International Journal of Research in Medical Sciences
Pandit FS et al. Int J Res Med Sci. 2023 Jun;11(6):2072-2076
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012

DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20231620

Original Research Article

Correlation between length of tibia and dimensions of distal articular surfaces: a morphometric study

Falak S. Pandit[1], Mohammad S. Itoo[1]*, Uroosa M. Fayaz[1], Rouf H. Rather[2], Ghulam M. Bhat[1]

[1]Department of Anatomy, Government Medical College, Srinagar, Kashmir, India
[2]Department of Community Medicine, Director Health Services, Srinagar, Kashmir, India

Received: 28 March 2023
Revised: 03 May 2023
Accepted: 08 May 2023

***Correspondence:**
Dr. Mohammad S. Itoo,
E-mail: dr.saleem68@gmail.com

ABSTRACT

Background: Estimation of stature can be done from long bones especially tibia and femur as they have a correlation with height. Tibia is most commonly used as it resists erosion and keeps its anatomical shape even after burial. However intact bones are rarely available. Most often the exhumed remains are in fragmentary condition leading to lack of adequate sample for the study. A way of increasing utility of such samples would be the establishment of techniques which would permit estimation of stature from long bone fragments. The current study provides a correlation between length of tibia and its distal dimensions which can be used in anthropology for measuring the stature of an individual.

Methods: A total of 50 tibiae were obtained from the bone bank of the Department of Anatomy, Government Medical College, Srinagar. Measurements were taken from the bone using vernier calipers. Morphometric data obtained was analyzed, measurements expressed in mean and standard deviation and Pearson's correlation test was carried out. This observational study was conducted within a period of 2 months, from April-June 2022.

Results: Width of talar facet with a Pearson's correlation of 0.62 and width of fibular notch with a correlation of 0.3 showed positive statistical significance ($p<0.05$). On the other hand, breadth of medial malleolus with a correlation of 0.18 and height of fibular notch with a correlation of -0.02 ($p>0.05$) was statistically insignificant.

Conclusions: The study showed a positive correlation ($p<0.05$) between length of tibia with the width of talar facet and fibular notch.

Keywords: Fibular notch, Medial malleolus, Stature, Tibia

INTRODUCTION

Forensic anthropology deals with the study of human remains in a forensic setting by applying skeletal analysis.[1] The information gathered is used to determine the identity, age, sex, stature, as well as cause of death.[2] Stature is one of the demographic factors that can be calculated. Stature is measured as the distance from the highest point of the head to the base of the feet. This length tends to increase with age, reaching a peak at adulthood. After that it decreases due to loss of elasticity of the intervertebral discs and compression of cartilage.[3]

Stature estimation involves deriving equations which show linear relationships between length of bones and stature. Therefore, estimate of stature is acquired by substituting the length of the bone into its appropriate regression formula. Intact long bones of the upper and lower extremities are used for deriving the regression equations for estimation of stature.[4] Estimation of stature by regression formula was first done by Karl Pearson in

1899. It is however to be noted that regression formula applicable to one population will not be applicable to another population. This is because ethnical features of a particular population are determined by the variations of the human skeleton. Thus, these equations are population and sex specific.[5]

However intact bones are rarely available on excavations. Most often the exhumed remains are in fragmentary condition leading to lack of adequate sample for the study. A way of increasing utility of such samples would be the establishment of techniques which would permit estimation of stature from long bone fragments.

Femur and tibia are the chiefly used bones for stature estimation.[6] In addition, other intact bones like skull, thoracic and lumbar vertebra, calcaneus, metacarpals and metatarsals can also be used. Femur bears a constant relationship with height; therefore femur/stature ratio can be used for height estimation. This ratio has been found to be independent of sex and ethnicity. Based on a study conducted by Feldesman it was concluded that length of femur contributes to 26.47% of the adult stature.[7]

Tibia is the most commonly used bone for stature estimation. This is because it opposes erosion and maintains its anatomical shape even after burial.[8] Individual differences are also noted in the morphometric parameters of long bones. These occur due to varying work load of muscles and joints, and the different hormone levels.[9] These variations are more prominent in the distal ends of the lower limb bones.[10] The distal articular surface of tibia is small in size when compared to the body weight it bears. As a result, it is subjected to high mechanical strain which in turn affects bone modelling. This leads to morphometric changes which can be seen in medial malleolus, talar facet and fibular incisura. This study aims to determine the correlation of length of tibia with its distal articular dimensions

METHODS

The present study was an observational type of statistical study which was conducted within a period of 2 months, from April-June 2022. It was conducted in the Department of Anatomy, GMC, Srinagar after obtaining ethical clearance from the institutional ethical committee. For this study a sample of 50 normal and dry tibiae were taken from the bone bank. These included tibiae of both right and left sides. Bones from both the sexes were taken into consideration with no differentiation. Bones that were incomplete or putrefied were not made part of the study. Also bones with chipped condyles or those showing signs of fracture were also excluded from the study.

An osteometric board was used to measure the total tibial length. Vernier callipers were used for the other measurements. The following measurements were taken. Length of tibia was taken as the distance from the highest point on the medial condyle to the lowermost point on the medial malleolus. Breadth of medial malleolus include mediolateral measurement on the surface of the malleolus as seen in Figure 1.

Width of talar facet include mediolateral dimension at the middle of joint as seen in Figure 2.

Height of fibular notch include distance between the tibial plateau and the point where the interosseous border divides into two. This can be demonstrated in Figure 3.

Width of fibular notch include distance between anterior and posterior tubercles of the fibular notch as seen in Figure 4.

Figure 1: Breadth of medial malleolus.

Figure 2: Width of talar facet.

The data collected was entered in MS Excel sheet. Mean and standard deviation was calculated for the above dimensions as tabulated in Table 1.

The results were then analysed using Statistical Package for the Social Sciences (SPSS) 20 to determine the correlation of length of tibia with its distal end dimensions. Pearson's coefficient was determined for each of the dimensions and presented in Table 2.

Figure 3: Height of fibular notch.

Figure 4: Width of fibular notch.

.

Table 1: Mean and standard deviation of the parameters.

Measure		Length of tibia	Breadth of medial malleolus	Width of talar facet	Height of fibular notch	Width of fibular notch
Minimum		32.3	2.2	1.8	2.5	1.8
Maximum		39.0	3.3	2.9	5.0	2.8
Mean		36.11	2.78	2.48	3.90	2.30
Std. Deviation		2.14	0.27	0.25	0.67	0.27
Median		36.70	2.80	2.50	4.00	2.30
IQR	25 Percentile	34.53	2.68	2.30	3.48	2.10
	75 Percentile	38.00	2.93	2.63	4.50	2.50

RESULTS

In the statistical analysis of this study, the breadth of medial malleolus showed a correlation of 0.18 with the length of tibia. As seen in Table 2, P-value appears to be 0.22 which indicates a statistically insignificant correlation. Similarly, the width of talar facet shows a correlation of 0.62. With P=0.000, it indicates a statistically significant correlation with the length of tibia. The height of fibular notch shows a correlation of -0.02 with P=0.91. This indicates an insignificant correlation.

Table 2: Correlation between length of tibia and distal articular dimensions.

Parameter:	Pearson's correlation	Sig. (2-tailed) (P-value)
Breadth of medial malleolus	0.18	0.22
Width of talar facet	0.62	0.000
Height of fibular notch	-.02	0.91
Width of fibular notch	0.3	0.03

Finally, the width of fibular notch shows a statistically significant correlation of 0.3 with the total tibial length, with P=0.03. Thus, it can be concluded that the width of talar facet and fibular notch have a statistically significant correlation with the length of tibia.

DISCUSSION

Estimation of stature is of great importance in forensic and archaeological studies.

In most of the studies, length of intact long bones is used to calculate the stature of an individual. Femur and tibia play an important role in such studies for identification of an individual, analysis of nutritional status and body size.[11] Role of tibia in such studies is understated as it shows significant inter-individual and sexual differences. In absence of lower limb bones, humerus, radius and ulna may be used. However due to unavailability of complete intact bones, fragments are used for this purpose.

In this study, a positive correlation was observed between the length of tibia and its distal articular measurements. It was observed that the width of talar facet and the width of fibular notch showed a statistically significant correlation with the length of tibia. The breadth of medial malleolus and the height of fibular notch on the other hand had a statistically insignificant correlation with the tibial length.

The data collected in this study was not differentiated according to gender. However, it has been suggested that maximum accuracy in the estimation of stature would have been possible if bones were differentiated in terms of sex.[12,13]

Estimation of maximum length of long bones from fragmentary measurements has been done in several studies using linear regressions. Authors recommend against the use of same regression equations for different populations as it can under or over-estimate the stature. Therefore, different regression formulae are used for different populations.

In the estimation of length of long bones from its fragments, determination of bony landmarks holds the highest importance. As such transverse diameters along the diaphysis are not appropriate. Therefore, measurements are taken from the proximal and distal ends of the bones. In this study dimensions are taken from the distal end of tibia because the lower end is greatly affected by the modelling that results because of intense biomechanical loading at the ankle joint.[15]

This study has few limitations. The study would have been more instructional if correlation was calculated between the length of tibia and its proximal articular dimensions as well.

CONCLUSION

This study was aimed at finding a correlation between the length of tibia with its distal articular dimensions. Presence of a positive correlation can help in the field of forensic medicine to a great extent. Information obtained can be used to determine the length of tibia from bony fragments. This can further be used in various other ways such as identification of an individual, determination of stature of an individual etc.

ACKNOWLEDGEMENTS

Authors would like to thank Dr. Ghulam Mohd Bhat, Head of Department, Postgraduate Department of Anatomy, Government Medical College, Srinagar for providing an opportunity to do this project and also for his constant support and guidance.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Ubelaker DH. Recent advances in forensic anthropology. Foren Sci Res. 2018;3(4):275-7.
2. Wright LE, Vasquez MA. Estimating the length of incomplete bones; Forensic standards from Guetamala. Am J Phys Anthropol. 2003;120:233-51.
3. Sjovold T. Stature estimation from the skeleton. In: Saukko JA, Knupfer PJ, Siegel GC (Eds.), Encyclopaedia of Forensic Sciences, London Academic Press; 2000:1600.
4. Chibba K, Bidmos MA. Using tibia fragments from South Africans of European descent to estimate maximum tibia length and stature. Forensic science international. 2007;169(2-3):145-51.
5. Babacan S, Kafa İM. Estimating the entire length of the fragmentary tibia with proximal and distal dimensions. Antropoloji. 2020(40):77-83.
6. Lundy JK. The mathematical versus anatomical methods of stature estimate from long bones. Ame J Fore Med Pathol. 1985;6(1):73-6.
7. Feldesman MR. Femur/stature ratio and estimates of stature in children. Ame J Phys Anthropol. 1992;87(4):447-59.
8. Pamela M, Musa M, Moses O, Gichambira G. Estimation of the length of the tibia from dimensions of the distal articular surfaces of the tibia in adult Kenyans. Inter J Health Biomed Res. 2013;1(4):250-7.
9. Brickley M, Mc Kinley JI. Guidelines to the Standards for recording Human Remains. Highfield, Southampton: BABAO, Department of Archeology, University of Southampton and Institute of Field Archaeologists, SHES, University of Reading, Whiteknights; 2004.
10. Burghardt AJ, Kazakia GJ, Ramachandran S, Link TM, Majumdar S. Age- and gender- related differences in the geometric properties and biomechanical significance of intracortical porosity in the distal radius and tibia. J Bone Miner Res. 2010;25(5):983-93.
11. Devi KS, Udhaya K. Regression analysis for estimation of tibial length using dimensions of its distal end-A South Indian population study. National J Clin Anat. 2014;3(2):64.
12. Iscan MY. Forensic Anthropology of sex and body size. (Editorial) Forensic Science International. 2005;147:107-12.
13. Scheuer L. Application of osteology to forensic medicine. Clin Anat. 2002;15(4):297-312.
14. Udhaya K, Sarala Devi KV, Sridhar J. Regression equation for estimation of length of humerus from its segments: A South Indian population study. J Clin Diagnos Res. 2011;5(4):783-6.
15. Kaloo RA, Khurshid N. Study of Correlation of Length of the Tibia with Dimensions of the Distal Articular Surfaces of the Tibia. Inter J Contem Med Res. 2019;6(9):11-3.

16. Holland TD. Estimation of adult stature from fragmentary tibias. J Forensic Sci. 1992;37(5):1223-9.
17. Ugochukwu EG, Ugbem LP, Ijomone OM, Ebi OT. Estimation of maximum tibia length from its measured anthropometric parameters in a Nigerian population. J Forensic Sci Med. 2016;2(4):222-8.
18. Sharma SK. A Prospective study to assess the proximal and distal dimensions of tibia and its correlation with length of tibia: an institutional based study. Inter J Health Clin Res. 2021;4(22):43-5.

Cite this article as: Pandit FS, Itoo MS, Fayaz UM, Rather RH, Bhat GM. Correlation between length of tibia and dimensions of distal articular surfaces: a morphometric study. Int J Res Med Sci 2023;11:2072-6.