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RESEARCH ARTICLE

MORPHOMETRIC STUDY OF TIBIA IN NORTH INDIAN POPULATION AND ITS CLINICAL RELEVANCE

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ABSTRACT

Introduction: Anthropometry refers to the measurement of the human individual or a part there of. Anthropometry measurements are very useful to estimate stature and bone length from the skeletal remains from anthropological remnant skeletons. Considering the fact that human tibia is a complex anatomic unit and its knowledge of the morphometric values is important in Forensic, Anatomic and Archeological cases in order to identify unknown bodies and stature, the present anthropometric study was undertaken.

Methodology: In this study, 50 (27 right and 23 left) intact human adult tibia were obtained from the bone bank of Department of Anatomy, Government Medical College Srinagar. In the study, a total of 07 parametric variables were obtained from the shaft of the Tibia according to standard anthropometrical method.

Results: The mean of cross sectional index for right tibias was 78.83± 7.35. Similarly mean of cross sectional index for left tibias was 80.01± 8.54. On applying statistical analysis (t test), it came out to be 0.015p (<0.05) which is statistically significant. The mean of Cnemicus Index for Right tibias was 68.16 ± 5.23 and for left side these values came out to be 68.02 ±7.48. These are not statistically significant. The mean of Length - Thickness Index were 31.95 ± 2.12 and 31.34 ± 2.08 for right and left Tibias respectively. This too was not significant statistically.

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INTRODUCTION

Anthropometry (Greek word anthropos "man" and metron "measure") refers to the measurement of the human individual. (Cheng *et al.,* 2009) Anthropometry is a series of systematized measuring techniques that express quantitatively the dimensions of the human body and the skeleton and is often viewed as a traditional and perhaps the basic tool of biological anthropology, but it has a long tradition of being used in medical sciences especially in the discipline of Forensic Medicine. It is highly objective and reliable in the hands of trained anthropometrists. The significance and importance of somatometry, cephalometry, craniometry and osteometry in the identification of human remains have been described and a new term of 'Forensic Anthropometry is coined. (Krishan, 2007) Anthropometry measurements are very useful to estimate stature and bone length from the skeletal remains from anthropological remnant skeletons. The very important step in assessing health and general body size trends in the given populations is stature estimated from the human skeletal remains (Hoppa and Gruspier, 1996) and it has an important role in the identification of missing persons into medical legal investigations. (Wright and Vasquez, 2003) Long bones such as tibia and femur of the lower limb collectively remain the best for the assessment of the living stature of the individual. (De Mendonça, 2000; Radoinova *et al.,* 2002) The tibia, popularly known as the shinbone, is situated in the antero-medial aspect of the leg parallel to the medial side of the fibula. (Moore *et al.,* 2010) It is the second largest bone in the body, with its length exceeded only by that of the femur. (Moore *et al.,* 2010; Standring, 2008) Although, it is comparatively vertical along its length, the proximal and distal ends extend outwardly. The tibia classically presents with three distinctive parts, viz. proximal and distal ends and a shaft. (Moore *et al.,* 2010; Standring, 2008)The nutrient foramen, which is situated obliquely at the superior end of the vertical line on the posterior surface, provides entry of nutrient artery into the medullary cavity. (Moore *et al.,* 2010; Shapiro, 2008; Kulkarni, 2012)

Aim of the study

The knowledge of the morphometric values of tibia is important in forensic, anatomic and archeological studies. So the present study was taken to:

1. To evaluate the morphometry of dried tibia.

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2. To use the obtained osteometric data to estimate the bilateral differences between the right and the left bones.

MATERIALS AND METHODS

In this study, 50 (27 right and 23 left) intact human adult tibia were obtained from the bone bank of Department of Anatomy, Government Medical College Srinagar. In the study, a total of 07 parametric variables were obtained from the shaft of the Tibia according to standard anthropometrical method. (Singh and Bhasin, 1970; Strecker *et al.,* 1997) The number of nutrient foramina for Tibia on both sides was also noted. Instruments Used for the study were Digital Vernier Caliper, Osteometric Board and measuring Tape.

Formulae used:

1. Cross-Section Index in Middle = (Transverse diameter in middle of bone/Maximum diameter in middle of Bone) X 100

In this formula Transverse diameter in middle of bone is calculated as straight distance from the medial tibial border to the interosseous crest at the level of nutrient foramen. Maximum diameter in middle of bone measures the straight distance of anterior crest from the posterior surface in the middle of the bone.

2. Cnemicus Index= (Transverse diameter at level of Nutrient foramen/ Sagittal iameter at level of Nutrient Foramen) X100

Transverse diameter at level of Nutrient foramen is straight distance from the medial border to the interosseous crest at the level of nutrient foramen. Sagittal diameter at level of Nutrient foramen measures straight distance of anterior crest from the posterior surface at the level of nutrient foramen.

3. Length - Thickness Index = (Maximum girth of shaft/Total length of Tibia) X100

Where Maximum girth of shaft is maximum circumference of shaft wherever found. Total length of Tibia measures straight distance from the cranial articular surface to the fibular condyle of Tibia i.e. lateral condyle to the tip of medial malleolus.

RESULTS

The data obtained in this study has shown remarkable difference between right and left tibias. It was found that only one right tibia possessed two nutrient foramen and rest of the tibias studied were having single nutrient foramina (Figure 1). The mean values of various parameters were shown in Table 1. The mean of cross sectional index for right tibiae was 78.83±7.35. Similarly mean of cross sectional index for left tibiae was 80.01± 8.54. On applying statistical analysis (t test) on it came out to be 0.015p (<0.05) which is statistically significant. The mean of Cnemicus Index for Right tibiae was 68.16 ±5.23 and for left side these values came out to be 68.02 ±7.48. These are not statistically significant. The mean of Length - Thickness Index were 31.95 ± 2.12 and 31.34 ± 2.08 for right and left tibiae respectively. This too was not significant statistically.

Table 1. Various Parameters obtained from the Present Study

S.N	Parameters	Right Mean ± SD	Left Mean ± SD
1	Transverse diameter in middle of Bone	21.44±1.80	22.47±2.50
2	Maximum Diameter in middle of Bone	20.33 ±2.43	20.17 ±2.18
3	Transverse Diameter at level of Nutrient Foramen	21.44±1.80	22.47±2.50
4	Sagital Diameter at level of Nutrient Foramen	31.55±2.83	33.13±2.47
5	Maximum Girth of shaft	115.68±7.87	115.37±7.25
6	Total length of Tibia	362.48±21.30	368.56±18.72

Table 2. Various indices obtained from the Present Study

S.N	Indices values	Right Mean ± SD	Left Mean ± SD
1	Cross sectional index	78.83 ±7.35	80.01±8.54
2	Cnemicus index	68.19±5.23	68.02±7.48
3	Length thickness index	31.95±2.12	31.34±2.08

Figure 1. Measurement of transverse diameter of Tibia at nutrient foramen (arrow) using Vernier's caliper

DISCUSSION

Morphometric tibial parameters are considered to be of medico-legal importance due to the provision of stature-group-specific formulae for the determination of "personal identity" in circumstances of unknown and unclaimed human remains. (Akhlaghi *et al.,* 2011; Bokariya *et al.,* 2012; Pelin and Duyar, 2003) The chief blood supply to long bones occurs through the nutrient arteries, which enter through the nutrient foramina. The supply is crucial during the initial phase of ossification and in techniques such as bone graft, tumor resections, traumas and in transplant procedure in orthopedics. (Bhatnagar *et al.,* 2014) Bhatnagar *et al*. (2014) conducted a study on 60 tibiae and found that out of total tibia examined 95% had a single nutrient foramen. Double nutrient foramina were observed in 5% of tibia. It was also found that 90.47% of the nutrient foramina were in the proximal third of the tibiae and in the rest of the tibiae examined (9.52%) Nutrient foramina were located in the middle third. There were no foramina in the distal third. Tejaswi *et al*. (2014) found that in 94.87% tibiae there were one foramen and in 1.28% tibiae there were two nutrient foramen. They also found that in 148 (94.9%) of tibiae the foramina was in the proximal third of bone and in 8 (5.1%) of tibiae it was in the middle third of the bone. There were no foramina in the distal third of the bone in both their study. (Bhatnagar *et al*., 2014; Tejaswi *et al.,* 2014) In our study, we

found that in all tibias (except one) there was only one nutrient foramen. Tejaswi *et al*. also found triple foramen in 3.84% of the tibiae. (Bokariya *et al.,* 2010) The presence of single nutrient foramen throughout the samples studied (except one) is remarkable difference compared to other long bones of human body. (Longia *et al.,* 1980; Bokariya *et al.,* 2011) The values of various indices calculated shows remarkable difference with that of humerus and femur. (Bokariya *et al.,* 2011; Bokariya *et al.,* 2010) This is of immense point of utility for medico-legal aspect where sometimes identity is to establish from part of bone only. (Zaslan *et al.,* 2003; Mohanty, 1998)

The discrepancies could be a result of factors such as age, sex, race and also environmental factors affecting bone growth, such as nutrition, physical development and genetic factors. Bokariya *et al*. (2012) found the mean of cross-sectional, Cnemicus length-thickness index for right and left tibias were 102.90, 66.17, 24.21 and 124.31, 67.31, 24.43 respectively. While in our study, we got mean of cross-sectional, Cnemicus, length-thickness index for right and left tibias 78.83, 68.19, 31.95 and 80.01, 68.02, 31.34. Our values of cross-sectional index were lower as compared to their study; rest all our values are similar to their study. Therefore, this study supplies the mean values of the different morphometric measurements of the tibia as well as information about its nutrient foramen. Hence, these measurements might help to indicate the characteristic morphological features of tibial segments in our population, and it will also help the orthopedic surgeon to place different implants in the reconstruction of tibial fractures during sports injury.

Conclusion

The knowledge of the morphometric values of tibia segments is important in Forensic, Anatomic and Archeological cases in order to identify unknown bodies and stature. Therefore our study supplies the mean values of the different morphometric measurements from the tibia. As a result, these measurements may help to indicate the characteristic morphological features of tibial segments in our population and also help the Orthopedic surgeon to place the various implants in the reconstruction of tibial fractures. Presence of single foramen throughout our study, place the tibia separately from other long bones of human.

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