The Osteometrical evaluation of bilateral femoral head for significant variability and its applied significance

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Abstract: The objective of present study is to determine the bilateral significant difference between the right and left side femoral head diameters, the correlation between diameters in each side and Osteometrical data in Indian population. The dimensions of the femoral head are important in preparation and selection of prosthesis or implants for femoral head and in the determination of gender. Difference in femoral head size was observed by previous studies. Present study is designed on random sample of 102 femur bones to determine bilateral significant difference between the right and left side femoral head diameters, to determine the correlation between diameters in each side and Osteometrical data in Indian population. The descriptive measures and inferential calculations were done. The student's t-test and Scatter plot, Pearson's correlation coefficient, and regression analysis were used to assess the objective. Statistical assessment with p-values < 0.05 was considered significant. The mean values (mm) for vertical diameters were 43.63±2.74 (left) and 43.62±2.63 (right). Anteroposterior diameters were 44.02±2.87 (left) and 43.92±2.84 (right).head circumference were 136.99±8.41 (left) and 138.06±8.97 (right). Significant variability was not found (p>0.05) among the bilateral femoral head diameters. Significant strong positive correlation (p<0.05) was observed between the vertical diameter and anteroposterior diameter. Result was compared with available researches. Conclusion: Significant variability in the femoral head diameter was not found. The vertical and anteroposterior diameters of femoral head showed strong positive correlation.

Keywords: Femur, Variability, Osteometrical, head, diameter.

INTRODUCTION

The expanded proximal end of femur is termed as head or caput [1]. The dimensions of the femoral head are important in preparation and selection of proper size of femoral head prosthesis or implants for femoral head replacement surgery [2] and hip arthroplasty [3]. Either individually or in combination Morphometry of femur plays important role in the determination of gender and studied by anatomists and anthropologists [4] using various parameters. Difference in femoral head size was observed by previous studies [4, 5]. Present study is designed to determine bilateral significant difference between the right and left side femoral head diameters, to determine the correlation between diameters in each side and Osteometrical data in Indian population.

MATERIALS AND METHODS

This primary research study was done on one hundred and two (n=102) femur bones of Indian origin. The study was performed in the Department of Anatomy, Malabar Medical College and Research Centre, Modakkallur, Calicut, Kerala, India, during 19th November 2013 TO 18th October 2014. The criteria for study were as mentioned in table-1.

PROCEDURE

Each bone was carefully inspected and parameters (figure-1) were measured using Vernier caliper by single investigator, according to standard osteometric methods [6, 7]. Average of three readings was recorded Parameter wise and side wise and the master table was prepared. Data analysis was done. Comparisons of the result with previous studies were carried out.

Statistical assessment [8, 9]

The descriptive measures [table-2] and inferential calculations were done manually. Frequency distribution was observed. Measures of central tendency and variability were calculated and evaluated. The student t-test and Pearson's correlation coefficient was used. The Variability between the bilateral sides was assessed by student's t test. Presence of Relationships and its strength between the vertical diameter and anteroposterior diameter were assessed by constructing Scatter plots, correlation coefficients and regression analysis. Statistical assessment with p-values < 0.05 was considered significant.

Table-1: Summary of methods and materials

1	Sample size (n)	102 (51 right, 51 left side)
2	Unit of Investigation	Intact femoral head of unknown sex
3	Study population	Indian
4	Pilot study	On thirty bones
5	Calculation of Sample size	With 1.8mm precision and 80% power
6	Inclusion criteria	Dry, adult Upper end of femur in regular form
7	Exclusion criteria	Deformed, pathological and fractured bone
8	Instruments & materials	Vernier caliper, magnification hand lens, camera, tables of random digits, Microsoft word and excel worksheets, markers.
9	Selection method	Simple random sampling
10	Parameters	1. Vertical diameter (VD), 2. Anteroposterior diameter (APD), 3. Head circumference (HC). [Diameters were measured (mm) at right angle to the long axis of the neck of femur].
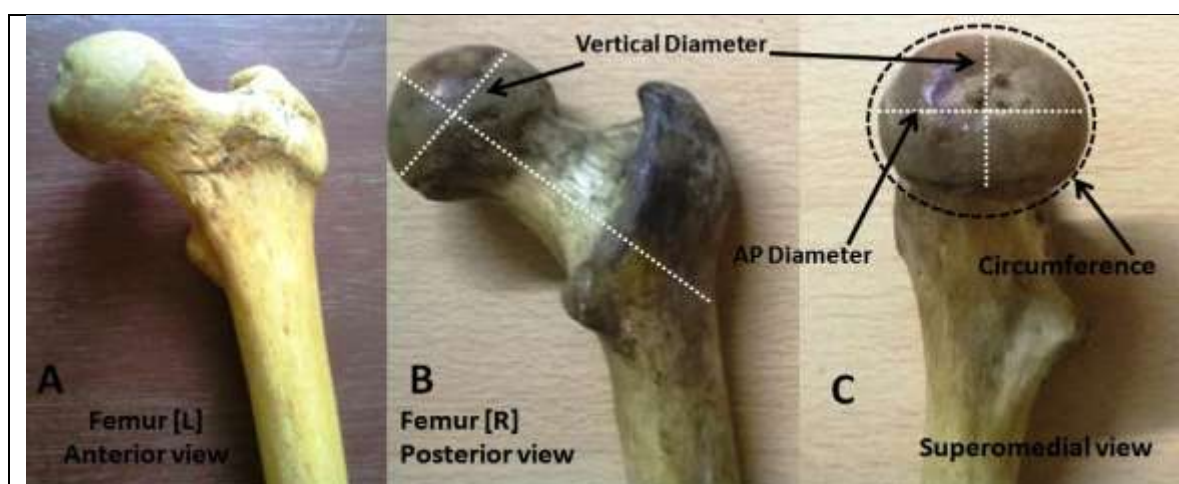
Fig-1: Proximal end of femur shown in different views.(AP=Antero Posterior)

RESULT

The diameters of the femoral head (table -3) were assessed for bilateral variation by student's t-test (p>0.05). Hence [8, 9] significant variability was not found (table-2).

Table-2 Comparisons of diameters of right and left side femoral head by student t tests.

Diameters	Left side	Right side	P value	Significance
Mean (VD)	43.63	43.62	p>0.05	Not significant
Variance (VD)	7.51	8.25		
Mean (APD)	44.02	43.92	p>0.05	Not significant
Variance (APD)	6.92	8.11		
(VD=Vertical diameter, APD=Anteroposterior diameter)				

Table-3 Descriptive statistics of femoral head study.

Description	VD(L)	VD (R)	APD (L)	APD (R)	HC (L)	HC (R)
Mean	43.63	43.62	44.02	43.92	136.99	138.06
S D	2.74	2.63	2.87	2.84	8.41	8.97
Median	43.28	43.31	43.81	43.73	136.01	137.28
Minimum	35.41	35.93	35.63	35.61	111.98	111.84
Maximum	52.73	52.51	52.33	52.37	164.75	164.38
(VD=Vertical diameter, APD Antero-Posterior Diameter, HC= Head Circumference, SD=standard deviation, L=left side, R=Right side).						

Presence of relationship and its strength between vertical and anteroposterior diameters in each side was assessed by constructing scatter diagrams (Figure-2 and 3) and correlation coefficient. Significant

strong positive correlation (r=0.988 right side and r=0.988 left side) was observed (0.01<p<0.005). The

proportion of variance, its significance and strength [8, 9] were calculated (table-4).

**Table-4 Correlations between vertical diameter and anteroposterior diameter of femoral head**

	Description	Left side	Right side
1	Coefficient of correlation	0.988	0.998
2	Coefficient of determination	0.977	0.996
3	Regression model	y=0.948x+2.19.	y=0.989x+0.347.
4	Intercept coefficient	2.19	0.347
5	Slope coefficient	0.948	0.989
6	P-value	0.01<p<0.005	Significant
7	Significance	0.01<p<0.005	Significant
[p-value= (two sided), significance= statistical significance at α≤0.05.]			
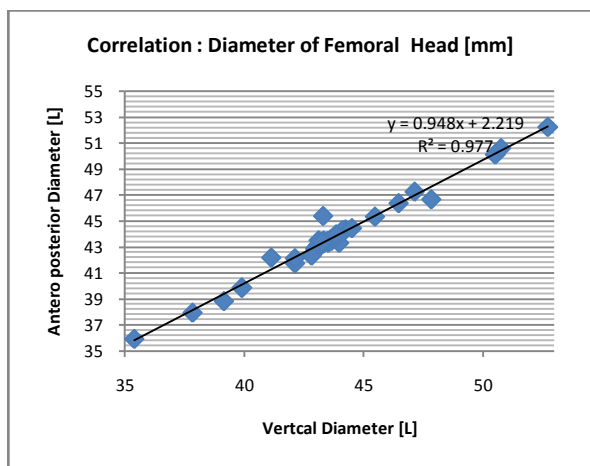
Fig-2: Scatterplot (left side) with least squares regression line and regression model
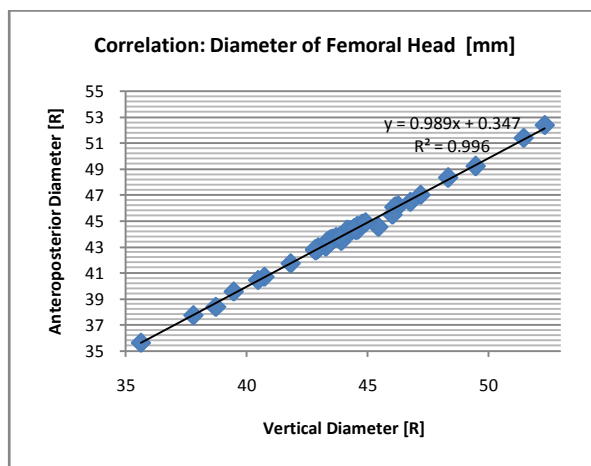
Fig-3: Scatterplot (right side) with least squares regression line and regression model

DISCUSSION

The mean values (mm) for vertical diameters were 43.63±2.74 (left) and 43.62±2.63 (right). Anteroposterior diameters were 44.02±2.87 (left) and 43.92±2.84 (right).head circumference were 136.99±8.41 (left) and 138.06±8.97 (right). While

comparing the bilateral diameters of femoral head, significant variability was not found (p>0.05). Significant strong positive correlation (r=0.997, p<0.05 on left side and r=0.988, p<0.05 on right side) was observed between the vertical diameter and anteroposterior diameter of femoral head.

Table -5: comparison of femoral head diameter (mm)

Researcher	Diameter	Population	Year
Present study	VD:43.63±2.74 (L), 43.62±2.63 (R), APD:44.02±2.87(L), 43.92±2.84 (R)	Indian	2015
Massin *et al.* [10]	VD:45.6 ± 4.2	Caucasian	2000
Hoaglund *et al.* [11]	VD:46.0	England	1980
Noble *et al.* [12]	VD:46.1 ± 4.8	Caucasian	1988
de sousa, E *et al.* [13]	VD:46.56±3.6	Brazil	2010
Chee Kean Lee *et al.* [14]	44.2 ± 3.0	Malaysian	2014
Dutchie *et al.* [15]	VD:50.2±0.6(Male), 45.2±0.6 (Female)	Scotland	1998
Akhtari A *et al.* [5]	VD:51.6 (Male), 45.7 (Female)	Bangladesh	2005
Singh *et al.* [16]	VD:52.02(Male), 46.8 (Female)	Nigeria	1986
[VD=Vertical diameter, APD=Anteroposterior diameter]			

Comparison of studies with different populations

Studies were reported that femoral head size vary [4] with respect to difference in gender, race, heredity, nature of work, mode of life and geographical factors related to life style. Study observed that each population [5] has its own osteometric values. Bilateral

variability: similar to present study results, previous studies were reported no significant bilateral difference studies [16] about the diameters. Closeness of the values can be seen on Indian, Caucasian [10], England [11] and Brazil [13] populations. The diameter of femoral head of Indian population was smaller and

Nigerians with comparatively larger diameter. Present study was done on dry bone. So thickness of articular cartilage has not accounted during measurements. Relationship: Positive correlation was found between the diameters of femoral head in study on Nigerian population [17]. Hence present study on Indian population concurs and corroborates with this study.

Developmental evidence [1]

The femur ossifies from five centers. It is the first long bone to ossify except clavicle. Secondary centre for the head appears during the first six months of birth and it is restricted till the 10th year, so that the epiphyseal line is horizontal. On maturation it appears like a hollow cup proximal to the neck. The capital epiphysis fuses in the 14th year in females and 17th year in males. The head is pressure epiphyses [1].

APPLIED / CLINICAL SIGNIFICANCE
Size of implants

It suggests that femoral head implants of equal size could be used bilaterally during [2] hip joint surgery.

Osteometry:

It helps in preparation of implants and in selection of specific or proper size implants required to the patient. Otherwise selection of improper size implant will result with alteration in soft tissue tension or patella femoral stress [18] and it could create serious problems for the patients in long run [19, 20]. To avoid the post surgical complications and for modeling, the measurements of femoral head diameter, horizontal offset and neck shaft angle are important [19, 21]. It is useful in designing the metal on metal hip resurfacing prostheses [22].

Medico legal significance

In determination of gender and age in the field of forensic medicine and anthropology [1, 4].

CONCLUSION

Significant variability in the femoral head diameter was not found. The vertical and anteroposterior diameters of femoral head showed strong positive correlation.

Limitations of study

The age and gender wise study were not done. Cadaveric specimen and Radiographs were not utilized.

Acknowledgements

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