



Original Research Article

Sex determination by talus: A comparative study

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ABSTRACT

Introduction: Heel bone of Horses was used by the soldiers as dice; hence the heel bone became called Taxillus means 'die'. The articular morphology of the human skeleton is subject to modifications by stresses imposed upon it. Since it is a weight-bearing bone, sexual dimorphic features ensure the correct identification of sex in optimum situations when the entire skeleton is present and well preserved and is from a known population, the totality of sexually dimorphic features ensures the correct identification of sex. However, the optimum situation is all too rare. Hence this study aims at the identification of the sex of an unknown skeleton.

Materials and Methods: The materials for the present study consisted of 96 humans dry Tali of unknown age and sex obtained from the Department of Anatomy, Kasturba Medical College, Centre of basic Sciences, Bejai, Mangalore and on X- Rays of 96 healthy normal subjects whose age and sex are known who were referred as patients within the data collection period to the Department of Radiology, Kasturba Medical College, Mangalore.

Results: The right-sided talus exhibited higher dimensions compared to the rest. By the demarcating point method, only a very few Tali were sexed correctly, 14.58% (14) in dry talus.

Conclusion: The study provides indications that talus forms one of the important Bone for diagnosis of sex and could be effectively used as an alternative in forensic cases.

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1. Introduction

Talus is the main tarsal bone that connects bones of the leg with the bones of the foot. It has neither muscular attachments nor tendinous attachments.¹ Tracing the origin of the name "Talus" Haliburton RA et al in 1958 recounted that the Roman soldiers made their dice from the heel bones of horses. Hence this heel bone became known as Taxillus, meaning die.² The articular morphology of the human skeleton is subject to modifications by stresses imposed upon it. A large number of skeletal features have in the past been shown to express sufficient sexual dimorphism to allow accurate identification of sex in skeletonized individuals. In optimum situations when the entire skeleton is present and well preserved and is from a known population, the totality of sexually dimorphic features ensures the correct

identification of sex. However, the optimum situation is all too rare. More frequently samples consist of at least some fragmentary or poorly preserved adults in which features of known utility in sex identification are not preserved.³ The purpose here is to address the problem of sex identification in these kinds of remains by using the metric attributes of a tarsal bone – the talus.

2. Aim

Aim is to study the sexual dimorphism of talus on dry bone and radiograph.

3. Materials and Methods

The materials for the present study consisted of 96 humans dry Tali of unknown age and sex obtained from the Department of Anatomy, Kasturba Medical College, Centre

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of basic Sciences, Bejai, Mangalore and on X- Rays of 96 healthy normal subjects whose age and sex are known who were referred as patients within the data collection period to the Department of Radiology, Kasturba Medical College, Mangalore.

3.1. Study sample size calculation

With 95% Confidence level and 80% Power, a sample size of 96 was calculated by using the formula,

$$\text{Sample size } (n) = \frac{2 \times (Z\alpha + Z\beta)^2 \times \sigma^2}{\delta^2}$$

$Z\alpha$ = Level of significance (95%)

$Z\beta$ = Required power (80%)

σ = Anticipated standard deviation of the parameter

δ = Test value of the difference between means

3.2. Study design

Comparative study.

3.3. Sampling method

Purposive sampling.

3.4. Duration

From October 2012 to May 2014 after obtaining the ethical committee approval.

Well preserved dry talus without any distortion and normal ankle radiograph were inclusion criteria, Dry Talus having obliterated anatomical landmark and a nkle joint radiograph having Talar and subtalar pathology.

3.5. Measurement of dimensions on dry bone

The selected Tali were serially numbered using self-adhesives. The talus was measured using the Osteometric board and Vernier caliper wherever applicable. All the measurements were taken to the nearest millimeter and were converted to centimeter and weight in grams.

The length of the talus- the distance between the foremost parts of the rounded articular surface of the head to the apex of the lateral tubercle⁴

The Breadth of the talus- the maximum distance between the medial and the lateral surface.⁴

The Height of the talus- the distance between the superior and inferior surface.⁴

The Volume of talus- calculated using length* breath* height

3.6. Measurements of dimensions on radiograph

The present study was also based on patients between the age of 25 years to 50 years who were scheduled for anteroposterior and lateral plain ankle radiographs because of clinical hindfoot symptoms. All patients without

radiological pathologies, fully able to load the foot were included in the study.

The volume of talus- calculated using length* breath* height

3.7. On anteroposterior radiograph

The breadth of the body of talus- the distance between the medial and the lateral surface.⁴

3.8. On lateral radiograph

Length of talus- the distance between the foremost parts of the rounded articular surface of the head to the apex of the lateral tubercle.⁴

Height of talus- the distance between the superior and inferior surface.

4. Observation and Results

4.1. Sex determination of talus (Dry Bone)

Sex determination of dry talus is done based on the demarcating points derived from morphometric measurements of the radiological parameters

4.2. Demarcating points

The demarcating points to classify the sex of unknown talus, as male, is derived by using the highest value of demarcating point of female (Mean+3 S.D) and as female is derived by using the lowest value of demarcating point of male (Mean-3 S.D).⁵ The Mean \pm 3 S.D values for both male and female talus were calculated and demarcating points were derived for X-ray talus as shown in Table 3.

By the demarcating point method, only a very few Tali were sexed correctly, 14.58% (14) in dry talus.

5. Discussion

In a study by Murphy AM in the year 2002 on sex assessment of prehistoric New Zealand Polynesian skeletal remains using talus the accuracy of sex determination ranges from 85.1% to 93.3%. When the discriminant score is greater than the sectioning point (0.05934) it indicates a male individual and vice versa with an expected accuracy of 93.3%. The single measurement that achieved the greatest discrimination between males and females was maximum length.⁹

In a study by Harris SM, Case DT (2009) on bones of the foot, it was observed that talus on the right side generally exhibited greater dimensions than those from the left side, indicating that the right talus may be more sexually dimorphic than those from the left side and also quoted that greater percentages of correct classifications for length and height dimensions than for width dimensions indicating that length and height measurements to be highly sexually

Table 1: Difference between parameters of Talus based on the side (Dry bone)

Parameters	Mean		S. D		P value (Student's t test)
	Right (n= 46)	Left (n= 50)	Right (n= 46)	Left (n= 50)	
Length of talus (cms)	5.3678	5.2108	0.5451	0.4147	0.115
Breadth of talus (cms)	3.8379	3.7641	0.3433	0.3438	0.295
Height of talus (cms)	2.7632	2.7496	0.2905	0.2703	0.812
Volume of talus (cu. cm)	58.0221	54.7528	14.8772	12.6209	0.248

Table 2: Difference between Parameters of Talus based on the side (Radiograph)

Parameters	Mean		S. D		P value (Student's t test)
	Right (n= 46)	Left (n= 50)	Right (n= 46)	Left (n= 50)	
Length of talus (cms)	5.7359	5.6306	0.6075	0.5331	0.368
Breadth of body of talus (cms)	3.0833	3.0990	0.4081	0.4238	0.854
Height of talus (cms)	3.2280	3.2248	0.6179	0.6078	0.979
Volume of talus (cu. Cm)	57.8570	57.2086	16.9943	17.8569	0.856

Table 3: Demarcating points of morphometric analysis of Talus for sex determination

Parameters of radiograph	Demarcating point	
	Male	Female
Breadth of body of talus	> 4.2524	< 2.0071
Length of talus	> 7.2282	< 4.4183
Height of talus	> 4.6741	< 1.5521
Volume of talus	> 90.2892	< 11.6865

Table 4: Comparison of an average length of male and female talus as done by few authors

Authors	Length of male tali	Length of female tali
Barrett CH, Cavallari W, Sciulli PW ³	5.85 cms	5.28 cms
Murphy AM ⁶	5.32 cms	4.79 cms
Steele DG ⁷	5.52 cms	4.92 cms
Bidmos MA, Dayal MR ⁸	5.16 cms	4.70 cms

dimorphic. The percentage of correctly classified talus from a total sample of 160 tali varied between 86.6% and 87.6%.¹⁰

5.1. Sexual dimorphism of talus on dry bone and radiology

The first step for physical anthropologists in analyzing a set of human skeletal remains is to accurately establish the sex of the individual. Accurate sex determinations are not only critical to forensic anthropologists in successfully establishing the identity of unknown individuals, but also to bio-archaeologists in generating demographic information or conducting social analyses of past populations. Therefore, physical anthropologists must have reliable, accurate sexing methods to adequately determine the sex of unknown individuals

By the demarcation method, only 14.4% of talus exhibited sexual dimorphism which is very low could be due

to the overlap of many variables in males and females. This low result gives scope and need for detailed study in this subject.

In a study by Lee UY et al the authors observed that the mean value for the size of the male talus is greater than that for females and variables such as Talar length, breadth and height had the highest accuracy for sexing ranging from 72.9% to 86.4%.¹¹

In the present study right, tali exhibited greater dimensions than left except a breadth of the Talus. In a study by Harris SM, Case DT²⁶ they observed that talus on the right side was generally exhibited greater dimensions than those from the left side, indicating that the right Tarsals may be more sexually dimorphic than those from the left side.

6. Conclusion

A further detailed study is required in-depth to identify sex from unknown talus due to low results.

7. Source of funding

None

8. Conflict of interest

None.

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