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Original Research Article

# MORPHOMETRIC ANALYSIS ALONG WITH ESTIMATION OF TOTAL LENGTH OF FEMUR AMONG POPULATION OF WEST BENGAL

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## ABSTRACT

**Background:** The femur is known for being the largest and strongest bone of human skeleton. The bone supports all of the weight of body during standing, walking, running etc. Morphology and statistical analysis of femoral anthropometry among different populations reveals a great amount of variations.

**Objectives:** The objectives of present study were to find out the measurements of Platymeric index, Robusticity index, and Foraminal index, for both right and left femurs. Our study was also aimed at estimation of total length of femur from Platymeric index and so, an attempt was made to find out the accuracy of correlation between total length of femur and Platymeric index among West Bengal population. The present study was also designed to reveal the number and position of nutrient foramina in respect to the proximal end of femur of both sides.

**Materials and Methods:** The study was undertaken in 66 adult intact human femurs obtained from Department of Anatomy of different Kolkata based medical colleges, for fulfilling objectives. Bone scale and sliding caliper were used to find out the measurements.

**Results:** Mean ± SD of Total length of right and left femur were 42.44 ± 2.87cm and 41.85 ± 3.34cm accordingly. Robusticity index of left femur was 12.50 ±0.83 and right was 12.36 ±0.99. Platymeric index of left and right femur were accordingly 89.76 ±9.57 and 93.94 ±14.95 and Foraminal index ranged between 36.28 – 54.98 for the left side and 33.33 – 62.5 for the right side. Regression equation formula for calculating Total length was Y = 0.2243 ã X + 20.69 by taking Platymeric index as independent variable i.e. X and Total length as dependent variable i.e. Y. Among the total femurs examined, 3 showed triple foramina and 19 femurs had double foramina. 4 femurs had no nutrient foramina; others had single foramina. All nutrient foramina were directed proximally.

**Conclusion:** The present study is useful in calculating the length of a long bone from a given fragment which is important mainly for medicolegal and anthropological purposes. Morphometric data is important for determination of sex, race, as well as to radiologists, rheumatologist and orthopedic surgeons for diagnosis and planning of treatment.

**KEY WORDS:** Femur, Platymeric index, Robusticity index, Foraminal index, Nutrient foramina, Regression formula equation.

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## INTRODUCTION

Morphology and statistical analysis of femoral anthropometry among different populations reveal great amount of variations, as they are likely to be affected by racial variations in diet, heredity, climate and other geographical factors related to life style [1]. The femur is the longest and strongest bone of the human body. Morphologically it is a typical bone consisting of upper and lower end and shaft in between. In the shaft of femur there are nutrient foramina, which give passages to the nutrient arteries of the medullary cavity of the bone, for its nourishment and growth. It has been suggested that the direction of the nutrient foramina is determined by the growing end of the bone, which is supposed to grow at least twice as fast as the non-growing end and as a result of this nutrient foramina move away from the growing end of the bone [2]. Skeleton plays important role in various sciences like medicine, forensic sciences, anthropology. Estimation of sex, age, race, stature by skeleton and the presence of disease is discovered by Krogman and Iscan. They stated that record of organic evolution largely written by the hard parts of body could be recognizable even many years after death [3].

Till now many studies have been done to widen the scope for better understanding of the morphometric structure of femur on different population. Khaleel N, Hussain S S made a study among south Indian population [4], while Bokariya P, Kothari R, Waghmare JE et al. showed anthropometric measures of femur among central indian population [1]. Very few studies have been done among the population of West Bengal, and here lies the importance of our study which revealed Platymeric index (PI), Robusticity index (RI), and Foraminal index (FI) along with Total length [TL] of femur and its correlation with the PI. Our study also observed the number and position of nutrient foramina in respect with the proximal segment of femur.

## MATERIALS AND METHODS

In the present study 66 (36 right and 30 left) intact human adult femurs were obtained from the teaching skeletal collections at the Department of Anatomy, West Bengal based medical colleges. The selected bones were normal with no appearance of pathological changes. The specific sex and age characteristics of the bones studied were unknown. Measurements were taken according to standard anthropometrical methods [5, 6].

The nutrient foramina of all bones were observed by the help of a hand lens. They were identified by their elevated margins and by presence of a distinct groove proximal to them. Only well defined foramina on diaphysis were accepted. Foramina at the ends of the bones were ignored. Number and position of nutrient foramina were observed. Directions were confirmed by introducing a stiff wire into the foramina.

Sliding caliper and osteometric board were used. Following formulas were used –

### ROBUSTICITY INDEX

$$\frac{\text{Sagittal Diameter of Middle of Shaft – ransverse Diameter of Shaft} \times 100}{\text{Total Length}}$$

**Sagital Diameter of Middle of Shaft:** it measured the distance between the anterior and posterior surface of the bone, approximately at the middle of the shaft i.e. the most prominent part of the linea aspera or two points farthest apart in sagital plane at mid shaft.

**Transverse Diameter of Middle of Shaft:** it measured the distance between the margins of the bone at right angle to sagital diameter of the middle of shaft or two points farthest apart in coronal plane at mid shaft.

**Total Length:** it measured the projective distance between the highest point of the head and the tangent to the lower surface of the two condyles.

### PLATYMERIC INDEX

$$\frac{\text{Upper Sagittal Diameter of Shaft} \times 100}{\text{Upper Sagittal Diameter of Shaft}}$$

**Upper Transverse Diameter of Shaft / Subtrochanteric Diameter:** It measured the transverse diameter of the upper end of the shaft, where it showed maximum lateral projection. When the projection was not clear, this measurement was taken 2.5 cm below the base of lesser trochanter. Transverse plane was to be understood with regard to upper epiphysis.

**Upper Sagital Diameter of Shaft:** It measured

the antero-posterior diameter of the upper shaft taken at right angle to the upper transverse diameter of shaft.

The level of 'platymetry' was divided into 4 groups in relation to the PI [7]. (Table 1)

**Foraminal index** =

$$\frac{\text{Distance of nutrient foramen from the proximal end of femur} \times 100}{\text{Total length}}$$

The measurements obtained were analyzed statistically using "MedCalc Statistical Software" for windows. The correlation was made between Platymeric index and the Total length. Regression equation with the Platymeric index as the independent variable was obtained using the total sample of both left and right femur (n= 66).

**Table 1:** Levels of Platymetry.

| Sr. No. | Level of Platymetry | PI range [min-max] |
|---|---|---|
| 1 | Hyperplatymetry | Less than 75.0 |
| 2 | Platymetry | 75.0-84.9 |
| 3 | Eurymetry | 85.0-99.9 |
| 4 | Stenometry | 100.0 and more |

## RESULTS AND DISCUSSION

**Table 2:** Mean ± SD, Range, p value of Total length, Robusticity index, Platymeric index, Foraminal index.

| Parameters | TL | | RI | | PI | | FI | |
|---|---|---|---|---|---|---|---|---|
| | Left | Right | Left | Right | Left | Right | Left | Right |
| MEAN ± SD | 42.44 ± 2.87cm | 41.85 ± 3.34cm | 12.50 ± 0.83 | 12.36 ± 0.99 | 89.76 ± 9.57 | 93.94 ± 14.94 | 45.55 ± 6.01 | 50.27 ± 8.58 |
| RANGE | 37.5 – 46.5cm | 36.1 – 46.8cm | 11.03 – 13.75 | 11.02 – 13.76 | 76.37 – 102.56 | 81.48 – 123.8 | 36.28 – 54.98 | 33.33 – 62.5 |
| p VALUE | 0.27 (> 0.05) | | 0.34 (> 0.05) | | 0.21 (> 0.05) | | 0.77 (> 0.05) | |

The mean ± SD, range of Total length of femur, Platymeric index, Robusticity index and Foraminal index are shown in Table 2. No significant difference was found between right and left femurs.

Mean values of Total length of right and left femurs were in accordance with those found by Khan SM, Hussain Saheb S [8] and Bokariya P, Kothari R et al. [1]. Strecker W, Keppler P et al. stated that mean values of length of right and left femora were found to be similar, although the left femora showed larger values than right, they were not significantly greater [9]. These results are in accordance with those found in our study. Pearson K and Bell J also stated that there was no significant statistical bilateral difference found in bones [10].

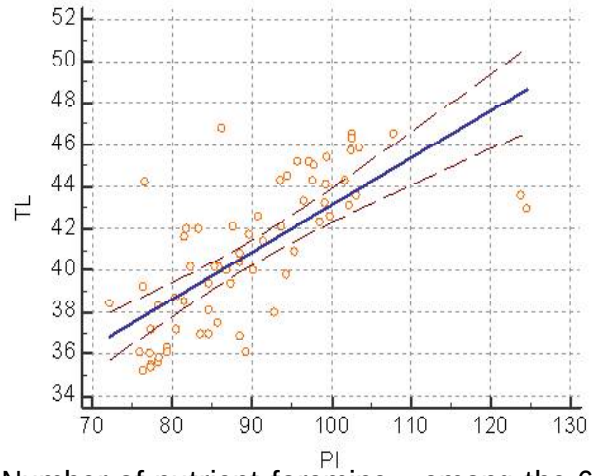
In our study, there was positive correlation found between Platymeric index and Total length which was statistically significant [Table-3]. Linear regression analysis was done between PI and TL [Diagram 1].

Regression equation Y = 0.2243 < X + 20.69 was derived by taking Platymeric index as independent variable i.e. X and TL as dependent variable i.e. Y. It can be utilized to calculate the Total length of a femur from a given fragment which has great medicolegal importance.

**Table 3:** Linear Regression Analysis.

| | |
|---|---|
| Variable Y [ Dependent variable ] | TL |
| Variable X [ Independent variable ] | PI |
| Sample size | 66 |
| Correlation coefficient r | 0.709 |
| Significance level | p<0.0001 |
| 95% confidence interval for r | 0.5637 to 0.8118 |

**Diagram 1:** Regression line with scatter diagram [ TL – Total length of femur, PI – Platymeric index ]




Number of nutrient foramina – among the 66 femurs, 40 femurs (24 right sided and 16 left sided) showed presence of single nutrient foramina which contributed 60.60% of total

bones examined, compared to 28.79% (19 femurs – 8 right sided and 11 left sided) of double foramina and 4.55% (1 right and 2 left sided femurs) of triple foramina. Nutrient foramina was absent in 3 right sided and 1 left sided femurs, which constituted 6.06% of total bones (Table 4).

**Table 4:** Number of nutrient foramina among bones with percentage.

| NO OF FORAMINA | NO OF BONES( % ) | | TOTAL NO OF BONES(%) |
|---|---|---|---|
| | Right (n=36) | Left (n=30 ) | n = 66 (100%) |
| Single | 24 (66.67%) | 16 (53.34%) | 40 [60.6%) |
| Double | 8 (22.22%) | 11 (36.66%) | 19 (28.79%) |
| Triple | 1 (2.78%) | 2(6.67%) | 3 (4.55%) |
| Absent foramina | 3 (8.33%) | 1 (3.33%) | 4 (6.06%) |

Direction and obliquity of nutrient foramina – all the foramina were directed proximally and there were no change in obliquity of the foramina.

In the present study, 60.6% of total bones examined had only one nutrient foramina, although, Forriol Campos F et al. [ 11 ], Gumusburun E et al. [ 12 ] reported approximately 30% with this features. The observation of 28.79% of bones having two nutrient foramina, is nearly similar to that reported by Mysorekar V R in 1967 [13 ], Sendemir & Cimen in 1991 [ 14 ] and Gumusburun et al. [ 12 ] in 1994, but it differs from the values reported by Forriol Campos F et al. ( 75% ) [ 11 ] in 1987. Three nutrient foramina were found in 4.55% of bones examined which differs from the study done by Pereira G A M et al. in 2011 [15]. According to Gumusburun et al. [12] 1.9% showed absence of nutrient foramina, but in the present study it was 6.06% of total observed bones.

## CONCLUSION

Morphometric data is important for determination of sex, race, as well as to radiologists, rheumatologist and orthopedic surgeons for diagnosis and planning of treatment. The present study is useful in calculating the length of a long bone from a given fragment which is important mainly for medicolegal and anthropological purposes. The present study also provided the data about nutrient foramina of femur, which may be helpful for orthopaedical surgical procedures and bone grafting. This study recorded data among the population of west Bengal, providing ethnic data to be used for comparison among different races.

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**Conflicts of Interests: None**

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