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# RECONSTRUCTION OF TOTAL LENGTH OF FEMUR FROM ITS PROXIMAL AND DISTAL FRAGMENTS

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## ABSTRACT

**Aims and Objectives:** To find out the correlation between maximum length of femur and its proximal & distal fragments**.** and to formulate regression equation for estimation of stature from maximum femoral length.
**Materials and methods:** This study consists 50 femur (27 of right side & 23 of left side). The maximum length of femur, proximal (P1,P2,P3,P4) and distal (D1,D2,D3,D4) measurements was taken with help of osteometric board and by vernier calliper.
**Results:** The correlation found in P1,P2,P3,P4, D1,D4 on right side femur and P2, P3, P4, D1, D4 on left side femur. The strongest correlation observed in the D4 on right femur and P2 of left femur. The result obtained were analysed and derived regression equation between maximum femoral length and its proximal and distal fragments.
**Conclusion:** The positive correlation between maximum femoral length and its proximal and distal fragments and regression equations derived in this study helpful to estimate stature in Medico-legal investigations and in Anthropometry.
**KEY WORDS:** Femur, Fragmentary Length of Femur, Regression Equation, Stature Estimation.

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## INTRODUCTION

The femur is the longest and strongest bone in the human body. It has one shaft, proximal end and distal end [1]. For the establishment of the identity, stature is one of the significant criteria. To know stature of individual length of long bones is required. Damage to long bones occurs by many causes making them fractured; so reconstruction of height of body becomes very difficult. In such cases, the relation between length of that bone and its fragments help in estimating height. Once relation found between maximum bone length and its fragments, by applying the regression formula, the height of the individual can be estimated [2].

Estimation of stature from the long bones particularly the tibia and the femur as these have direct correlation to the height of an individual [3]. Femur was selected in the present study because it is one of the long bones which helps in assessing the height of the individual more accurately as compared to the other long bones. Grossly mutilated skeletal remains are a big challenge for forensic expert and physical anthropologist in the identification of the deceased.

In the present study, the length of the femur was assessed in relation to the different fragments of femur. This study is an effort to derive regression equations for the reconstruction of the length of the femur from its fragments.

## MATERIALS AND METHODS

For this study 50 femur were randomly selected not knowing the age and sex of bones. Out of the 50 femur, 27 of right & 23 of left side were studied in department of anatomy, pacific medical college, Udaipur, Rajasthan**.** The maximum length of femur was taken with help of osteometric board [fig.1] and proximal and distal measurements by vernier calliper [fig.2]. Maximum femur length (MFL) measured from head in upper end to lower articular surfaces of condyles.

On the proximal end of femur-

P1- Maximum distance between lower most point on superior articular margin to the apex of greater trochanter.

P2 – apex of greater trochanter to lower margin of lesser trochanter.

P3 – maximum distance between mid point of superior & inferior margin of neck.

P4 - Maximum horizontal distance between two points of greater trochanter.

On the distal end of femur-

D1 – distance between medial and lateral epicondyle

D2 – maximum thickness at most concave part of tibial articular surface

D3 – maximum width of intercondylar fossa

D4 – maximum distance between adductor tubercle to the lower most point on articular margin of medial condyle

Descriptive statistics were produced on all data using the microsoft office excel 2010 & SPSS Statistical analysis software. Correlation coefficients were obtained and Regression equations were formulated from these coefficients. In the simple linear regression equations (y = a + b x) , y is the MFL, a is the intercept, b is the slope, x is the measure of the predictor variable.

## OBSERVATIONS AND RESULTS

Table 1 shows the MFL, length of proximal and distal fragments of right and left side femur. There is a correlation found in P1,P2,P3,P4, D1,D4 on right side femur and P2, P3, P4, D1, D4 on left side femur. The strongest correlation observed in D4 on right side femur and P2 of left side femur. There is also negative correlation was found on D3 (- 0.05) of left side femur.

**Fig. 1:** Measurement of length of femur.

**Fig 2:** Measurments of proximal and distal fragments of femur.

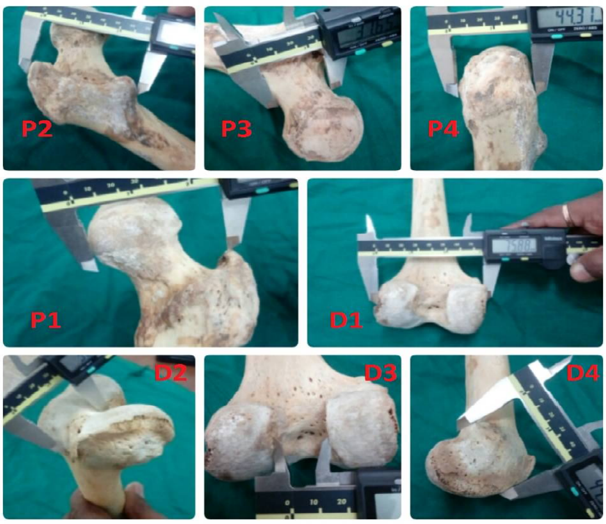

**Fig. 3:** Scatter diagram (length of the femur against D4 of right side femur).

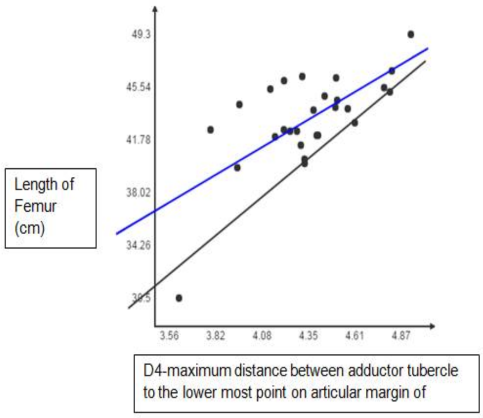


**Fig. 4:** Scatter diagram (length of the femur against P2 of left side femur).

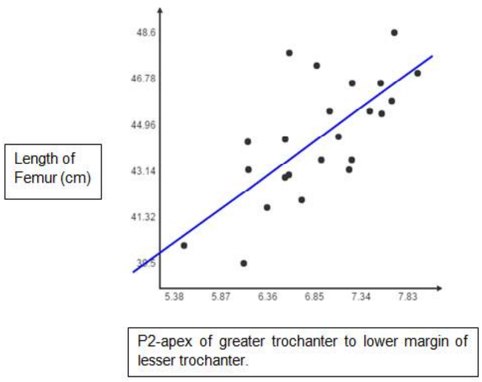


**Table 1:** Mean values of maximum femur length (MFL), and proximal and distal segments of right & left side femur.

| Measurements | RIGHT FEMUR | | LEFT FEMUR | |
|---|---|---|---|---|
| | Mean | SD | Mean | SD |
| MFL | 43.24 | ± 3.38 | 44.45 | ±2.36 |
| P1 | 5.77 | ±0.48 | 6.02 | ±0.41 |
| P2 | 6.65 | ±0.64 | 6.8 | ±0.62 |
| P3 | 3.14 | ±0.27 | 3.18 | ±0.36 |
| P4 | 3.9 | ±0.27 | 3.98 | ±0.25 |
| D1 | 7.6 | ±0.46 | 7.77 | ±0.48 |
| D2 | 3.04 | ±0.34 | 3.19 | ±0.36 |
| D3 | 2.25 | ±0.32 | 2.29 | ±0.34 |
| D4 | 4.3 | ±0.31 | 4.44 | ±0.32 |

All measurements are in centimetre (cm)

**Table 2:** Correlation coefficients.

| Measurements | Correlation coefficients (r) | |
|---|---|---|
| | RIGHT | LEFT |
| P1 | 0.49 | 0.21 |
| P2 | 0.55 | **0.7** |
| P3 | 0.5 | 0.62 |
| P4 | 0.52 | 0.43 |
| D1 | 0.54 | 0.44 |
| D2 | 0.24 | 0.2 |
| D3 | 0.04 | -0.05 |
| D4 | **0.68** | 0.44 |

**Table 3:** Simple linear regression.

| Measurements | RIGHT | LEFT |
|---|---|---|
| Proximal segments | MFL= 23.03 + 3.50(P1) | MFL= 26.03 + 2.71(P2) |
| | MFL= 23.71 + 2.93(P2) | MFL= 31.54 + 4.05(P3) |
| | MFL= 23.67 + 6.23(P3) | MFL= 27.95 + 4.14(P4) |
| | MFL= 18.36 + 6.37(P4) | |
| Distal segments | MFL= 13.19 + 3.96(D1) | MFL= 27.70 + 2.15(D1) |
| | MFL= 11.08 + 7.49(D2) | MFL= 29.90 + 3.27(D4) |

**Table 4:** Comparison of maximum femur length between other studies and present study.

| Study | Maximum Femur Length (MFL) |
|---|---|
| Partha Pratim Mukhopadhyay et al 2010 [4] | 41.82 (±3.05) |
| Sandeep Singh et al. 2013 [5] | 43.26 (±2.67) |
| Sarzoo Desai et al. 2013 [6] | 43.71(±2.80) |
| Chandran M 2011 [7] | 39.5 (±1.40) |
| Present Study | Right=43.24(± 3.38)<br>Left=44.45(±2.36) |

## DISCUSSION

Knowledge of the morphometric values of femoral segments is important in forensic, anatomic and anthropological cases to estimate the stature of unknown.

Stevenson studied length of cadaver and its dry bone lengths of 48 northern Chinese male skeletons in mongoloid group and find out the ratio between bone length and height of individual [8].

Femur length can be determined from the head and neck of femur, if only a fragment of proximal femur available with head and neck of femur [9].

Peterson has considered that in most studies only a small number of skeletons are available in most studies for analysis [10]. The sample size used in present study was better for establishing a relationship between long bone length and stature.

So many studies were done in different races by Bidmos on South african population who presented the regression equations for stature estimation by measuring 6 fragments of Femur which includes vertical neck diameter, upper breadth of femur, epicondylar breadth, bicondylar breadth, lateral condyle length, and medial condyle length [11].

In the present study regression equations derived for stature estimation by measuring 4 proximal (P1 P2 P3 P4) and 4 distal (D1 D2 D3

D4) fragments and its relation with maximum femoral length.

Such studies on different population have been done by Turkish Celbis & Agritmis [12], German Mall, Hubig, Buttner et al. [13]. Mukhopadhyay P [4] Sarzoo Desai[6], Sing S[5], Kate and Mazumdar[14] also successfully estimated stature from length of femur and humerus by regression method in Indian sample. The present study is also a population specific study and the regression equation derived is specific for Rajasthan, India population.

Most of the previous studies done on femoral fragment measurements were done irrespective of the side of femur bone. In the present study, the mean total length of femur and its proximal and distal segments was calculated separately for right and left side of femur.

## CONCLUSION

In the case of if only proximal and/or distal parts of femur bones found, equations presented in this study can help to find out maximum femoral length from which the stature can be estimated. This is also helpful in Medico-legal investigations and in Anthropometry.

**Conflicts of Interests: None**

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