Study of Correlation of Length of the Tibia with Dimensions of the Distal Articular Surfaces of the Tibia

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ABSTRACT

Introduction: Long bones have been used for estimation of stature of individuals in forensic analysis. Most often only fragments of bone are recovered from which length of bone is to be estimated. The present study was aimed to determine correlation of length of tibia with dimensions of distal articular surfaces in North Indian population.

Material and methods: 30 tibiae were obtained for the present study from the Department of Anatomy, SKIMS Medical College Srinagar. Measurements were taken from the bone using vernier calipers. Mean and standard deviation was measured for all the dimensions. Pearson's correlation test was carried out for those dimensions that showed a linear association with the length of tibia.

Results: Moderate linear association was observed between length of tibia with the breadth of medial malleolus, height of fibular incisura and the length and width of tibial plafond.

Conclusion: From the obtained data simple linear regression equations were deduced which would predict the expected maximum length of the bone.

Keywords: Length of the Tibia with Dimensions, Distal Articular Surfaces of the Tibia

INTRODUCTION

Stature of individual is key for identification in forensic analysis.[1] Stature can be estimated from long bones especially tibia and femur as they have correlation with height.[2] In this context tibia is ideal as it resists erosion and keeps its anatomical shape for long even after burial.[3] The tibia along with femur is the longest bone of the skeleton and has shaft and two extremities. The Lower Extremity (distal extremity) is much smaller than the upper and presents five surfaces-anterior, posterior, medial, lateral and inferior; it is prolonged downward on its medial side as a strong process, the medial malleolus.

Bones differ from individual to individual on osteometric parameters that include the length of these bones due to hormonal differences, differential loading at joints and muscle bulk.[4] These differences are clearly displayed in the long bones and have been used for stature estimation in forensic analysis.

High mechanical loading at lower ends of long bone of the lower limb are responsible for displaying significant inter - individual differences. The distal tibia is subjected to high biomechanical strains as it bears all the body weight during the stance phase of gait in a relatively small surface area that in turn affects bone modeling. Significant differences in the dimensions of the distal tibia have been reported for the fibular incisura, the medial malleolus and the tibial plafond.[5-8] Osteometric dimensions differ between populations, formula derived for a particular population is not applicable to other population.[3,1]

The present study was aimed to determine correlation of length of tibia with dimensions of distal articular surfaces in North Indian population.

MATERIAL AND METHODS

For the present study, total of 30 dry and processed tibias, irrespective of side, grossly normal and complete were obtained from the Department of Anatomy, SKIMS Medical college Srinagar and from skeleton sets used by medical students of the SKIMS Medical college Srinagar for their academic course.

Measurements were taken on the bone using vernier calipers. The length of tibia was defined as the vertical distance from the superior point on the medial tibial condyle to the inferior point on the medial malleolus.[9]

The following measurements were taken on the fibular incisura:

Width of the fibular incisura: 1 cm proximal to the tibial plafond, the distance between anterior and posterior tubercles of fibular incisura

Depth of the fibular incisura: The distance from the deepest point of the incisura to a line between tips of the anterior and posterior tubercles.

Height of the fibular incisura: The vertical distance between the point where the interosseous border of the tibia splits into anterior and posterior edges and the tibial plafond.[10]

Medial malleolus: Height of medial malleolus (MM); the distance from its base at the tibial plafond to its tip. Breadth of medial malleolus: defined as its anteroposterior length.[5]

Tibial plafond: Width of the tibial plafond: Mediolateral dimension of the talar facet taken at the middle of the joint.

Length of the tibial plafond: The anteroposterior dimension of the talar facet at the middle of the joint were also measured.

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Parameters	Mean	Std. Deviation
Length of tibia	35.7310	1.84403
Width of tibial plafond	2.9020	0.24813
Length of tibial plafond	3.0883	0.28615
Width of fibular incisura	2.3300	0.25561
Depth of fibular incisura	0.5007	0.07404
Height of fibular incisura	3.6267	0.53435
Height of medial malleolus	1.6133	0.28976
Breadth of medial malleolus	2.3000	0.18228

Table-1: Mean and standard deviation of parameters in centimetres

Length of tibia and:	Pearson's correlation
Width of tibial plafond	0.623
Length of tibial plafond	0.443
Height of fibular incisura	0.267
Depth of fibular incisura	0.033
Width of fibular incisura	0.402
Breadth of medial malleolus	0.438
Height of medial malleolus	0.063

Table-2: Correlation between the length of the tibia and dimensions of the distal tibia

RESULTS

In the present study, the mean and standard deviation was calculated for each of the dimensions (Table 1). The results were then analyzed under simple regression analysis which shows the relationship of the dimensions of the various parameters with the length of the tibia (Table 2). Pearson's coefficient is determined for each of the parameter and tabulated (Table 2). Simple linear regression equations are then deduced from the obtained data which would predict the expected maximum length.

Simple regression formulae were obtained which shows the formulae for the length of tibia from its distal parameters.

Simple regression formula relative to different dimensions:

Length of Tibia = 22.29 + 4.63 × (Width Tibial Plafond)

Length of Tibia = 26.91 + 2.86 × (Length Tibial Plafond)

Length of Tibia = 28.98 + 2.9 × (Width of fibular incisura)

Length of Tibia = 35.32 + 0.83 × (Depth of fibular incisura)

Length of Tibia = 32.39 + 0.92 × (Height of fibular incisura)

Length of Tibia = 35.08 + 0.4 × (Height of Medial Maleolus)

Length of Tibia = 25.54 + 4.43 × (Breadth of Medial Maleolus)

DISCUSSION

Identification of individual in medico legal cases by forensic and archeological analysis of skeletal remains obtains the data from which stature can be estimated and in archeological studies general body size of the population and nutritional status is analyzed[11]

Among all long bones, tibia can be used in the estimation of stature as it displays significant inter-individual and sexual differences. Tibia is reported to display significant sexual differences at its distal end and if its dimensions are used to estimate the length of the tibia the height of the individual can be ascertained. The regression formulae of specific population can under or over-estimate stature when applied in another population.[3] Thus, authors have recommended that same regression equations should not be applied to all populations.[1,12] Data was sex aggregated in the current study, though availability of sex would have given greatest accuracy in estimating stature.[13] However, it has been noted that sex had no role in differences of the femur length, therefore both sexes were aggregated in our analysis.

For estimating the length of the long bone from its fragments the use of accurately recognizable landmarks is mandatory. Inability in defining the precise landmarks makes the transverse dimensions along the diaphysis not appropriate for estimating the length. Therefore measurements on the fragments of the proximal or distal diaphysis are the only locations left. Hence the dimensions of the distal segments of the tibia were selected for our present study. This is so because intensive bio mechanical loading at the ankle joint affects the dimensions greatly by modeling. Linear regressions have been derived by several authors to estimate the length of long bones from the dimensions of their fragments in different populations.[12-16] In our present study we also derived regression equations to estimate the length of the tibia from measurements of its distal end in North Indian population. Moderate correlation between the dimensions of the distal tibia and its length has been demonstrated in the current study. For the estimation of stature, determination of length of the tibia is important.[17,2]

Since there is positive correlation between these dimensions and length of the tibia, they can be used in estimating length of tibia.

CONCLUSION

This study was mainly aimed at finding the correlation between the various dimensions of the tibia and the total length of the tibia, with an intention to derive formulae that would define the relationship. The study contributes to the existing data regarding the tibial length and the length of its various parameters and the derived formula may be used in forensic investigations where the stature of a person in question is to be determined and only incomplete bones are available.

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