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Research Article

Hip and Femoral Neck Morphometry In Correlation with Intertrochanteric Femur Fracture In Elderly

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Abstract

Introduction

Proximal femur fractures are the most common injury pattern in elderly and they were expected to rise significantly until 4.5 to 6.3 million worldwide by 2050. The aim of this study was to determine the correlation between several hip and proximal femoral morphometry paramaters with the incidence and the severity of intertrochanteric femur fracture.

Materials and Methods

This was a cross-sectional study conducted on consecutive series of 45 patients who were older than 60 years and diagnosed as closed intertrochanteric femur fracture. Equal number of healthy elderly people were enrolled for comparison. Anterior-posterior projection pelvis x-ray of the subjects were obtained and analysed for parameters, as follows: Femoral Neck Length (FNL), Femoral Neck Shaft Angle (FNSA), and Medial Offset (MO), Mid-Pelvis Caput Distance (MCD), Acetabulum-Acetabulum distance (AcAc), and Acetabulum-Head distance (AcH). The severity of fracture was determined by AO/OTA classification.

Results

There were 45 subjects in each categories with matched sex and singh index.Proximal femur morphometry (Longer FNL, larger FNSA, longer MO) were found to be significantly correlated (p 0.000) with the occurence of intertrochanteric femur fracture. However, they were not correlated with the severity of the fracture. Hip morphometry parameters (MCD, AcAc, and Ach) were found to have no correlation ($p > 0.05$) with the occurence of intertrochanetric femur fracture.

Conclusion

In conclusion, we found that proximal femur morphometry (MO, FNL, and FNSA) were significantly correlated with the incidence of intertrochanteric femur fracture in our study population.

Keywords: Intertrochanteric Femur Fracture; Hip Morphometry; Proximal Femur Morphometry

Introduction

Since the number of individuals older than 65 years is expected to double in 2040, several studies predict the prevalence of proximal femur fracture to rise significantly until 4.5 to 6.3 million worldwide by 2050 [1,2]. It become the most common injury pattern in patients older than 50 years and women has 3 times greater risk [3]. Anatomically, hip fracture is divided into 3 categories, i.e, femoral neck fracture, intertrochanteric femur fracture, and subtrochanteric femur fracture.

The incidence of hip fracture is associated with osteoporosis in older population. More than 250.000 hip fractures in US were said to have correlation with osteoporosis [4]. One of the methods to assess osteoporosis was introduced by Singh et al in 1970. Singh index can be used as one of the easy and rapid method to assess osteoporosis using radiographic imaging [5]. It was a classification based on the visibility of the trabecular types seen in the femoral neck based on the radiographic imaging.

Hip joint is a ball-socket joint that consist of pelvic acetabulum and femoral head. Its biomechanics are determined by proximal femur and acetabulum morphometry. The joint will form specific angle to achieve stable and congruent articulation [7]. Moreover, proximal femoral morphometry showed signifficant correlation with the incidence of fracture and osteoarthritis [8]. The inclincation angle that is formed by the femoral neck against the femoral shaft determines the effectivenes of abductor muscles, the length of lower extremity, and pressureon the hip joint [9].

We studied a group of subjects with intertrochanteric femur fracture and compared with a group of non fracture subjects with similiar characteristics to determine the correlation between several hip and proximal femoral morphometry paramaters with the incidence and the severity of intertrochanteric femur fracture.

Materials and Methods

This was a cross-sectional observational study conducted on consecutive series of patients with Indonesian Mongoloid race who were diagnosed as closed intertrochanteric femur fracture in Dr Sardjito general hospital Yogyakarta, Indonesia. The inclusion criterias were the patient shouldu be older than 60 years and the cases were foundfrom January 2012 to December 2013. Patients who were unable to walk actively or required walking aid before the fracture were excluded from the sample selection. For comparison, healthy subjects with similiar baseline characteristic were enrolled. Singh index was used as the parameter to assess the osteoporosis conditionbetween 2 groups. Sex-matched subjects were enrolled to achieve the homogenicity of the subjects.

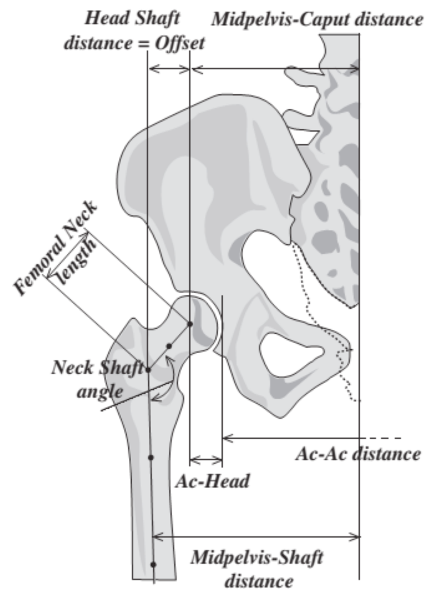

Figure 1. The diagram of hip and proximal femur morphometry used in this study (Weidow et al., 2005).

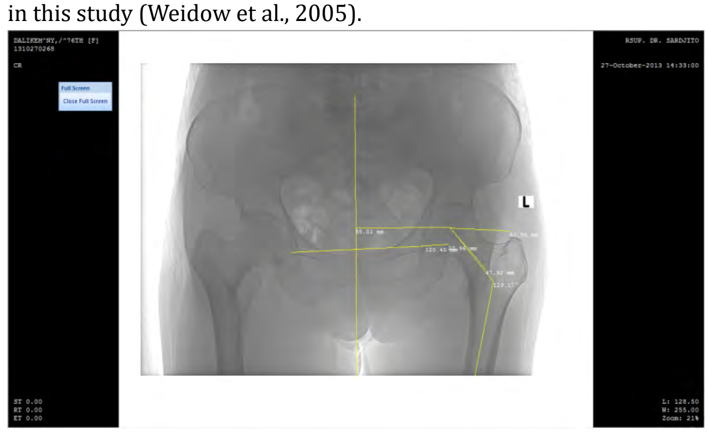

Figure 2. The measurement of hip and proximal femur morphometry in this study.

Anterior-posterior projection pelvis x-ray of the subjects were analysed to measure the proximal femur morphometry, as follows: Femoral Neck Length (FNL), Femoral Neck Shaft Angle (FNSA), and Medial Offset (MO), and hip morphometry, as follows: Mid-Pelvis Caput Distance (MCD), Acetabulum-Acetabulum distance (AcAc), and Acetabulum-Head distance (AcH).

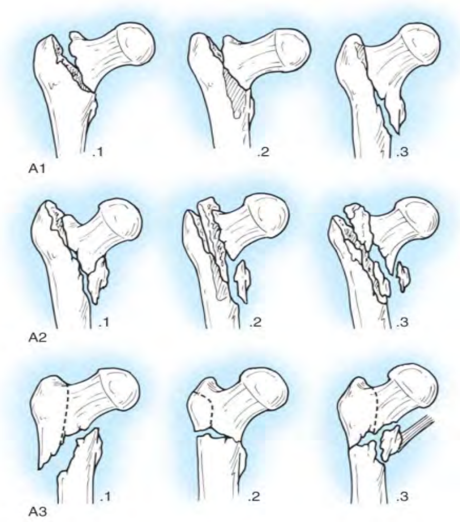

Figure 3. The severity of intertrochanteric femur fracture based on OA/OT classification (1990).

FNL was measured from the center point of the head femur until the basis of cervical femur, FNSA was defined as the angle that is formed by the intersection of the line of femoral neck and proximal femoral shaft. MCD is the distance between midpoint of the pelvis to the center of femoral head. MO is the distance between the center of femoral head to the deepest part of greater trochanter. AcAc was measured from the outer part of the acetabulum teardrop to the outer part contralaterally, while the AcH was measured from the outer part of the acetabulum to the center point of femoral head. The severity of fractures was determined by AO/OTA classification (Figure 3). Independent T test was performed as the statistical analysis to determine the variable differences between fracture and non fracture group. In addition, ANOVA and post hoc multivariate analysis were used to determine the correlation of variables based on the severity of the fracture.

Results

There were 45 elderly intertrochanteric femur fracture patients and the other 45 healthy elderly patients were met the criterias and enrolled in this study.The subjects in each categories showed similiar sex and Singh Index withp value of 1.000 and 0.832 respectively (table 1).

This study showed that proximal femur morphometry were found to be significantly correlated with the occurence of intertrochanteric femur fracture (table 2). Longer FNL, larger the angle of the femoral neck shaft, longer MO were seen in intertrochanteric femur fracture subjects (figure 4).

However, those 3 parameters were not significantly correlated with the severity of the intertrochanteric femur fracture based on ANOVA and post hoc multivariate analysis (table 3 and 4).

Characteristics		Intertrochanteric Femur Fractures Patient	Non Fracture Patient	P Value
Sex	Male	13(28%)	13 (28%)	1.000
	Female	32(72%)	32 (72%)	
Singh Index	2	8 (17.7%)	8 (17.7%)	0.832
	3	20 (44.4%)	24 (53.3%)	
	4	13 (28.8%)	9 (20.0%)	
	5	4 (8.9%)	4 (8.9%)	
Side affected	Right side	20 (45.0%)		
	Left side	25 (55.0%)		
Fracture types	A1.1	4 (8.9%)		
	A1.2	2 (4.4%)		
	A1.3	2 (4.4%)		
	A2.1	19 (42.2%)		
	A2.2	10 (22.2%)		
	A2.3	2 (4.4%)		
	A3.1	-		
	A3.2	2 (4.4%)		
	A3.3	4 (8.9%)		

Table 1. The characteristics of the subjects.

This study also showed that hip morphometry parameters (MCD, AcAc, and Ach) were found to have no difference statistically in the occurence of intertrochanteric femur fracture with p value more than 0.05 (table 2).

		N	Mean ± SD	Mean Difference 95% CI	P Value
FNL	Fracture patients	45	46,50±5,51	7.861 (5.180 – 10.542)	0,000
	Non fracture patients	45	38,64±7,17		
FNSA	Fracture patients	45	134,46±3,60	4.348 (2.863 – 5.834)	0.000
	Non fracture patients	45	130,12±3,48		
MO	Fracture patients	45	51.96±6.26	10.208 (7.594 – 12.821)	0.000
	Non fracture patients	45	41.75±6.20		
MCD	Fracture patients	45	90.72±8.36	2.377 (-1.295 – 6.050)	0.202
	Non Fracture patients	45	88.34±9.16		
AcAc	Fracture patients	45	124.70 ± 12.10	-3.029 (-7.514 – 1.455)	0.183
	Non fracture patients	45	127.73 ± 9.09		
AcH	Fracture patients	45	24.91 ± 4.00	0.454 (-1.106 – 2.015)	0.564
	Non fracture patients	45	24.45 ± 3.42		

Table 2. The correlation between FNL, FNSA, MO, MCD, AcAc, and AcH with intertrochanteric femur fracture.

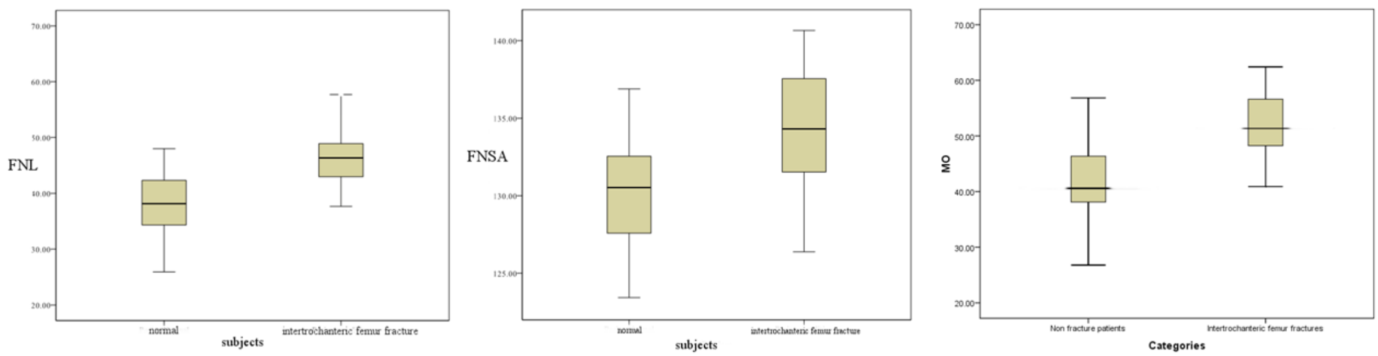

Figure 4. Boxplots of the FNL, FNSA, and MO of the normal subjects compared with intertrochanteric femur fracture subjects.

		N	Mean ± SD	95% Confidence Interval		P Value
				Lower Bound	Upper Bound	
FNL	Types A1	7	40.16 ± 4.00	36.4643	43.8672	0.665
	Types A2	32	38.01 ± 8.02	35.1150	40.9119	
	Types A3	6	40.21 ± 4.98	34.9792	45.4408	
FNSA	Types A1	7	129.85 ± 3.80	126.3402	133.3741	0.470
	Types A2	32	129.86 ± 3.59	128.5730	131.1645	
	Types A3	6	131.77 ± 2.41	129.2410	134.3056	
MO	Types A1	7	43.50 ± 3.23	40.5080	46.4920	0.272
	Types A2	32	42.04 ± 6.25	39.7862	44.2975	
	Types A3	6	38.15 ± 7.95	29.8033	46.5034	

Table 3. Descriptive and ANOVA analysis of FNL, FNSA, and MO based on the severity of the fracture.

	Types of Severity		Mean Difference	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound	
FNL	Type A1	Type A2	2.15228	3.03625	.760	-5.2243	9.5288
		Type A3	-.04429	4.04833	1.000	-9.8797	9.7911
	Type A2	Type A1	-2.15228	3.03625	.760	-9.5288	5.2243
		Type A3	-2.19656	3.23721	.777	-10.0613	5.6682
	Type A3	Type A1	.04429	4.04833	1.000	-9.7911	9.8797
		Type A2	2.19656	3.23721	.777	-5.6682	10.0613
FNSA	Type A1	Type A2	-.01161	1.46294	1.000	-3.5658	3.5426
		Type A3	-1.91619	1.95058	.592	-6.6551	2.8227
	Type A2	Type A1	.01161	1.46294	1.000	-3.5426	3.5658
		Type A3	-1.90458	1.55976	.448	-5.6940	1.8848
	Type A3	Type A1	1.91619	1.95058	.592	-2.8227	6.6551

		Type A2	1.90458	1.55976	.448	-1.8848	5.6940
MO	Type A1	Type A2	1.45813	2.56956	.838	-4.7846	7.7009
		Type A3	5.34667	3.42608	.274	-2.9770	13.6703
	Type A2	Type A1	-1.45813	2.56956	.838	-7.7009	4.7846
		Type A3	3.88854	2.73963	.340	-2.7674	10.5445
	Type A3	Type A1	-5.34667	3.42608	.274	-13.6703	2.9770
		Type A2	-3.88854	2.73963	.340	-10.5445	2.7674

Table 4. Post Hoc tukey analysis of FNL, FNSA, and MO based on the severity of the fracture.

Discussion

As mentioned before in the literature published by Cummings et al, the incidence of hip fractures were closely related to elderly population, ninety percent of hip fracture in elderly population was caused by fall. Fall in elderly that may result fracture consist of several factors. The fall that causes direct collision on the intertrochanteric area, insufficient protective mechanism, soft tissue surrounding trochanteric not adequate to muffle the energy of the falls, and weakening of bone strength may explain why hip fracture risk in elderly is higher [11].

This study showed that female population has higher incidence in the occurence of intertrochanteric femur fractures and these findings was similiar to another study10. Factors that may contribute and cannot be modified was age and female gender. In female population, osteoporosis happen shortly after menopouse where the estrogen level was decrease dramatically. Osteoporosis will increase the risk of fracture due to decrease in bone mass density [1].

Longer offset that was seen to be significantly correlated with the occurence of intertrochanteric femur fracture might be due to the direct collision on the trochanteric area where longer offset indicates the position of trochanter more laterally and more prone to direct impact [12]. Moreover, if the protective response is slower, hip may receive direct force from the fall. Elderly people move slower, and if the balance is off, they tend to fall into the lateral side where the collision will directly hit the greater trochanteric area [13]. More effective abductor muscle force arm can be achieved in longer offset resulting in larger force on the abductor muscle insertion site in greater trochanter. If there was sudden pulling of abductor muscle, the intertrochanter area will have to withstand a greater force.

Femoral neck shaft angle is important component in correlation with intertrochanteric femur fracture. When the angle is larger than 125, it can increase the weight that is received by the hip joint and the amount of muscle strength needed to withstand the body weight [7]. More valgus FNSA will increase the force at the femoral head which then forwarded into femoral neck and shaft. Intertrochanteric area which lies as transitional zone can be assumed as the place where the majority of the force was received. Moreover, with age, the bone trabeculae will decrease and it will affect the intertrochanteric area resistance against the force [14].

Longer femoral neck length has greater risk of fracture when load is given on the central axis [7]. On the contrary to our results, study by Karlsson et al showed that the difference may be due to different study subjects. Our study was only comprise of intertrochanteric femur fracture and not included other types of hip fractures [15].

Conclusion

In conclusion, we found that proximal femur morphometry (MO, FNL, and FNSA) had significantly correlated with the incidence of intertrochanteric femur fracture in our study population.

A Conflict of Interest

All authors disclose any financial and personal relationships with other people or organisations that could inappropriately influence (bias) this work.

Ethical Statement

All procedures were in accordance with the ethical standards of the institutional and/or national research committee.

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