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Original Research

Estimation of total length of femur from measurements of proximal and distal segments

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ABSTRACT:

Background: To evaluate total length of femur from measurements of proximal and distal segments. **Materials & methods:** A total of 30 dry bone samples were included. 15 from each side were studied. Along with maximum femoral length, 4 proximal and distal segmental measurements were measured following the standard method with the help of osteometric board, and digital Vernier'scaliper. Results were analysed using SPSS software. **Results:** 15 dry femora samples from each side were included. Even though there was difference between right and left sided measurements, but when compared between the right sided and left sided measurements by applying student t-test, there was no statistical significant difference between two groups except for the DMc with p-value of 0.03. **Conclusion:**Femoral length can be calculated from the segmental measurements.

Keywords: femur, segments, medial condyle.

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INTRODUCTION

The hip joint is very stable and it is the largest joint of the body. This specific feature is governed by the typical anatomical shape of articulating surfaces and ligaments. It is a multiaxial, ball, and socket joint. Its maximum stability is due to the deep insertion of the head of the femur into the acetabulum.[1] The femur is one of the largest bones of the body subjected to maximum weight-bearing; its typical geometric shape gives it strength and stability. Morphometric parameters, including hip axis length, femoral head width, have been related to the mechanical strength of the proximal femur. [2]The morphology of the proximal femur, especially the relationships between the head, neck, and the proximal shaft, has been investigated numerous times. There are many pathologies like avascular necrosis, osteoporotic fractures, osteoarthritis etc, and a greater understanding of the anatomy of this area might refine treatment options for these conditions. [3]

Along with the use of proximal femoral measurements in estimating the total length of femur, it also determines the strength of femur to resist the hip fracture.[4] The physical characteristics of the bone, like bone mass, size and geometry of the proximal epiphysis of the femur allow predicting the risk for hip fractures in different populations. [5]The dimensions were found to be correlated with the type of fracture in proximal femur. [4,6]For example, more number of patients with intra capsular fracture were found to have higher neck length as compared to the extra capsular fracture.[7] Similarly, geometry and measurements of distal femur is important for the design of joint replacement prosthesis and fixation material. Preoperative templating for arthroplasty usually involves the contra lateral, healthy side, based on the assumption that there are no side-to-side differences. [8]The femur is the longest and strongest bone in the human body. It has shaft, proximal end and distal end. The shaft is slightly convex anteriorly. [9] Femur is selected in the present study because it is

one of the long bones which helps in assessing the height of the individual more accurately compared to the other long bones. Grossly mutilated skeletal remains are a big challenge for forensic pathologist and physical anthropologist in the identification of the deceased. The application of osteometry is most important in medico legal investigation for estimating the height which is part of achieving the goal of estimating age at the time of death, sex, race, ancestry, ethnicity, stature, body weight and body build. The details of individualizing characteristics i.e. amputation, fractures, ankylosis, deformities and bone pathologies and to some extent the cause of death if reflected in the skeletal remains are also essential in the identification of the individual. The objective is to enable the law enforcement agencies to achieve the ultimate goal of personal identification. Pearson's derivation of regression formulae for calculation of stature of an individual by the length of long bones was done in case of dead or dry bones. [10] Hence, this study was conducted to evaluate the total length of femur from measurements of proximal and distal segments.

MATERIALS & METHODS

A total of 30 dry bone samples were included. 15 from each side were studied. Along with maximum femoral length, 4 proximal and distal segmental measurements were measured following the standard method with the help of osteometric board, and digital Vernier'scaliper. Bones with gross defects were excluded from the study. Measured values were recorded separately for right and left side. Student-t test was done.The data was collected. Results were analysed using SPSS software. A p-value less than 0.05 were taken as statistically significant between two groups.

RESULTS

15 dry femora samples from each side were included. Even though there was difference between right and left sided measurements, but when compared between the right sided and left sided measurements by applying student t-test, there was no statistical significant difference between two groups except for the DMc with p-value of 0.03.

Table 1: Descriptive statistic of all the measurement along with level of significance of mean differences between right and left side

Variables	Side	Mean	P- value
Segment 1	Right =15	5.95	0.6
	Left =15	5.91	
Segment 2	Right =15	3.19	0.9
	Left =15	3.20	
Depth of medial condyle (DMc)	Right =15	6.02	0.03
	Left =15	5.78	
Neck length	Right =15	3.66	0.1
	Left =15	3.92	
Neck circumference	Right =15	9.37	0.7
	Left =15	9.26	

One proximal (Seg 1) and two distal (Seg 2 and DMc) measurements were taken in regression equation. (R-value =0.60) in the variation in the MFL was due to Seg 1 and DMc segmental measurements.

Table 2: Estimation of MFL from proximal and distal measurements

Variables	R (correlation coefficient)	P - value
Segment 1	0.60	<0.001
Segment 1 and Depth of medial condyle	0.71	<0.001
Segment 1,Depth of medial condyle and segment 2	0.79	<0.001

DISCUSSION

Plenty of skeletal remains are found either accidently or when exhumation of buried cadavers is carried out. Estimation of stature from skeletal remains has great importance in forensic medicine. Moreover, it has been reported that stature may vary from person to person, throughout the day and in different population. [11]Pan measured the maximum lengths of humerus, radius, ulna, femur, tibia and fibula in 142 male and female east Indians [Hindu], in fresh state with articular cartilages covering the ends. [12]Stevenson studied measurement of cadaver length and dry bone lengths of 48 northern Chinese male skeletons in mongoloid group to find out the ratio between bone length and height of individual. [13]Hence, this study was conducted to evaluate the total length of femur from measurements of proximal and distal segments.

In the present study, 15 dry femora samples from each side were included. Even though there was difference between right and left sided measurements, but when compared between the right sided and left sided measurements by applying student t-test, there was no statistical significant difference between two groups

except for the DMc with p-value of 0.03. A study by Khanal L et al, cross-sectional study was done among 60 dry femora (30 from each side) without sex determination in anthropometry laboratory. Measured values were recorded separately for right and left side. The value of segmental measurements were different between right and left side but statistical difference was not significant except for depth of medial condyle (p=0.02). All the measurements were positively correlated and found to have linear relationship with the femoral length.[14]

In the present study, one proximal (Seg 1) and two distal (Seg 2 and DMc) measurements were taken in regression equation. (R-value =0.60) in the variation in the MFL was due to Seg 1 and DMc segmental measurements. Another study by Solan S et al, determine the lengths of the femoral fragments and to compare with the total length of femur in south Indian population, which will help to estimate the stature of the individual using standard regression formulae. A number of 150, 72 left and 78 right adult fully ossified dry processed femora were taken. The femur bone was divided into five segments by taking predetermined points. The proportion of segments to the total length was also calculated which will help for the stature estimation using standard regression formulae. The mean total length of femora on left side was 43.54 ± 2.7 and on right side it was 43.42 ± 2.4. The measurements of the segments-1, 2, 3, 4 and 5 were 8.06± 0.71, 8.25± 1.24, 10.35 ± 2.21, 13.94 ± 1.93 and 2.77 ± 0.53 on left side and 8.09 ± 0.70, 8.30 ± 1.34, 10.44 ± 1.91, 13.50 ± 1.54 and 3.09 ± 0.41 on right side of femur.[15]Shital M. et al. in their study of 187 male and 179 female femora, found the mean value of the vertical diameter of the head of the femur to be 43.61 mm in males and 38.7 mm in females. Comparing the mean values in males and females, they found the vertical diameter higher in males than females and was statistically highly significant. [16]Various studies were done by investigating the multiple bones of the body for potential use in stature estimation: long bones, cranial height, scapula, clavicle and oscoxa and vertebra. [17,18]Regression formulae derived from major long bones are generally considered to be more accurate than those utilizing other bones of hand and foot.[19] Since, the femur is not always recovered intact in forensic cases like casualties, terrorist attack, natural disaster and motor vehicle accident; this has necessitated the derivation of regression equations for estimating the length of femur, from the fragments of femur. [20]

CONCLUSION

Femoral length can be calculated from the segmental measurements; and femoral length can be used to calculate the stature of the individual.

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