Original Article

OSTEOMETRY OF FEMUR WITH ITS CLINICAL IMPLICATIONS

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ABSTRACT

Introduction: Femur osteometry is important for establishing individual identity, designing of prosthesis for hip replacement surgeries, nail application, and determination of age and sex. Review of previous study showed a lack of extensive database. This study was undertaken to build baseline data for femur osteometry in North Indian population.

Material & Methods: One hundred and fifteen dry human femur of undetermined age and gender were collected for this study. Parameters namely length of femur, vertical diameter of head, transverse diameter of head, epicondylar breadth and neck shaft angle were measured using a vernier calliper. Data was analysed statistically using SPSS 19 software.

Results: The mean values for length, vertical diameter head, transverse diameter head , epicondylar breadth and neck shaft angle were 418.16+27.34 mm, 38.43 ± 3.87mm, 35.41 ± 3.76mm, 72.06 ± 6.55mm and 121.5 º ± 6.14 respectively for the studied population.

Conclusion: Study signifies the importance of collecting ostemetric data of femur for a specific population due to ethnic and environmental factors affecting it.

Keywords: Femur, osteometry, vertical diameter head, transverse diameter head, epicondylar breadth, neck shaft angle.

INTRODUCTION

Femur is the strongest and longest bone of human body. A comprehensive insight into physical characteristics of bone helps forensic anthropologist to provide information on slight distinctions in human skeleton that are helpful in finding individual identity [1]. Apart from identification of an individual, it can be used for trauma analysis, photographic superimposition, and to determine time interval since death of an individual [2].

Fracture of neck of femur and hip joint dislocation is commonly seen in clinical practice. Data of diameter of the head and neck of the femur is crucial in orthopaedic surgery in prosthesis and nail application. It is required in radiology to determine age and recognise bone pathology. The femoral normative values can be used by plastic and reconstructive surgeons in their reconstruction and medical rehabilitation [3].

In forensic osteology, finding of sex from skeletal remains is of utmost value and depends largely on data techniques to give precise information. In addition, long bones either singly or jointly are used for determining sex [4].

The hard composition of femur makes it the ideal bone to be preserved for forensic examination [5].

When previous literature was reviewed, it was found that there was lack of an extensive database in North Indian population. Since the morphometric measurements vary with sex, age, race, ethnicity, climate and other geographical factors, regional variation is found in dimensions [6], hence this study

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was undertaken to study and analyse the various dimensions of femur in North Indian population.

MATERIAL AND METHODS

One hundred and fifteen (Right=58, Left=57) adult dry human femurs of unknown gender were collected from bone bank of Department of Anatomy, University College of Medical Sciences, Delhi and Heritage Institute of Medical Sciences, Varanasi. Unossified, deformed and fractured bones were excluded from the present study. Materials required for the study were osteometric board, digital vernier calliper, thread, clay, angle measuring protractor, measuring scale, tape and marker pencils

The following dimensions were measured [7]:

Length of femur (ML) (Fig. 1 A):

In anatomical position, the highest point on the head was identified and marked as point a and a line drawn from highest point in coronal plane wherever it cut the lower extreme articular margin of the lower end of femur was taken as point b. The distance between points a and b were measured using a measuring tape.

Vertical diameter of head (VDH) (Fig. 1 B):

The maximum diameter of head in vertical plane was measured by using a digital vernier calliper.

Transverse diameter of head (TDH) (Fig. 1 C):

The maximum diameter of head in transverse plane taken at right angle to vertical diameter by using a digital vernier calliper.

Epicondylar breadth (ECB) (Fig. 2 A):

The distance between the most projected points on the epicondyles was measured using a digital vernier calliper.

Neck shaft angle (NSA) (Fig. 2 B):

The angle made by axis of shaft with the axis of the upper anterior column. Axis of column is computed by using a thread which divides the anterior surface of the column in two equal halves. Axis of the shaft is computed by a thread which spreads in the mid sagittal plane over the anterior surface of the bone from the upper end of the oblique line stretching between the condyles.

Statistical analysis: The data was measured in millimetre (mm), tabulated and analysed using SPSS 19 software. The results were compared accordingly. The level of significance was marked at $p<0.05$ at 95% confidence interval.

Fig 1: Photograph showing measurement of: A. Length of femur (ab), B. Vertical diameter of head, C. Transverse diameter of head

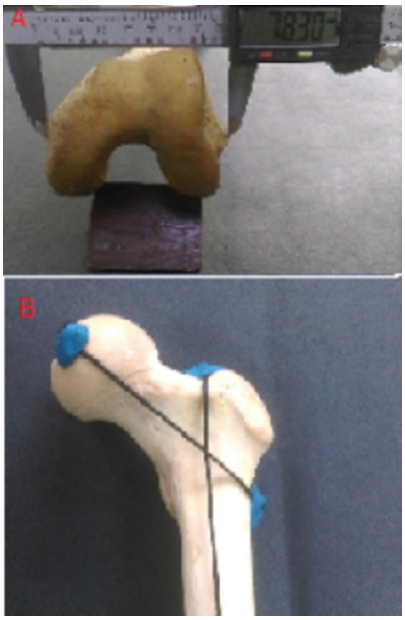

Fig 2: Photograph showing measurement of: A. Epicondylar breadth B. Neck Shaft angle

OBSERVATION AND RESULTS

Average length of femur was 418.16+27.34 mm with mean left side length as 420.23+26 mm and mean right side length as 416.13+28 mm. The average mean vertical diameter of head was 38.43 ± 3.87mm, mean right transverse diameter of head was 38.17 ± 3.76mm and left was 38.7 ± 4 mms The average mean transverse diameter of head was 35.41 ± 3.76mm, mean right transverse diameter of head was 35.53 ± 3.68mm and left was 35.37 ± 3.83mms. The average mean epicondylar breadth was 72.06 ± 6.55mm with mean right epicondylar breadth as 72.48 ± 6.38 mm and left as 71.63+6.75mm. The average mean neck shaft angle was 121.5 ± 6.14°, mean right neck shaft angle was 119.37 ± 4.52 and left was 123.7 ± 6.7 (Fig. 3 & 4).

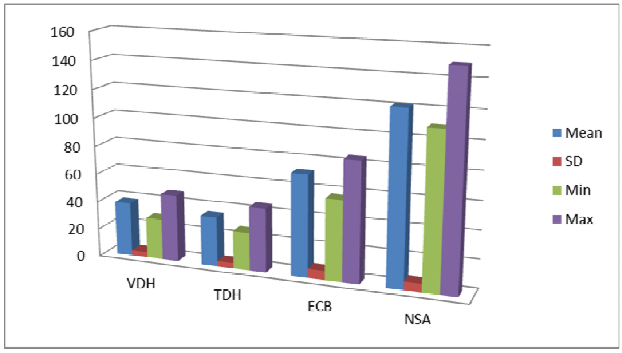

Fig. 3: Bar diagram showing mean, standard deviation, minimum and maximum values for various parameters (VDH: vertical diameter of head, TDH: transverse diameter of head, ECB: epicondylar breadth, NSA: neck shaft angle)

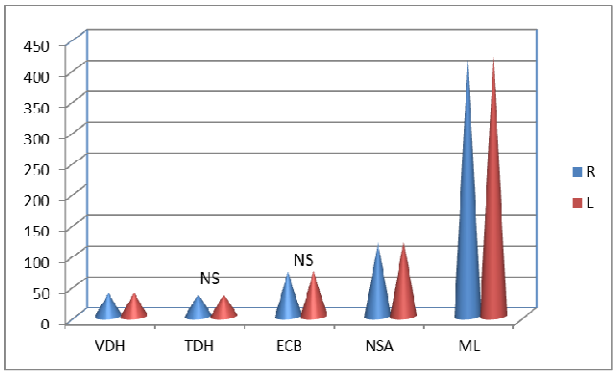

Fig. 4: Comparison of femur parameters on right and left sides

DISCUSSION

The present study was an attempt to construct data on different dimensions of adult femur in North Indian population. When osteometric data of various dimensions of femur was compared with other racial groups (Asian, African and Turkish), it was found that mean values of ML, VDH, TDH, ECB and NSA were 418.16+27.34 mm, 38.43 ± 3.87mm, 35.41 ± 3.76mm, 72.06 ± 6.55mm and 121.5 ± 6.14° respectively in our study and were statistically significant ($p<0.05$) [8-10] (Table 1).

On an average, mean value of all parameters in our study were found to be lower when compared with African, Turkish and Asian groups [8-10] (Fig. **5**).

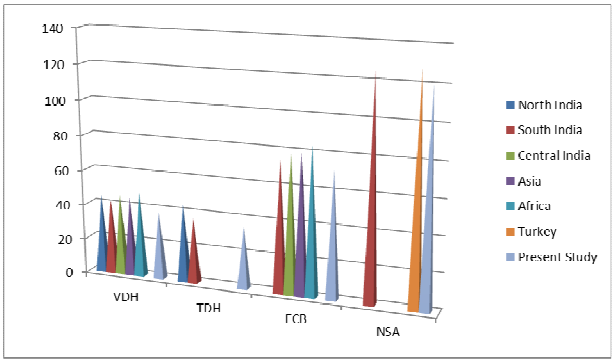

Fig. 5: Comparing mean values of various femoral parameters from across the world

Data from various Indian origin population groups were used for regional comparison. Most of the parameters like ML, VDH, ECB and NSA were variable as far as statistical significant difference was concerned [5, 11-13]. Difference was statistically significant with respect to these parameters when data from present study was compared with that from central and North Indian population. However, the difference was statistically non-significant for these parameters when compared with South Indian studies [5,12] (Table 1).

VDH was the only parameter which showed statistically significant difference amongst various population groups. Both regional and racial variations were found [5, 8-13] (Table 1). The variability in this parameter should be particularly kept in mind when designing prosthesis for specific population groups to ensure better treatment outcomes.

The knowledge about different diameter of the head and neck of the femur is essential in orthopedic

surgery in prosthesis and nail application. This is helpful in radiological practice in recognising pathology of bone and for determination of age [3].

Data of femoral head from both sexes is required for structuring of prosthesis used in hip replacement surgery [14]. Sex can determined concretely by discriminant function analysis and can be estimated by 85% accuracy in case of vertical diameter and 81.7% in case of transverse diameter [12,15].

As explained above, osteometric measurement of femur can be used extensively in anatomy, forensic science, radiology, orthopedic surgery, and structuring of prosthesis of femoral head [16]. To the best of our knowledge no other Indian study has collected and analysed such an extensive database, considering the fact that our sample size was largest and several parameters were measured. This study will effectively contribute to build an elaborate baseline data for North Indian population.

Table 1: Comparison of various parameters between various population groups

Parameter	Authors	Region	Sample number	Mean (mm)	´p´ value	Significance Level
Length	Pillai et al. (2014)	India South	50	437±31	0.001	NS
	Purkait & Chandra (2014)	India Central	80	450±21	<0.0001	S
	Steyn & Iscan (1997)	Africa	56	450±27	<0.0001	S
Vertical Diameter Head	Pillai et al. (2014)	India South	50	42±3.5	<0.0001	S
	Khaleel & Shaik (2014)	India South	50	42±3.6	<0.0001	S
	Purkait & Chandra (2014)	India Central	80	46±2.3	<0.0001	S
	Pandey & Gaikwad (2016)	India North	60	44±3	<0.0001	S
	King et al. (1998)	Asia	70	45±1.9	<0.0001	S
	Steyn & Iscan (1997	Africa	56	48±2.6	<0.0001	S
	Atilla et al. (2007)	Turkey	114	45±4.1	<0.0001	S
Transverse Diameter Head	Pillai et al. (2014)	India South	50	37±3	0.0070	NS
	Pandey & Gaikwad (2016)	India North	60	44.6	<0.0001	S
Epicondylar Breadth	Pillai et al. (2014)	India South	50	75±6.0	0.0064	NS
	Purkait & Chandra (2014)	India Central	80	78±4.5	<0.0001	S
	King et al. (1998)	Asia	70	78±3.5	<0.0001	S
	Steyn & Iscan (1997)	Africa	56	84±4.6	<0.0001	S
Neck Shaft Angle	Pillai et al. (2014)	India South	50	106±6.5	<0.0001	S
	Khaleel & Shaik (2014)	India South	50	125±6.5	0.0005	NS
	Atilla et al. (2007)	Turkey	114	128±4.7	<0.0001	S

CONCLUSION

This study reinforces the importance of collecting extensive database for osteometric measurements of femur for varied population groups as they get affected by ethnic and environmental factors. This is to ensure better treatment outcomes.

REFERENCES

1. Takale S, Bagal G. Sex determination from the upper end and length of the femur: A morphometric study. JMSCR. 2016; 4 (2):9257-61.
2. Camps FE, Robinson AE, Lucas BGB, Thomas FC. G Randwohl's Legal Medicine. 3rd ed. Bombay: K M Varghese Company; 1998:110.
3. Sembian U, Muhil M, Srimathi.T, Muthukumar T, Kumari NSD. A study of sexual dimorphism in femora of rural population of south Tamilnadu, India. JCDR. 2012; 6(2): 163-165.
4. Krogman WM, Iscan MY. Human Skeleton in Forensic Medicine. 2nd ed. Springfield: Charles C. Thomas; 1986.
5. Pillai TJ, Lakshmi Devi CK, Sobha Devi T. Osteometric studies of human femur. IOSR J Dental Med Sci. 2014; 13(2):34-39.
6. Singh SP and Singh S. The sexing of adult femora: Demarking points for Varanasi zone. Journal of the Indian Academy of Forensic Sciences 1972 B; 11:1- 6.
7. Buikstra JE, Ubelaker DH. 1994. Standards for Data Collection from Human Skeletal Remains. Fayetteville Arkansas: Arkansas Archaeological Survey, Research Series No. 44.
8. Steyn M, Iscan MY. Sex determination from the femur and tibia in South African Whites. Forensic Sci Int. 1997; 90 (1-2):111-119.
9. King CA, Iscan MY, Loth SR. Metric and comparative analysis of sexual dimorphism in the Thai femur. J Forensic Sci. 1998; 43 (5): 954-58.
10. Atilla B, Oznur A, Caglar O, Tokgozoglu M, Alpaslan M.. Osteometry of the femora in Turkish individuals: a morphometric study in 114 cadaveric femora as an anatomic basis of femoral component design. Acta Orthop Traumatol Turc. 2007; 41(1):64-68.
11. Purkait R, Chandra H. A study of sexual variation in Indian femur. Forensic Sci Int. 2004; 146 (1):25-33.
12. Pandey R, Gaikwad H. Sex determination by discriminant function analysis of femoral heads of a North Indian population. Indian Journal of Forensic and Community Medicine. 2016; 3(3): 172-175.
13. Khaleel N, Shaik HS. Osteometric study of human femur. Int J Res Med Sci. 2014; 2(1):104-107.
14. Chauhan R, Paul S, Dhaon BK. Anatomical parameters of North Indian hip joints-Cadaveric Study. J Anat Soc India. 2002; 51(1):39-42.
15. Hsiao TH, Chang HP, Liu KM. Sex determination by discriminant function analysis of lateral radiographic cepahlometry. J Forensic Sci. 1996; 41(5):792-5.
16. Shivashankarappa A, Prasad NC and Pavan PH. A study on femur neck shaft angle and its clinical importance. International Journal of Orthopaedics Sciences. 2017; 3(4): 755-757.