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ORIGINAL ARTICLE

Age-related Comparison of Hip Joint Morphology in Isolated Femur Neck Fractures

Saygın Kamacı[1]
ORCID: 0000-0002-8887-9333

Sancar Bakırcıoğlu[2]
ORCID: 0000-0001-5403-3324

Ömür Çaglar[1]
ORCID: 0000-0002-0346-8528

Bülent Atilla[1]
ORCID: 0000-0003-4796-0642

A. Mazhar Tokgözoğlu[1]
ORCID: 0000-0002-1375-8115

[1]Hacettepe University Department of Orthopedics and Traumatology, Ankara, Türkiye.

[2]Cermik State Hospital, Diyarbakır, Türkiye.

Corresponding Author: Saygın Kamacı
E-mail: sayginkamaci@gmail.com

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ABSTRACT

Objective: Femoral neck fractures mostly occurs due to high-energy trauma in young population and management differs compared to elderly. Different geometric parameters in the hip joint can play a role in fracture morphology regarding to the age. Present study aims to compare hip morphology between young and elderly population

Materials and methods: 45 patients with isolated femoral neck fracture included to the study. Patients were divided into two regarding to the age; group 1 (younger than 60 yr.) and group 2 (older than 60 yr.). Garden and Pauwels classifications, Sharp angle (acetabular index-AI), acetabular depth (AD), Hip-axis length (HLA), Neck-shaft angle (NSA), Center-edge angle (CE), Singh indexes and femur head extrusion indexes were compared between groups.

Results: The mean age of group 1 (22 patients) was 48 ± 10.4 while the mean age of group 2 (23 patients) was 77 ± 6.3. Significant differences found in 3 parameters; the mean HLA (13.4 ± 1.4 cm vs 12 ± 1.1 cm) (p: 0,034), the Sharp angle (37.9° ± 5° vs 40.3° ± 3°) (p: 0.047) and the CE (38.1° ± 6.2° vs 34.8° ± 4.5°) (p: 0.48) between group 1 and 2 respectively. No statistically significant difference was found in terms of AD, NSA, Singh index and extrusion index.

Conclusions: Our study shows influence of proximal femoral and acetabular morphology on femoral neck fracture in young patients and may help future studies to reveal the relevance between hip morphology and fractures type.

Keywords: femoral neck fracture, garden, hip axis length.

INTRODUCTION

Femoral neck fractures (FNF) are commonly seen in the elderly patients after a minor trauma [1]. However, they account for only 2-3% of all femoral fractures in adults and may be challenging due to resulting from high-energy trauma [2-4]. Classification of FNF depending on the location includes: subcapital, transcervical and basicervical pattern. Common fracture pattern in adults is transcervical fracture with a vertical orientation and instability accompanied by loss of cortical bone. High risk of nonunion, malunion and avascular necrosis arises due to the complexity of the neck fracture in young population as well [5-7]. Pauwels emphasized the significance of vertical orientation of the fracture in his classification [8]. Subsequent studies about the outcome of vertical fractures have shown greater risk for complications and poor healing as well [5, 9, 10].

Management of FNF in young adults and understanding the differences compared to elderly population is crucial. Arthroplasty procedures are not ideal even in comminuted fractures and several fixation methods have been described. The main goal of the treatment is to preserve native hip joint and to return to high level of activity. Therefore,

a better understanding of the nature of the FNF may improve treatment strategies and decrease complications. A few studies about the relationship proximal femur geometry and fracture pattern especially for intertrochanteric fractures in elderly patients have been performed [11-13]. Increased hip axis length (HAL) and neck shaft angle (NSA) have been found related with osteoporotic FNF [14, 15]. However, there is no consensus about the relevance of hip morphology and fracture type in young population. Paucity of studies performed to further characterize the pathoanatomic properties of the fracture pattern in patients under 60 years of age [9].

Thus, we aimed to determine morphological differences between young and elderly patients. We hypothesized that different geometric parameters can play a role in fracture type regarding to the age.

METHODS

Institutional review board approval was obtained at our institution. 192 patients who underwent surgery for FNF in our clinic between 2009 and 2017 were retrospectively reviewed. Patients with isolated femoral neck fracture were divided into two as group 1 (younger than 60 yr.) and group 2 (older than 60 yr.). Patients who had fracture in contralateral hip and those with pelvic fractures, pathologic fractures, paralysis, lower limb deformities, metabolic bone disease, and surgical history on the same extremity were excluded from the study. 45 of 192 patients who met the criteria were included in the study. The difference between the Garden and Pauwels classifications, Sharp angle (acetabular index-AI), acetabular depth (AD), Hip-axis length (HLA), Neck-shaft angle (NSA), Center-edge angle [10] (Figure 1), Singh indexes and femur head extrusion indexes were assessed on the standard A-P pelvis radiographs (Figure 2). Measurements made on contralateral hip and obturator foramen index was used for standardization of preop and immediate postop AP pelvis radiographs. The picture and Archiving Communication System (PACS) were used to assess radiographic records in all patients.

Statistical analysis was performed using the software package SPSS (IBM Corp Released 2015: IBM SPSS Statistics for Mac US, Version 23.0. Armonk, NY, USA) means, standard deviations (SD), medians and range are used for continuous variables. Normality was assessed using the one-sample Kolmogorov-Smirnov test and analyses of each parameter between groups was performed using the T-test. Parameters with p values less than 0.05 were considered as statistically significant.

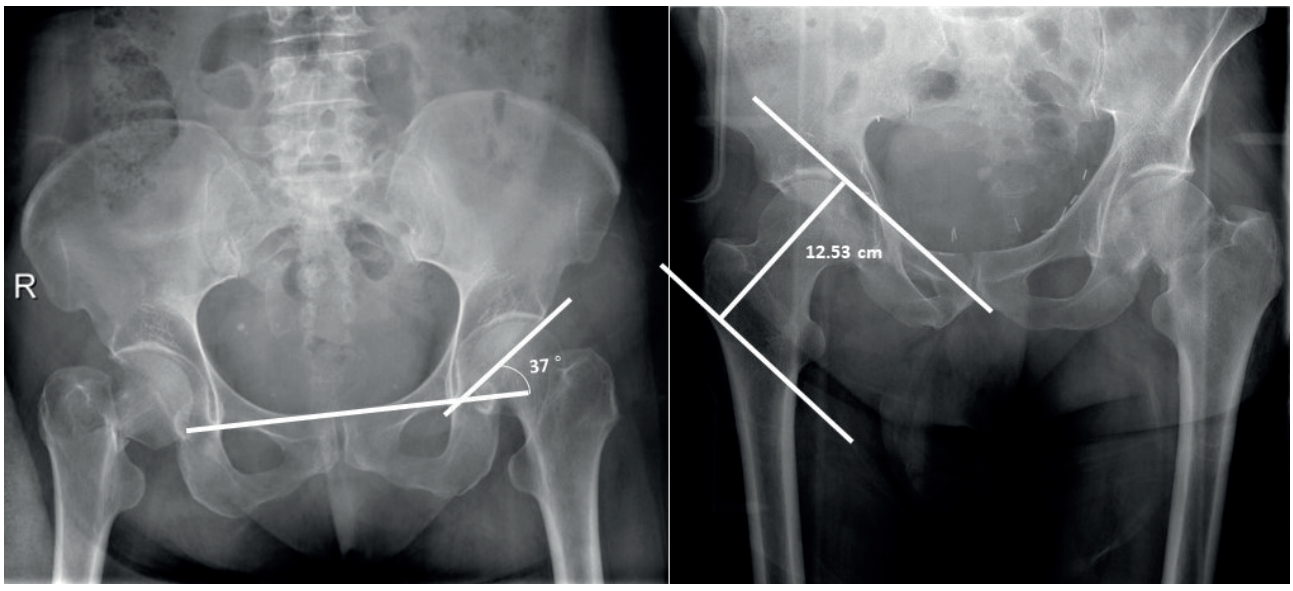

Figure 1. The Sharp angle (also known as acetabular index) is formed between Hilgenreiner line and second line that extends along the acetabular outer corner (a), The hip axis length was measured as a line extending along the femoral axis from the base of the greater trochanter to the inner pelvic rim (b).

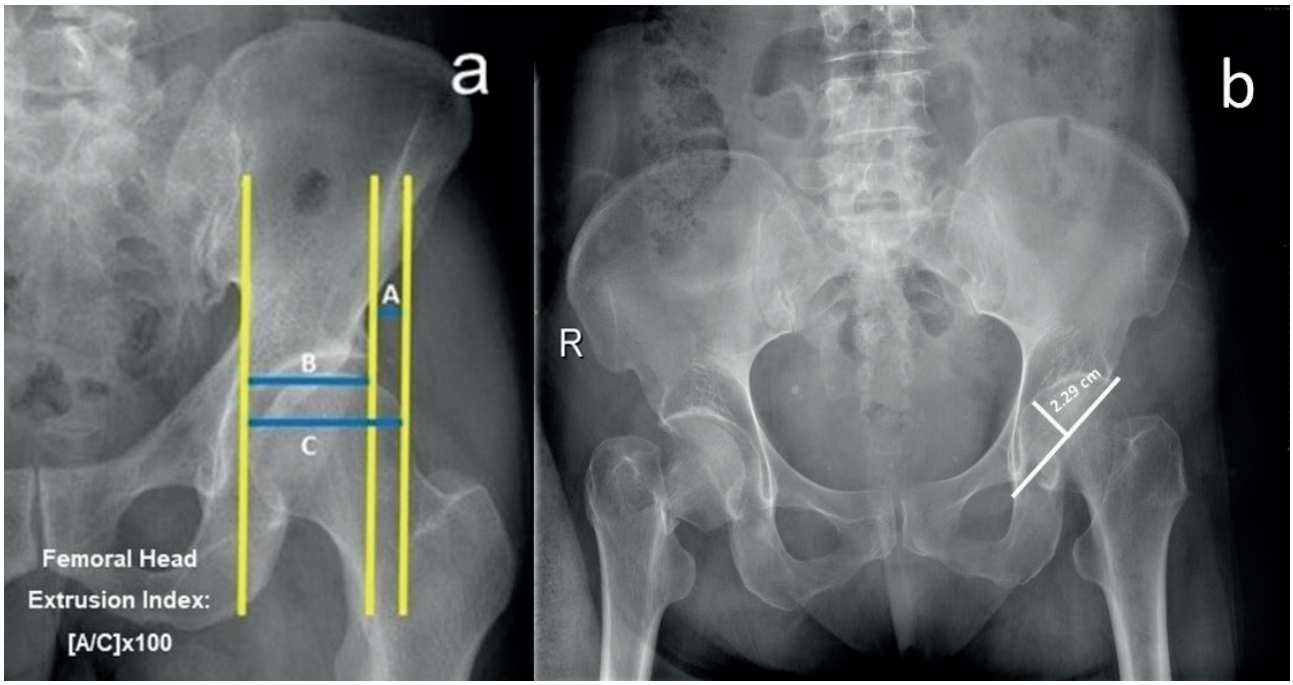

Figure 2. Femoral head extrusion index is measured by dividing the horizontal distance of the lateral femoral head that is uncovered by acetabulum to the total distance or width of the femoral head (a). Acetabular depth was measured by a tangent line is drawn from the most lateral edge of the acetabulum to the teardrop on the same side. A perpendicular line is drawn to the deepest point of the acetabular roof (b). All of the measurements have been made on contralateral healthy hip.

RESULTS

The mean age of group 1 (22 patients) was 48 ± 10.4 while the mean age of group 2 (23 patients) was 77 ± 6.3. There was no significant difference between the two groups in terms of gender. In the group 1: 73% of the fractures were transcervical, 13.6% were basicervical and 13.6% were subcapital. In the group 2: 48.8% of the fractures were subcapital, 46.8% were transcervical and 4.3% were basicervical. 86% of the fractures were displaced in group 1, while 78% of the fractures were displaced in group 2 (p: 0.69) (Table 1). 68.2% (15 patients) of the fractures were Pauwels type 3 in group 1 and only 2% of the fractures (2 patients) were classified as Pauwels type 3 in the group 2 (p:0.001).

We found statistically significant differences in the mean HLA (13.4 ± 1.4 cm vs 12 ± 1.1 cm) (p: 0,034), the Sharp angle (37.9° ± 5° vs 40.3° ± 3°) (p: 0.047) and the CE (38.1° ± 6.2° vs 34.8° ± 4.5°) (p: 0.48) between group 1 and 2 respectively. No statistically significant difference was found in terms of AD, NSA, Singh index and extrusion index. Table 2 demonstrates radiological results between groups.

Table 1. Demographics of the study groups.

	Group 1 (<60 yr.)	Group 2 (>60 yr.)	P Value
Number of Patients	22	23	
Mean Age	48±10.4	71±6.2	**<0,001**
Gender (Male/Female)	13/9	11/12	0,647
BMI	23.3±4.3	22.6±5.4	0,434
Location			
-Subcapital	%13.6	%48.8	
-Transservical	%72.7	%47.8	**0,03**
-Basiervical	%13.6	%4.3	
Garden 3&4 (n.o patients)	%86.4 (19)	%78.3 (18)	0,69

Table 2. Results of radiological parameters between groups.

	Group 1 (<60 yr.)	Group 2 (>60 yr.)	P value
Acetabular Index	37.8° ± 4.6°	40.3° ± 3.4°	**0.047**
Acetabular Depth	1,06 ± 0.3	1±0.2	0.344
Hip Axis Length	13 ± 1.4 cm	12.2 ± 1.1 cm	**0.034**
Neck-Shaft Angle	134.5° ± 5°	132.2° ± 5.2°	0.134
Lateral-Central Edge Angle	38.1° ± 6.2°	34.8° ± 4.5°	**0.048**
Singh Index	5.7 ± 0.5	2.6 ± 1.1	<0.001
Extrusion Index	12.3 ± 4.3	11.9 ± 6.4	0.783

DISCUSSION

There are several approaches preferred by the surgeons for the treatment of FNF in young patients. After Pauwels pointed out the importance of vertical orientation, many studies using computed tomography (CT) as well revealed the relationship between intraarticular complex lower limb fractures pathoanatomy and the fracture type. FNF in younger patients mostly occurs from high-energy trauma. Injury pattern in this individuals is a transcervical vertical fracture extending toward the medial calcar and lesser trochanter. The injury occurs due to strong displacement forces across the hip that may lead to failure of fixation and malunion with overall complication rates ranging from 20%-80%. The reason for the difference between the two groups in terms of Garden and Pauwels classification can be predicted as the younger patients having more vertical and unstable fractures as a result of high-energy trauma. [16, 17]. Understanding the morphology and geometry of the both native hip joint and fracture may help explain high complication and failure rates seen of vertical neck fractures in patients under the age of sixty years.

Several studies comparing osteoporotic hip fractures regarding bone quality, age and morphology have been performed previously. Most of them assessed the proximal morphology as an important factor for determining the fracture type [9, 18, 19]. Cory et al. investigated the fracture morphology of high shear angle vertical neck fractures in young adult patients under age of fifty years and vertical coronal fractured averaged 60 degrees and axial fracture obliquity averaged 24 degrees with deficiency in the posterior neck. They stated that major femoral neck comminution was identified in 96% of cases [9]. Maeda et al. compared the femoral morphology and bone mineral density between FNF and trochanteric fractures and found no significant differences of bone mineral density between groups. However, they stated that patients with trochanteric fractures showed a smaller neck shaft angle and smaller cortical index at the isthmus compared to patients with femoral neck fractures [20]. Recently, Rotem et al. studied about hip morphology whether it is influencing the anatomic location of hip fractures in elderly patients. They found significant higher NSA, shorter HLA and a narrower femoral neck diameter in extracapsular fractures compared to the intraarticular ones. The authors concluded that proximal femoral geometry were found to correlate with the location of hip fractures [12]. Additionally, Frost et al. also evaluated the influence of acetabular and femoral versions on fractures of the femoral neck and found no correlation between proximal femur fracture type and acetabular or femoral version [21].

HAL was defined for the first time by Faulkner et al. and he reported increased values were relevant with the risk of hip fracture [13]. Subsequent studies showed that increased HAL was more related with FNF and no relationship found with intertrochanteric fractures. Increased in the HAL proves a higher distance between the center of the hip and lateral part of the femur. Therefore, it represents increase of the load on femoral neck. In our study, HAL was found statistically higher in young patients with more vertical fractures as well. Our study evaluates these radiological parameters between the location of femoral neck fractures in age-related cohorts. Preliminary results of our cohort may help future studies in this regard.

There are some limitations of our study as well; Patients were evaluated retrospectively, CT scans were performed on patients deemed suitable by the emergency department, therefore we couldn't be able to evaluate the whole study group with tomography. Additionally, the study did not assess the influence of injury mechanism over the FNF type. Furthermore, this cohort has a small sample size which could lead to the possibility of a type 2 error. However, to our knowledge this is the first study comparing morphological differences of neck fractures between young and elderly patients. Thus, our findings may help to reveal whether geometrical parameters influence the type and location of the FNF in future studies with larger cohort. Since this study only presented radiological measurements, further studies are needed to evaluate the clinical usefulness of the study findings.

CONCLUSION

This study reveals the influence of proximal femoral and acetabular morphology on FNF between young and elderly patients. Increased HAL and CE might be associated with neck fractures in young population. These findings might provide baseline information for further studies.

Author contribution

Study conception and design: SK, SB, and BA; data collection: SK, and SB; analysis and interpretation of results: SK, SB and OC; draft manuscript preparation: SK, BA, and AMT. All authors reviewed the results and approved the final version of the manuscript.

Ethical approval

Ethical approval was obtained from the Hacettepe University Faculty of Medicine local ethics committee (GO 22/1030).

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Conflict of interest

The authors declare that there is no conflict of interest.

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