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Research Article

MORPHOMETRIC STUDY OF PROXIMAL FEMUR IN FRACTURED AND NONFRACTURED POSTMENOPAUSAL WOMEN

LOPAMUDRA NAYAK*, SUSMITA SENAPATI, SITANSHU KUMAR PANDA, PRAFULLA KUMAR CHINARA

Department of Anatomy, Institute of Medical Sciences & Sum Hospital, Bhubaneswar, Odisha, India. Email: shashibehera1971@gmail.com

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ABSTRACT

Objective: This study was conducted to investigate the risk of hip fracture using proximal femoral morphometry in fractured and nonfractured postmenopausal women.

Methods: We conducted an observational cross-sectional study with 138 postmenopausal women (49 fractured and 89 nonfractured). The hip axis length (HAL), femoral neck axis length (FNAL), acetabular width (AW), femoral head width (FHW), femoral shaft width (FSW), and femoral neck shaft angle (FNSA) were measured in all cases by dual energy X-ray absorptiometry. We also studied the correlation between body mass index (BMI) with all the parameters in fractured and control groups.

Results: The mean age, height, weight, and BMI were 61.24±3.23, 163.94±7.84 cm, 71.88±9.14 kg, and 26.72±2.78 kg/m^2, respectively, in fractured patients. In nonfractured patients the values were 59.73±5.32, 161.73±4.25 cm, 69.54±6.25 kg, and 26.74±2.23 kg/m^2 respectively. The mean HAL, FNAL, AW, FHW, FSW, and FNSA were 130.5±3.18 mm, 111.26±3.64 mm, 18.2±1.91 mm, 53.46±1.51 mm, 37.45±1.82 mm, and 132.76±3.15 degree in case group and 130.84±4.74 mm, 112.48±4.08 mm, 17.57±2.32 mm, 53.4±1.86 mm, 35.29±1.82 mm, and 128.76±3.6° in control group, respectively.

Conclusion: The femoral parameters such as HAL, FNAL, AW, and FHW do not indicate any correlation between fractured and control groups, whereas FSW and FNSA were significantly higher in case group. The FNSA was having significant negative correlation with BMI in fractured group while that was having a significant positive correlation in the nonfractured group. This observation will be helpful in exploration of its clinical significance in proximal femoral fracture.

Keywords: Proximal femur, Morphometry, Postmenopausal, Fracture.

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INTRODUCTION

The femoral heads support the entire weight of the body suggesting that the morphometry of the proximal femur may contribute to femoral neck strength [1]. It is now widely accepted that the risk of fracture particularly at the proximal femur, which is strongly associated to osteoporosis disease, constitutes a public health problem due to its widespread incidence among adults; its dramatic consequences for the quality of life those sustaining a fracture and due to the challenges it brings to national health-care system, namely those concerning resource allocation. Proximal femoral fractures in elderly patients are considered severe and have a direct and negative impact on the life expectancy and quality of life of these patients [2]. The characteristic morphology of the proximal extremity of the femur and the muscle balance of the hip are factors that make weight bearing possible. Bone fracture in old age usually associated to osteoporosis and often caused by falls represents a serious public health problem, as it broadly affects the population and can significantly reduce individual wellbeing or even anticipate death. Keeping this in mind our study aims to predict the risk of hip fracture using proximal femoral geometry. Further, we studied whether there is any correlation between body mass index (BMI) with all the parameters.

METHODS

This study was observational cross-sectional study undertaken to compare proximal femoral morphometry in fractured and nonfractured women. The study population was subjected in 138 postmenopausal women (49 fractured and 89 nonfractured) attending various outpatient department of the hospital and coming to the Department of Radiology, Institute of Medical Sciences & Sum Hospital, Bhubaneswar. Inclusion criteria: Patients with history of fracture due to minor trauma, age group 50-65 years. Exclusion criteria: Patients with history of fracture due to osteoporosis, bilateral hip fracture, metabolic bone diseases, malignancy, and renal failure. Terminal illness, psychiatric illness, and severe dementia.

Before starting this study ethical clearance taken from the appropriate authority of Institute of Medical Sciences & Sum Hospital, each and every patient was informed about the study before including and a written consent was signed.

Radiographic assessment

The pelvic radiograms were taken with 15-30° of internal rotation of the hips in supine position. The beam centered in the symphysis pubis with a film focus distance of 100 cm. For morphometric measurements 15 inch × 12 inch films were taken. One longitudinal line was drawn over the film and few perpendicular lines 1 cm apart were drawn on that longitudinal line. The film was placed over that radiograms to facilitate accuracy and consistency of measurements and points of desired measurements were marked over lines. For all patients, skiagrams of left femur were taken for uniformity. The study protocol was approved by the Institutional Ethical Committee.

Following parameters are being considered for fractured and nonfractured patients; (Fig. 1)

- Hip axis length (HAL): From the base of the lateral part of the greater trochanter up to the inner pelvic brim
- Femoral neck axis length (FNAL): Length from the lateral part of the greater trochanter up to the caput femoris
- Acetabular width (AW): Line from caput femoris up to inner pelvic brim

- Femoral head width (FHW): Broadest cross section of femoral head
- Femoral shaft width (FSW): Width 3 cm below the center of the lesser trochanter
- Femoral neck shaft angle (FNSA): Angle between neck and shaft of femur.

Observation

In this radiological study of morphometry of proximal femur in 138 postmenopausal women over 50-year of age were included in the study, out of which 49 women were with fracture and 89 were in control group. Comparison of age, height, weight, and BMI with femoral geometry between the two groups were done using independent sample t-test. Study of association of age, height, weight, and BMI were undertaken following Chi-square test. SPSS 16.0 was used to analysis the data.

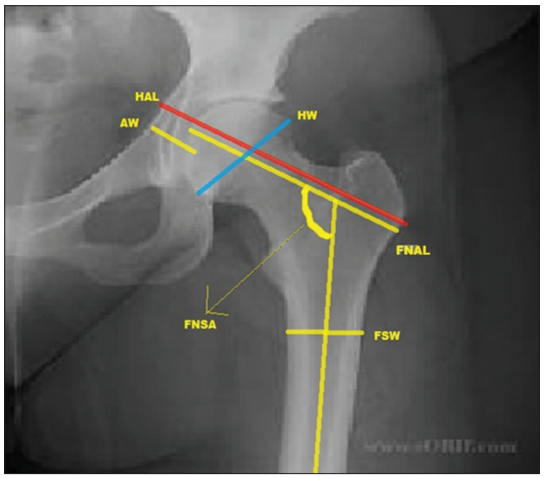

Fig. 1: Hip image shows different femoral neck measurements

Table 1: Comparison of age, height, weight, and BMI between the two groups

Group	Fractured		Nonfractured		t	p
	n	Mean	n	Mean		
Age	49	61.24±3.23	89	59.73±5.32	1.609	0.11
Height	49	163.96±7.84	89	161.73±4.25	2.168	0.032
Weight	49	71.88±9.14	89	69.94±6.25	1.469	0.144
BMI	49	26.72±2.78	89	26.74±2.23	−0.053	0.958

BMI: Body mass index

Table 1 showing that, mean age in the fractured group was 61.24±3.23 and that in nonfractured group was 59.73±5.32 (p=0.11). Mean heights in case (fractured) and control (nonfractured) group were 163.96±7.84 cm and 161.73±4.25 cm, respectively, with (p=0.032). Mean weights in case and control groups were 71.88±9.14 kg and 69.94±6.25 kg, respectively, (p=0.144). BMI for case and control groups were 26.72±2.78 kg/m^2 and 26.74±2.23 kg/m^2 (p=0.958).

Study of association of age, height, weight, and BMI with the groups in Table 2 also indicated no association of age, weight, and BMI with the case and control groups (p≥0.05). However, in the fractured group 44.2% were having a height in the range of 155-165 cm and 55% in the range 166-180 cm and the, respective, percentage in nonfractured group was 80 and 20 (p=0.000). This indicated nonfractured group was having more shorter people than the case group.

Comparison of femoral geometry with or without hip fracture is presented in Table 3. The mean HAL of fractured group was 130.5±3.18 mm and nonfractured group was 130.84±4.74 mm (p=0.658). Mean femoral neck in the case and control group were 111.26±3.64 mm and 112.48±4.08, respectively, (p=0.084). Similarly, the mean AW were 18.2±1.91 mm and 17.57±2.32 mm (p=0.104) and FHW 53.46±1.51 mm and 53.4±1.86 mm (p=0.845) in case and control group, respectively. The above femoral parameters do not indicate any significant difference between the case and control group. On the other hand, mean FSW in case and control group was 37.45±1.82 mm and 35.29±1.82 mm (p=0.000). This was significant higher in case group. Similarly mean FNSA was 132.76±3.15° in case group and 128.76±3.6° in control group, respectively, (p=0.000). This was significantly higher among the case group. The comparison can also be seen in groups in Fig. 2. Except FSW and FNSA, there is some visible difference all other parameters are comparable.

Correlation between femoral geometry with BMI in fractured and nonfractured groups is presented in Table 4. HAL, FNAL, AW, FHW, and FSW do not exhibit any correlation with BMI both in the fractured and nonfractured group. The FNSA among the fractured group was having significant negative correlation (−0.320, p=0.025) with BMI while that was having significant positive correlation (0.297, p=0.005) in the nonfractured group. Fig. 2 depicted scatter diagram to visually see the relationship between femoral parameters and BMI. Only FNSA in both the groups indicated linier relationship, while relationship in fractured group is inverse (negative) that in nonfractured group is direct (positive).

Table 2: Study of association of age, height, weight, and BMI with groups

Age interval (years)	n (%)			χ^2, p
	Fractured	Nonfractured	Total	
50-60	20 (40.8)	51 (58.0)	71 (51.8)	χ^2=3.703, p=0.054
61-70	29 (59.2)	37 (42.0)	66 (48.2)	
Total	49 (100)	88 (100)	137 (100)	
Height class (cm)				
155-165	19 (44.2)	68 (80.0)	87 (68.0)	χ^2=16.823, p=0.000
166-180	24 (55.8)	17 (20.0)	41 (32.0)	
Total	43 (100)	85 (100)	128 (100)	
Weight class (kg)				
55-70	21 (42.9)	49 (55.1)	70 (50.7)	χ^2=1.882, p=0.17
71-86	28 (57.1)	40 (44.9)	68 (49.3)	
Total	49 (100)	89 (100)	138 (100)	
BMI class				
Underweight	0 (0.0)	0 (0.0)	0 (0.0)	χ^2=2.531, p=0.282
Normal	13 (26.5)	17 (19.3)	30 (21.9)	
Overweight	30 (61.2)	65 (73.9)	95 (69.3)	
Obese	6 (12.2)	6 (6.8)	12 (8.8)	
Total	49 (100)	88 (100)	137 (100)	

BMI: Body mass index

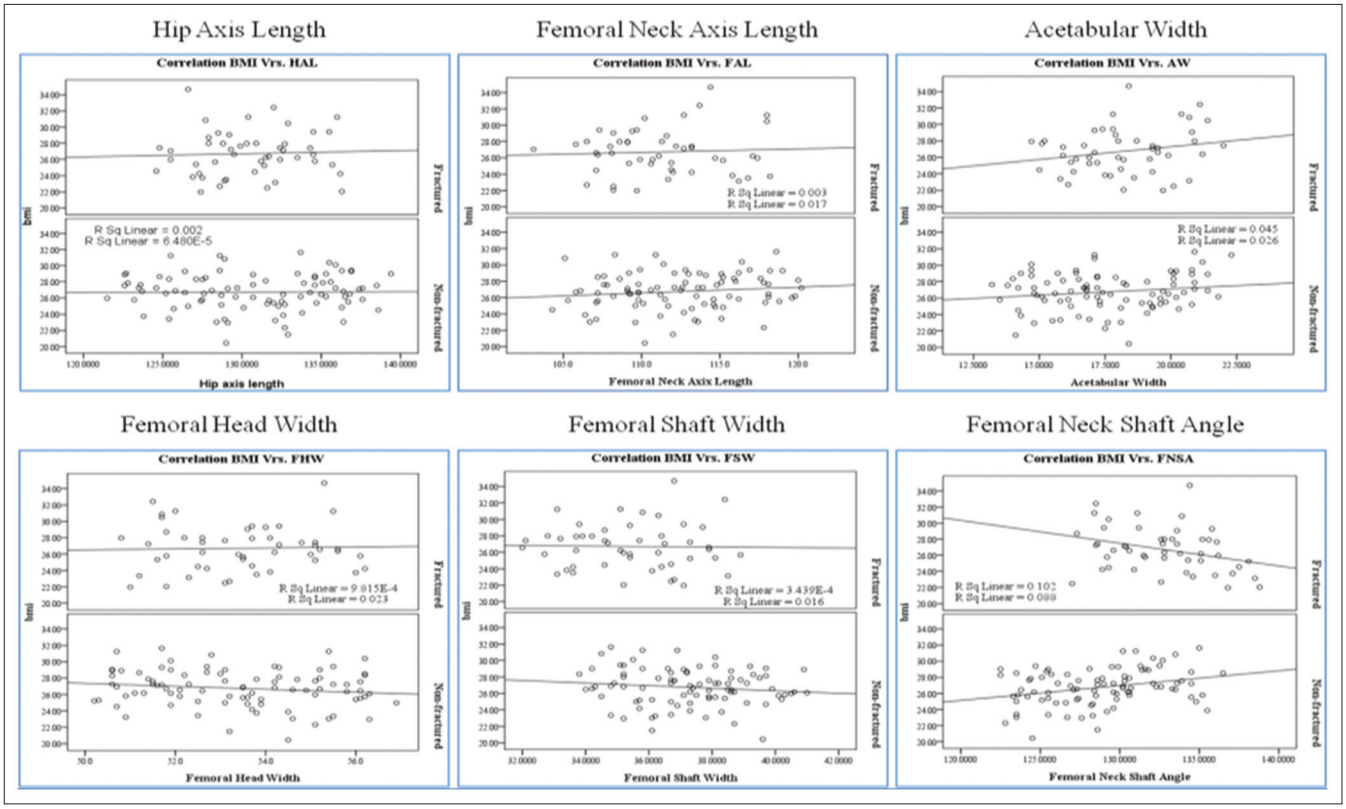

Fig. 2: Correlation between femoral geometry and body mass index

Table 3: Comparison of femoral geometry with and without hip fracture

Group	Fractured		Nonfractured		t	p
	n	Mean	n	Mean		
HAL (mm)	49	130.5±3.18	89	130.84±4.74	−0.443	0.658
FNAL (mm)	49	111.26±3.64	89	112.48±4.08	−1.739	0.084
AW (mm)	49	18.2±1.91	89	17.57±2.32	1.634	0.104
FHW (mm)	49	53.46±1.51	89	53.4±1.86	0.196	0.845
Femoral shaft width (mm)	49	37.45±1.82	89	35.29±1.82	−5.696	0.000
FNSA (degree)	49	132.76±3.15	89	128.76±3.6	6.52	0.000

HAL: Hip axis length, FNAL: Femoral neck axis length, AW: Acetabular width, FSW: Femoral shaft width, FNSA: Femoral neck shaft angle, FHW: Femoral head width

Table 4: Correlation between femoral geometry with BMI

Group	Parameter	BMI	
		Pearson correlation	Significant p
Fractured	HAL	0.045	0.760
	FNAL	0.056	0.704
	AW	0.213	0.142
	FHW	0.031	0.831
	FSW	-0.019	0.899
	FNSA	-0.320*	0.025
Nonfractured	HAL	0.008	0.940
	FNAL	0.13	0.224
	AW	0.162	0.129
	FHW	-0.153	0.153
	FSW	-0.127	0.234
	FNSA	0.297**	0.005

*Correlation is significant at the 0.05 level (two-tailed). **Correlation is significant at the 0.01 level (two-tailed). HAL: Hip axis length, FNAL: Femoral neck axis length, AW: Acetabular width, FSW: Femoral shaft width, FNSA: Femoral neck shaft angle, FHW: Femoral head width

DISCUSSION

This cross-sectional study was conducted to compare proximal femoral morphometry of fractured and nonfractured postmenopausal women. There is no association of age, weight, and BMI with case and control group, whereas the nonfractured group is having more shorter people than the fracture group. The femoral parameters such as HAL, FAL, AW, and HW do not indicate any significant difference between fracture and nonfractured group. However, FSW and FNSA are significantly higher in case group. A study conducted by Calis *et al*. [3] involving 261 postmenopausal women (232 control and 29 fractured) shows that, no significant differences are there in the measurement of HAL, FAL, AW, and HW. FNSA is significantly higher, which is similar to our study. However, the finding of FSW is contrast to our study. Study condcuted by Bergot *et al*. [1] shows that, HAL and FNSA are significantly longer in fractured patients. Alonso *et al*. [4] compared hip geometry of 605 Spanish postmenopausal women (295 fractured and 310 nonfractured). He found that the FNSA and FNW are significantly higher in fractured group, but there was no significant difference in measurement of HAL in both the groups. El-Kaissi *et al*. [5] aimed to find out the relationship between femoral geometry and the risk of hip fracture in postmenopausal Caucasian women. Fractured patients had greater FSW and FAL than in controls. This finding is not correlated with our study. Yang *et al*. [6] investigated the relationship between the proximal femoral geometry and the occurrence of hip fracture in elderly Chinese women in Taiwan. FNSA and FSW of the subjects with hip fracture were not significantly different from the controls. These results are contrast with our study. With increasing number of persons surviving beyond the age of 60-70 years, injury to the femoral neck is becoming more common. These are major injuries and most of them require operative treatment as early as possible.

CONCLUSION

We conclude that, the femoral anthropometry parameters such as FSW and FNSA are significantly higher in fractured group. There is a negative correlation between FNSA and BMI in fractured group whereas a positive correlation in control group. This study will be helpful in the improvement of public health policies design and implementation to deal with the problem of bone fracture in the elderly population.

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