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Original Basic Article

The Relationship between Morphometry of The Proximal Femur Bone and The Type of Proximal Femur Bone Fracture in The Elderly Female Population at RSUP H. Adam Malik Medan from 2017 to 2022

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Abstract

Background:
Fractures of the pelvic bone are frequently encountered in elderly patients and are often associated with increased mortality rates. At the moment, identifying osteoporosis as a risk factor for proximal femur fractures is the primary focus. The morphometry of the proximal femur can also be utilized to predict the risk factors for proximal femur fractures. This study was conducted to assess the relationship between proximal femur bone morphometry and proximal femur fractures in elderly women at H. Adam Malik General Teaching Hospital, Medan.

Material & Methods:
This study is an observational analytical research aimed at investigating the relationship between the morphometry of the proximal femur bone and the type of proximal femur bone fracture in an elderly female population. The study will adhere to predetermined inclusion and exclusion criteria. The morphometric variables measured in this study are hip axis length (HAL), femoral head diameter (FHD), femoral neck length (FNL), femoral neck diameter (FND), horizontal offset (HO), and femoral neck shaft angle (FNSA).

Result:
This study collected 90 samples, with 15 of them not meeting the inclusion and exclusion criteria, resulting in a final sample size of 75. Out of 75 research samples, the Hip Axis Length (HAL) has an Eta test value of 0.264. The Femoral Head Diameter (FHD) has an Eta test value of 0.162. The Femoral Neck Diameter (FND) has an Eta test value of 0.276. The Femoral Neck Length (FNL) has an Eta test value of 0.277. The Horizontal Offset (HO) has an Eta test value of 0.277. The Femoral Neck Shaft Angle (FNSA) has an Eta test value of 0.488.

Conclusion:
This study reports a weak correlation between the morphometry of hip axis length, femoral neck diameter, femoral neck length, femoral neck diameter, and horizontal offset of the proximal femur with proximal femur fractures. Furthermore, a moderate correlation was found between the morphometry of the femoral neck-shaft angle of the proximal femur and the type of proximal femur fracture.

Introduction

Osteoporosis is a disease characterized by decreased bone mass and increased risk of fractures. Fractures of the pelvic bone are frequently encountered in elderly patients and are often associated with increased mortality rates.[1] Fracture of proximal femur is commonly found in elderly patients and guidelines for managing this type of fracture are still evolving.[2] Fractures occur when external forces exceed the bone's

capacity to absorb energy due to changes in elasticity.[3] The risk of trauma is caused by various factors such as senile dementia, neurological disorders, hemiplegia, alcohol abuse, and psychotropic drugs.[4]

Proximal femur fracture occurred in approximately 7% of young people and 24% of older people.[5] Researchers estimate that the number of proximal femur fractures will reach 6.3 million cases worldwide in 2050, including 3.25 million cases in Asia. The mortality rate within the first year after a proximal femur fracture is estimated to be between 20% and 33%.[6]

Currently, the examination of osteoporosis as a risk factor for proximal femur fractures is the primary reference. The examination that can be performed using the Dual Energy X-Ray Absorptiometry (DXA) device is used to assess bone mineral density. The Singh Index can also assess bone density by evaluating trabeculae in the proximal femur bone. The morphometry of the proximal femur can also be utilized to predict the risk factors for proximal femur fractures.[1,2,7] This study was conducted to assess the relationship between proximal femur bone morphometry and proximal femur fractures in elderly women at H. Adam Malik General Teaching Hospital, Medan.

Methods

This study is observational analytical research using a case series approach to investigate the relationship between morphometry of the proximal femur bone and the type of proximal femur bone fracture in the elderly female population at RSUP H. Adam Malik Medan. This research was conducted at the Department of Orthopaedics and Traumatology, Faculty of Medicine, Universitas Sumatera Utara / RSUP H. Adam Malik Medan. The study sample consisted of patients who underwent radiological examination of X-Ray Pelvis AP from January 2017 to December 2022, and met the inclusion and exclusion criteria.

The inclusion criteria for this study are elderly women who underwent radiological examination of the Pelvis AP with a diagnosis of femoral neck fracture, intertrochanteric femur fracture, and subtrochanteric femur fracture. The exclusion criteria for this study are subjects with congenital abnormalities in the proximal femur bone, tumors in the proximal femur bone, infections in the hip joint, osteonecrosis abnormalities in the femoral neck, and fractures in the pelvic bone.

The morphometric variables investigated in this study are Hip Axis Length (HAL), Femoral Head Diameter (FHD), Femoral Neck Length (FNL), Femoral Neck Diameter (FND), Horizontal Offset (HO), and Femoral Neck Shaft Angle (FNSA). This variable was measured by two experienced orthopaedic specialists using AP pelvis X-ray images (Figure 1). Next, a normality test will be conducted on the variable. Subsequently, the relationship between morphometry and proximal femur fractures will be analyzed using the Eta test.

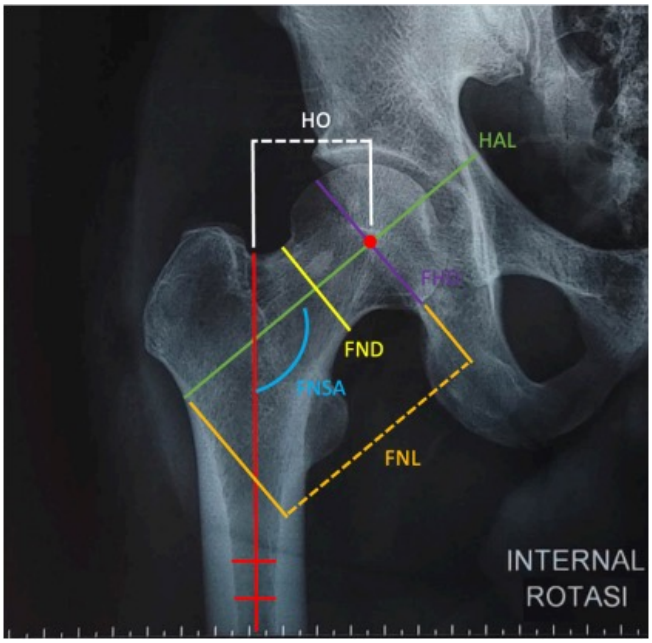

Figure 1. Morphometry of the proximal femur bone

Results

This study collected 90 samples, with 15 of them not meeting the inclusion and exclusion criteria, resulting in a final sample size of 75. Table 1 displays the characteristics of the sample in this study. The most commonly observed fractures in this study were intertrochanteric and femoral neck fractures, with frequencies of 29 patients (38.6%) each.

This study was conducted by measuring the hip axis length, femoral head diameter, femoral neck diameter, femoral neck length, horizontal offset, and femoral neck-shaft angle. This research was conducted by two individuals who possess the same qualifications, namely the Orthopaedic and Traumatology Specialist Doctor Education Programme. Table 2 presents the results of the Kappa test and the normality test for the data on proximal femur morphometry measurements.

Out of 75 research samples, the Hip Axis Length (HAL) has an average value of 10.0 ± 0.65 (Intertrochanteric Fracture), 10.5 ± 0.82 (Neck Fracture), and 10.5 ± 1.2 (Subtrochanteric Fracture) with an Eta test value of 0.264. The mean values for Femoral Head Diameter (FHD) are 4.62 ± 0.34 (Intertrochanteric Femur Fracture), 4.68 ± 0.38 (Femoral Neck Fracture), and 4.79 ± 0.53 (Subtrochanteric Femur Fracture), with an Eta test value of 0.162. The mean values for Femoral Neck Diameter (FND) are 2.98 ± 0.23 (Intertrochanteric

Table 1. Sample characteristics in the study

Characteristics	Frequency (%)	Ages (Mean)
Type of Fractures		
Intertrochanter Femur	29 (38.6)	75.1 ± 6.8 (62 – 87)
Collum Femur	29 (38.6)	73.4 ± 7.5 (60 – 92)
Subtrochanter Femur	17 (22.8)	67.1 ± 5.0 (61 – 78)

Table 2. Kappa test and Normality on proximal femur morphometry measurement results

Variables	Value (Uji Kappa)	Normality test
Hip Axis Length	0.851	0.200
Femoral Head Diameter	0.836	0.200
Femoral Neck Diameter	0.877	0.200
Femoral Neck Length	0.878	0.200
Horizontal Offset	0.864	0.197
Femoral Neck Shaft Angle	0.851	0.200

Femur Fracture), 3.16 ± 0.33 (Femoral Neck Fracture), and 3.11 ± 0.26 (Subtrochanteric Femur Fracture) with an Eta test value of 0.276. The mean values for Femoral Neck Length (FNL) are 6.91 ± 0.56 (Intertrochanteric Femur Fracture), 7.21 ± 0.50 (Femoral Neck Fracture), and 7.33 ± 0.81 (Subtrochanteric Femur Fracture), with an Eta test value of 0.277. The average value of the Horizontal Offset (HO) is 3.68 ± 0.50 (Fracture of the Intertrochanteric Femur), 3.87 ± 0.40 (Fracture of the Femoral Neck), and 7.33 ± 0.81 (Fracture of the Subtrochanteric Femur), with an Eta test value of 0.277. The average value of the Femoral Neck Shaft Angle (FNSA) is 125.8 ± 03.0 (Intertrochanteric Femur Fracture), 125.6 ± 2.9 (Femoral Neck Fracture), and 130.1 ± 4.4 (Subtrochanteric Femur Fracture) with an Eta test value of 0.488.

Discussion

The research findings indicate that the mean HAL value in intertrochanteric femur fractures is significantly smaller, with a value of 10.0 ± 0.65, compared to fractures in the femoral neck and subtrochanteric region, which have an Eta test value of 0.264, suggesting a weak correlation. The study conducted by Barrido et al found that the mean HAL value in intertrochanteric fractures was 10.33 ± 0.53, which is smaller compared to subtrochanteric femur fractures and femoral neck fractures. A smaller HAL value is considered protective against intertrochanteric fractures, with a value of 0.85 (p=0.011).[6] In their study, Nayak et al examined the association between HAL and proximal femur fractures using the Pearson correlation test. However, they concluded that no correlation was found, with a p-value of 0.53.[8]

The research findings revealed that the mean FDH value in intertrochanteric femur fractures is significantly lower at 4.62 ± 0.34 compared to fractures in the femoral neck and subtrochanteric femur, with an Eta test value of 0.162, indicating a weak correlation. The study conducted by Yang et al found that the mean FHD value for intertrochanteric femur fractures was 4.87 ± 0.25, which was lower than the value of 4.95 ± 0.23 for femoral neck fractures. However, after conducting a statistical test using ANCOVA, no relationship was found between the type of fracture and FHD.[4] Nayak et al also found no correlation between FHD and the type of fracture in the proximal femur (p=0.658).[9]

Table 3. Results of morphometric analysis with proximal femur fracture

Variables	Fracture of Intertrochanter (n = 29)	Fracture of Collum (n = 29)	Fracture of Subtrochanter (n = 17)	The value of Eta's analysis
Hip Axis Length	10.0 ± 0.65 (8.4 – 11.7)	10.5 ± 0.82 (8.9 – 12.3)	10.5 ± 1.2 (8.5 – 12.1)	0.264
Femoral Head Diameter	4.62 ± 0.34 (4.05 – 5.62)	4.68 ± 0.38 (3.90 – 5.44)	4.79 ± 0.53 (3.92 – 5.65)	0.162
Femoral Neck Diameter	2.98 ± 0.23 (2.57 – 3.57)	3.16 ± 0.33 (2.37 – 3.80)	3.11 ± 0.26 (2.67 – 3.36)	0.276
Femoral Neck Length	6.91 ± 0.56 (5.95 – 8.40)	7.21 ± 0.50 (6.12 – 8.02)	7.33 ± 0.81 (5.92 – 8.58)	0.277
Horizontal Offset	3.68 ± 0.50 (2.34 – 4.74)	3.87 ± 0.40 (2.95 – 4.57)	3.84 ± 0.43 (3.23 – 4.88)	0.198
Femoral Neck Shaft Angle	125.8 ± 3.0 (120 – 135)	125.6 ± 2.9 (121 – 132)	130.1 ± 4.4 (123 – 136)	0.488

The research findings revealed that the mean FND value in intertrochanteric femur fractures is significantly lower, with a value of 2.98 ± 0.23, compared to fractures in the femoral neck and subtrochanteric femur fractures, with an Eta test value of 0.276, indicating a weak correlation. Han et al. obtained a mean FND value of 3.18 ± 0.23 and found a significant association with intertrochanteric femur fractures ($p<0.001$).[7] The study conducted by Pires et al also concluded that there is no association between FND and proximal femur fractures, as indicated by the Kolmogorov-Smirnov test for data distribution (0.105) and a p-value of >0.200.[10]

The research findings revealed that the mean FNL value in intertrochanteric femur fractures is significantly lower at 6.91 ± 0.56 compared to fractures in the femoral neck and subtrochanteric femur fractures, with an Eta test value of 0.277, indicating a weak correlation. The research conducted by Kazemi et al concluded that the mean FNL value in sub-trochanteric femur fractures is greater compared to intertrochanteric and femoral neck fractures, and a relationship was found between FNL and the type of proximal femur fracture with a p-value of 0.032.[3] Sayit et al conducted a study on the relationship between FNL and types of proximal femur fractures and concluded that there is no association between the type of proximal femur fracture and FNL, with a p-value of 0.722.[5]

The research findings indicate that the average Horizontal Offset value in intertrochanteric femur fractures is significantly smaller, with a value of 3.68 ± 0.50, compared to fractures in the femoral neck and subtrochanteric femur fractures, with an Eta test value of 0.198, suggesting a weak correlation. Barrido et al. conducted a study using the ANCOVA statistical test and found that an increase in HO is associated with an increased risk of intertrochanteric femur fracture, with a p-value of 0.036.[6]

The research findings reveal that the mean FNSA value for intertrochanteric femur fractures is significantly lower at 125.8 ± 3.0 compared to femoral neck fractures and subtrochanteric femur fractures, with an Eta test value of 0.488, indicating a weak correlation. Barrido et al. conducted a study using the ANCOVA statistical test and found that an increase in FNSA (Femoral Neck Shaft Angle) would increase the risk of intertrochanteric femur fracture, with a p-value of 0.033.[6] The research conducted by Pires et al and Lima et al concluded that there is no correlation between FNSA and the type of fracture in the proximal femur.[8,10]

Conclusion

This study indicates a weak correlation between the femoral neck diameter, femoral neck length, and horizontal offset proximal femur with the types of femur fractures—femur intertrochanter, neck femur , and subtrochanteric femur. Furthermore, a moderate correlation was found between the morphometry of the femoral neck-shaft angle of the proximal femur and the types of intertrochanteric femur fracture, femoral neck fracture, and subtrochanteric femur fracture.

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