role in acetabular cup migration in THA (25). However, studies examining hemiarthroplasty have reported few and conflicting data regarding acetabular erosion. Emre et al. stated that bone quality was important in terms of acetabular protrusion. They reported a correlation between acetabular erosion and the severity of osteoporosis (20). However, Davalillo et al. found no correlation between osteoporosis and acetabular erosion in their retrospective patient series (7). Similarly, the present study found no correlation between acetabular erosion and the severity of osteoporosis. Prospective studies with long-term follow-up should be performed in this regard.

This study had some limitations. It was a single-center retrospective study with a limited number of patients. Also, important parameters such as nutritional status, body mass index, and activity level of patients could not be evaluated. Further, only two types of prostheses were used in the study, and all of them were cementless prostheses, leading to selection bias. In addition, multivariable logistic regression was not performed because of the retrospective design, limited sample size, and the relatively small number of Baker grade 2–3 cases, which could have resulted in overfitting and unstable estimates. All radiographic measurements were performed by a single observer; therefore, intra- and interobserver reliability analyses were not performed, which should be considered when interpreting the radiographic findings. Variability in radiographic positioning may have affected the accuracy of the measurements.

This study demonstrated that female sex and a bipolar femoral head diameter ≤48 mm were risk factors for the development of acetabular erosion in the medium to long term among patients who underwent hemiarthroplasty for proximal femoral fractures. However, no correlation was observed between age, femoral stem type, LLD, FO, and osteoporosis with acetabular erosion. Risk factors such as female sex and the use of a small femoral head should be carefully examined in the individualized surgical decision-making process. Hemiarthroplasty may be more appropriate in older patients and those with low activity levels.

Ethics Committee Approval: Approval was obtained from the local ethics committee (Niğde Ömer Halisdemir University Non-Interventional Clinical Research Ethics Committee, reference number 2025/121), and the study was conducted in accordance with the principles of the Declaration of Helsinki.

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Conflict of Interest: The authors have no declarations of conflicts of interest.

Informed Consent: Consent forms were not obtained due to the retrospective design.

Authorship Contributions: Concept: HY, OG; Design: HY, OG; Supervision: OG; Materials: HY, TK, KEB; Data Collection or Processing: HY, TK, KEB; Analysis or Interpretation: HY; Literature Review: HY; Writing: HY; Critical Review: KEB, OG.

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