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Research Article

A cross-sectional study on under-emphasized sex determining parameters of femur

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ABSTRACT

Background: There have been researches done based on using 'Maximum length' of femur for sex determination. We, the authors of the present study, formulated an index including both (maximum length & girth) and named it as Femoral Girth Index (FGI). An attempt has been made by the authors, with this study, to arrive at appropriate conclusions regarding sex determination using dry femurs representing South-Eastern India (Kancheepuram district region) using three parameters namely, 'Maximum length', 'Maximum girth' and FGI.
Methods: FGI was calculated using the observed values of 'Maximum length' and 'Maximum girth' of the femurs. Formula used for calculating the FGI was, "Maximum girth of shaft of femur/Maximum length of femur x 100". Statistical analysis was done using three parameters, namely, maximal length of femur (L), maximum girth of femur (G) and FGI. Significance of the results was assessed implementing unpaired t test.
Results: The results were very significant with the application of unpaired t test in relation to the three parameters, maximal length of femur, maximum girth of femur and femoral girth index.
Conclusions: We believe that the study results can be reliably used for dry, fully ossified femurs of southern India. FGI, when more than 19.57, is indicative of males and when less than 19.57, is indicative of females.

Keywords: Femur, Girth, Maximum, Unpaired, Study

INTRODUCTION

How often do we prioritize a femur for determining sex from a set of skeletal remains received for expert opinion? The answer is almost 'never'. Our priority is always a hip bone followed by skull. The well-known Krogman's rule gives only 80% chances of being right while opining on femur. We, the authors of the present study, felt the need to increase these chances by doing more research on this issue.

Sex determination of an individual from skeletal remains is still a challenge to the field of Forensic Medicine as it was a decade ago. Many researches have been done to develop sophisticated criteria to determine sex from skeletal remains as accurately as possible. Pelvic bone is leading the race and is therefore the bone of choice for determining sex. Mastoid,[1] craniofacial region,[2] mandible[3] and other bones of the human skeleton are also used for sexing. But in case of femur, a long bone, sexual dimorphism is still a concern despite efforts by various researchers. Therefore, need was felt by the authors of the

present study to take these efforts a step further. Sexual dimorphism of femoral head has been studied by several researchers, namely, Javdekar,[4] Kate[5] in sample from fifteen cities of India, Singh & Singh[6] in Varanasi zone of India, Purkait and Chandra[7] in Bhopal, India.

There is no doubt that the stature of a person is proportional to his/her femoral length. A logical reason for considering 'Maximum length' of femur for sex differentiation by various authors could be the obvious difference in stature between a reference male and a female. But, some females are as tall as males. Therefore, authors of the present study felt that using 'Maximum length' of femur alone for sex differentiation was not enough; we thus introduced maximum femoral girth factor. Logical reason was that femurs belonging to tall females could be as long as that of males, but may not necessarily be as stout as male femurs. There have been researches done based on using 'Maximum length' of femur for sex determination, namely, Hema et al.,[8] Pandya et al.[9] and Rajeshwari et al.[10] We formulated an index including both (maximum length & girth) and named it as Femoral Girth Index (FGI). An attempt has been made by the authors, with this study, to arrive at appropriate conclusions regarding sex determination using dry femurs representing South-Eastern India (Kancheepuram district region) using three parameters namely, 'Maximum length', 'Maximum girth' and FGI.

METHODS

Material for this cross-sectional study consisted of 33 dry human femurs of known gender (left sided were 15 and right were 18, femurs belonging to males were 17, and those belonging to females were 16). Gender was preliminarily assessed by examining important parameters like maximum diameter of Femoral Head (FH), Femoral Neck-Shaft angle (FNS), prominence of linea aspera, Femoral Bi-condylar Width (FBW). All the bones were fully ossified (adult) bones and free from any pathological or congenital defect (Figure 1). The study was conducted on bones from teaching collection of the Anatomy department at Karpaga Vinayaga Institute of Medical Sciences and Research Centre, Kancheepuram, Tamil Nadu. Fully ossified, dry and intact femurs of known gender were included. Deformed, malformed bones with congenital anomalies and sexual dimorphism were excluded from the study. With 34 bones available, 1 was excluded by implementing exclusion criteria. Keeping confidence level at 95% and confidence interval at 3, sample size was determined as 33 femurs.

Hepburn's osteometric board, scale and thread were used for measurements wherever necessary. Maximum length (L), the maximum distance from the most superior point on the femoral head to the most inferior point on the bi-condylar plane, was measured with the help of osteometric board, and the measurements were recorded in centimeters (Figure 2). Maximum girth (G) of shaft of femur was measured using thread (Figure 3), and later, the cut thread was measured with a measuring scale in centimeters. Maximum girth was assessed at that point where linea aspera was most prominent. FGI was calculated using the observed values of 'Maximum length' and 'Maximum girth' of the femurs. Formula used for calculating the FGI was, "Maximum girth of shaft of femur/Maximum length of femur x 100".

Figure 1: Sample size (33 femurs).

Figure 2: Maximum length (L) measurement with osteometric board.

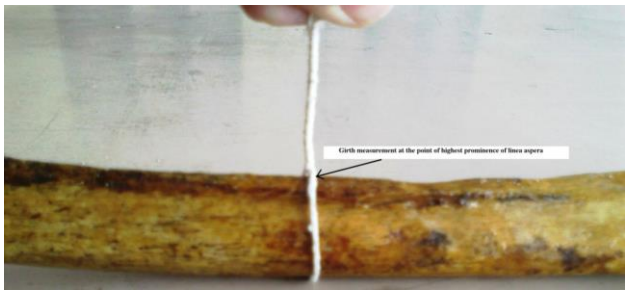

Figure 3: Maximum girth (G) measurement of femur shaft.

Statistical analysis was done using three parameters, namely, maximal length of femur (L), maximum girth of femur (G) and FGI. The study samples were divided into two groups, femurs with male features and femurs with female features. All the three parameters were tabulated under these groups and statistically analyzed for P value with unpaired t test. Also, correlation study was done on

maximum length and girth of all the femurs using scatter graph of linear regression type (Figure 4).

RESULTS

Unpaired t test results with Length (L) as parameter; the two-tailed P value equaled 0.0050. By conventional criteria, this difference is considered to be statistically very significant (Table 1). The mean of males group minus females group equaled 2.000. 95% confidence interval of this difference was 0.649 to 3.351. The two-tailed P value was less than 0.0001 with Girth (G) as parameter. By conventional criteria, this difference is considered to be statistically extremely significant (Table 2). The mean of males group minus females group equaled 0.500. 95% confidence interval of this difference was 0.273 to 0.727. The two-tailed P value was less than 0.0001 with FGI too; which meant statistically extremely significant (Table 3). The mean of males group minus females group equaled 0.2500. 95% confidence interval of this difference was 0.1486 to 0.3514. Low positive correlation (Figure 4) was seen with scatter chart (correlation graph of linear regression type) between length (x axis) and girth (y axis) of the 33 femurs.

Table 1: Unpaired t test results of femur with length as parameter.

Length (L)	Mean (cm)	Standard Deviation (SD)	Standard Error of Mean (SEM)	n	Results (R)	Statistical Significance (SS)
Male features	42.5	2.5	0.606	17	P value=0.005 >41.4 cm=Male <40 cm=Female 40-41.4 cm=Dimorphic	Very significant
Female features	40.5	0.9	0.225	16		

Table 2: Unpaired t test results of femur with girth as parameter.

Girth (G)	Mean (cm)	Standard Deviation (SD)	Standard Error of Mean (SEM)	n	Results (R)	Statistical Significance (SS)
Male features	8.4	0.4	0.097	17	P value<0.0001 >8.1 cm=Male <8 cm=Female 8-8.1 cm=Dimorphic	Extremely significant
Female features	7.9	0.2	0.05	16		

Table 3: Unpaired t test results of femur with femoral girth index (FGI) as parameter.

FGI (G/L x 100)	Mean (cm)	Standard Deviation (SD)	Standard Error of Mean (SEM)	n	Results (R)	Statistical Significance (SS)
Male features	19.76	0.19	0.0461	17	P value<0.0001 >19.57=Male <19.57=Female	Extremely significant
Female features	19.51	0.06	0.015	16		

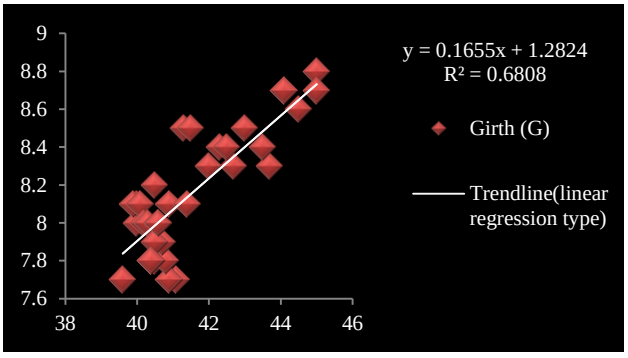

Figure 4: Scatter chart (linear regression type) demonstrating low positive correlation.

DISCUSSION

Pandya et al.[9] from Jamnagar and Rajeshwari et al.[10] from Maharashtra reported a little higher numbers on mean and standard deviation of maximum femoral length of femurs belonging to both males and females. This could be due to comparatively tall stature of the reference population in northern and central India, where these studies were done. Hema et al.[8] from Mangalore reported comparatively similar results as ours. Mangalore is coastal city of southern India, but a little north of Kancheepuram where our study was done.

Linea aspera is a rough ridge on the posterior surface of femur formed due to vigorous activity of the muscles

attached to it. Prominent linea aspera is very significant for femurs belonging to males as it's a general view that a reference male has a greater routine muscular activity compared to a reference female. Prominent linea aspera adds up to an already thick shaft of a femur belonging to a male. Therefore, maximum girth of shaft of femur is a very important factor in sexing of a femur. Less commonly, some proportion of females accustomed to high routine muscular activity (For example-female labourers, farmers, etc.) do tend to have a prominent linea aspera, and on the contrary, some males leading sedentary life may not have a prominent linea aspera. This explains low positive correlation scatter chart (correlation graph of linear regression type) between length (x axis) and girth (y axis) of the 33 femurs, which means, long femurs need not be proportionally stout. However, the general rule that a femur with a prominent linea aspera is more indicative of belonging to a male stays.

As already discussed, prominent linea aspera is an important contributor to the overall girth of the femur. This prominence can be very well appreciated by being able to hold the ridge (linea aspera) with thumb and index finger. If the ridge cannot be convincingly held, we subjectively infer as femur belonging to a female or being dimorphic. However, these are the ways of subjective assessment. It's never a comfortable situation when it comes to opining on sex of a femur. Hip bones are still the favorites for this task. Femurs are preferred for stature estimation. Therefore, furthermore research on sexing of a femur was felt needed by the authors of the present study. Our study is a step towards this goal. Femoral Girth Index (FGI) is a reliable way of objective assessment. We achieved very significant results on all the three parameters, 'Maximum length', 'Maximum girth' and Femoral Girth Index (FGI). Thus, our study results can be reliably used for femurs belonging to southern India.

CONCLUSION

We, the authors of the present study, believe that the study results can be reliably used for femurs belonging to southern India. Using maximum length as parameter, we infer that femurs with maximum length more than 41.4 cm belong to males and those less than 40 cm belong to females. Femurs with maximum length between 40 cm and 41.4 cm are sexually dimorphic. Using maximum girth as parameter, we infer that femurs with maximum girth more than 8.1 cm belong to males and those less than 8 cm belong to females. Femurs with maximum girth between 8 cm and 8.1 cm are sexually dimorphic. Using Femoral Girth Index (FGI) as parameter, we infer that femurs with FGI more than 19.57 belong to males and those less than 19.57 belong to females.

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REFERENCES

1. Hema N, Avadhani R, Bhagya B. Mastoid process - a tool for sex determination, an anatomical study in South Indian skulls. Int J Biomed Res. 2013;4(2):106-10.
2. Vineeta S, Rashmi S, Rajesh KR, Satya NS, Tej BS, Sunil KT. An osteometric study of North Indian populations for sexual dimorphism in craniofacial region. J Forensic Sci. 2011;56:700-5.
3. Rishi P, Rajan B. Sexing of mandible using ramus and condyle in Indian population: a discriminant function analysis. Eur J Anat. 2013;17(1):39-42.
4. Javdekar BS. A Study of the measurements of the head of the femur with special reference to sex - a preliminary report. J Anat Soc India. 1961;10:25-7.
5. Kate BR. A study of the regional variation of the Indian femur - the diameter of the head - Its medicolegal and surgical application. J Anat Soc India. 1964;13(1):80-4.
6. Singh SP, Singh S. The sexing of adult femora: demarking points for Varanasi zone. J Indian Acad Forensic Sci. 1972;11:1-6.
7. Purkait R, Chandra H. Sexual dimorphism in femora: an Indian study. Forensic Sci Communicat. 2002;4(3):1-6.
8. Hema N, Bhagya B, Sucharitha S, Avadhani R. Metric assessment of femur using discriminant function analysis in South Indian population. Int J Anat Res. 2013;2:29-32.
9. Pandya AM, Singel TC, Akbari VJ, Dangar KP, Tank KC, Patel MP. Sexual dimorphism of maximum femoral length. Natl J Med Res. 2011;1(2):67.
10. Rajeshwari S, Bhosale, Zambare BR. Sex determination from femur using length of femur in Maharashtra. JDMS. 2013;3(4):1-3.

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