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Original Research Article

TALAR INDICES IN NORTH INDIANS: A DIMORPHIC STUDY

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ABSTRACT

Background: Talus, the keystone of human tarsus is often recovered intact and is vital for sex, race, age and sex determination. The Talar indices describe a ratio between two quantitative measures and are specific for north indian population. Though, the morphometric parameters for Talus can be utilized to identify sex, no work is available on dimorphic potential of talar indices and possibility of prediction of index when index of other side is known.

Aim: The present pioneer study depicts baseline data for talar indices in north indians and explores their dimorphic potential . The study ascertains probability of determining index of one side if index on other side is known.

Materials and Method: 500 dry north indian tali (250 males; 250 females) of known sex (right left ratio 1:1) were studied. The Right length-breadth index, Left length-breadth index, Right length height index and Left length height index were determined.

Results: When indices as measured for right and left sides were compared they were found to be insignificant in males and statistically significant in females ($p<0.05$). The correlation coefficient values indicate that it is improbable to predict a parameter when the same parameter on the other side is known. The correlation coefficients are partially positive for some pairs and partially negative for other pairs. Only the Left length breadth index was found to be statistically significant in sexes ($p<0.05$).

Conclusion: This pioneer study provides baseline data for Talar indices. It is improbable to predict an index on one side when same index on other side is known. Though talar dimensions are dimorphic , the indices lack dimorphic potential in North Indian population. The direct methods of bone measure are more reliable than ratios for sex determination and estimation in north indians.

KEY WORDS: Talar Indices, North Indians, Dimorphic.

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INTRODUCTION

Talus is the second largest tarsal bone and is anatomically important. The talus is the link between the foot and the leg through ankle joint [1]. The talus is the keystone of the human tarsus and is a composite bone formed by the fusion of os tibiale and os intermedium [2]. This bone is often recovered intact[3]. The calcaneus and talus are often chosen in dimorphic studies because they are the largest and strongest tarsals. During locomotion the talus is a weight-bearing bone and all human populations

show at least some sexual dimorphism in size and weight [4].

No doubt,the talus is vital for sex,race ,age and sex determination.The indices describe a ratio between two quantitative measures and are specific for North Indian population[5]. These indices can be used to identify race and sex. The present study is the pioneer study depicting baseline data for talar indices. It is expected that these indices can be utilized to identify north indian population group. The present study also ascertains probability of determining index of one side if index on the other side is known. It also explores the dimorphic potential and propensity of these parameters in north indians.

MATERIALS AND METHODS

500 dry north indian tali (250 males; 250 females) of known sex ,right left ratio 1:1 were taken. The Right length-breadth Index, Left length-breadth Index, Right length height Index and Left length height Index were determined. The methodology for measuring different talar parameters was adopted from work done by Steele DG (1976) [6].The study was conducted in the department of Anatomy in Government Medical Colleges of Punjab during the period 2011-2016.

All measurements were taken using vernier callipers with least count of 0.02.

Length of the talus (mm): The maximum length of the talus was taken between the most posterior point of the trigonal process , to the most anterior point on the navicular facets shown in fig. 1.

Breadth of the talus (mm): This reading was taken with the inferior face of the talus lying on the horizontal plane .The fixed end of the caliper was placed at the medial most point on the talus bone and the moving end was approximated to the most lateral point on the lateral surface. Thus the breadth (fig.2) was taken between the most medial point and the most lateral point .

Height of the talus (mm): The maximum height was measured and recorded as shown in fig 3.

After taking the above measurements on the prepared proformas the talar indices were determined for the north indian population.

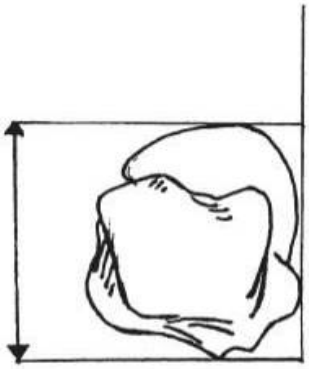


Fig. 1: Measuring the length of Talus.

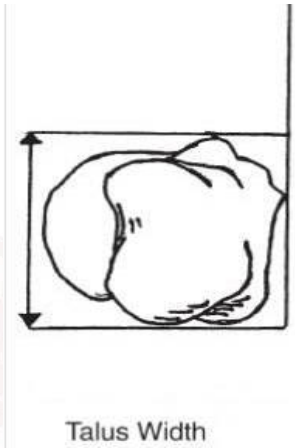
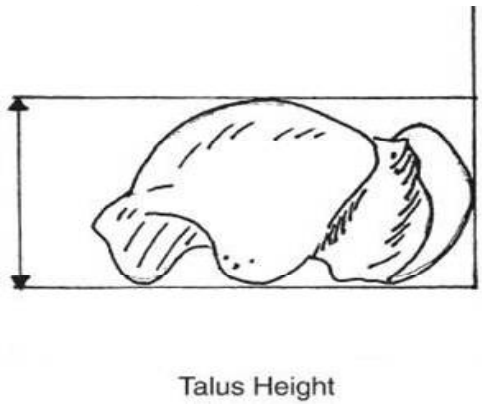


Fig. 2: Measuring the breadth of Talus.

Fig. 3: Measuring the height of Talus.



The indices were calculated using formulae described below:

INDICES:

Length - breadth Index:

$$\frac{\text{Breadth of the bone}}{\text{Length of the bone}} \times 100$$

Length - height Index:

$$\frac{\text{Talus height}}{\text{Talus length}} \times 100$$

The data obtained was further analyzed statistically. The various statistical methods used were:

Mean, Standard deviation, Coefficient of correlation, 95% Confidence interval values for talar indices and Statistical significance of talar indices in sexes ('p' value).

RESULTS

Table 1: Mean values and related parameters for Talar indices in North Indian males and females.

RLBI-Right length breadth index,
LtLBI-Left length breadth index,
RLHI-Right length height index,
LtLHI-Left length height index.

Gender	Values	RLBI	LtLBI	RLHI	LtLHI
MALE	Mean	72.3616	71.3504	56.354	56.6004
	Std. Deviation	5.54627	8.83228	2.44208	4.17095
	Minimum	55.03	38.46	52.57	47.21
	Maximum	82.19	83.33	60.99	68.09
	Median	71.93	72.14	55.9	55.95
FEMALE	Mean	73.6396	76.6164	55.6232	57.9816
	Std. Deviation	4.10485	4.80927	4.77821	3.39205
	Minimum	62.72	65.21	39.62	52.6
	Maximum	84.57	85	62.51	64.69
	Median	74.07	76.92	56.02	56.98
TOTAL	Mean	73.0006	73.9834	55.9886	57.291
	Std. Deviation	4.87199	7.52405	3.77358	3.82664
	Minimum	55.03	38.46	39.62	47.21
	Maximum	84.57	85	62.51	68.09
	Median	72.985	74.985	56.015	56.49

Table 2: (95%) Confidence Interval Values for talar indices in North Indian Males and Females.

Indices	Sex	Mean	Std. Devn	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
RLBI	Male	72.3616	5.54627	1.10925	70.0722	74.651	55.03	82.19
	Female	73.6396	4.10485	0.82097	71.9452	75.334	62.72	84.57
	Total	73.0006	4.87199	0.689	71.616	74.3852	55.03	84.57
LtLBI	Male	71.3504	8.83228	1.76646	67.7046	74.9962	38.46	83.33
	Female	76.6164	4.80927	0.96185	74.6312	78.6016	65.21	85
	Total	73.9834	7.52405	1.06406	71.8451	76.1217	38.46	85
RLHI	Male	56.354	2.44208	0.48842	55.346	57.362	52.57	60.99
	Female	55.6232	4.77821	0.95564	53.6509	57.5955	39.62	62.51
	Total	55.9886	3.77358	0.53367	54.9162	57.061	39.62	62.51
LtLHI	Male	56.6004	4.17095	0.83419	54.8787	58.3221	47.21	68.09
	Female	57.9816	3.39205	0.67841	56.5814	59.3818	52.6	64.69
	Total	57.291	3.82664	0.54117	56.2035	58.3785	47.21	68.09

Table 3: Showing statistical significance of Talar parameters in same sex in North Indian population.

Gender	Sides	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the difference		t	Sig 2 tailed
					Lower Bound	Upper Bound		
Males	RLBI - LtLBI	1.0112	10.0895	2.0179	-3.15354	5.17594	0.501	0.621
	RLHI - LtLHI	-0.2464	5.2676	1.05352	-2.42076	1.92796	-0.234	0.817
Females	RLBI - LtLBI	-2.9768	5.98818	1.19764	-5.4486	-0.505	-2.486	.020*
	RLHI - LtLHI	-2.3584	5.69377	1.13875	-4.70867	-0.00813	-2.071	.049*

* Statistically significant 'p'<0.05

Table 4: Showing statistical significance of Talar indices in sexes in North Indian population.

Indices	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
RLBI	0.922	0.342	-0.926	48	0.359	-1.278	1.38001	-4.0527	1.4967
LtLBI	1.713	0.197	-2.618	48	.012*	-5.266	2.01135	-9.31009	-1.22191
RLHI	3.143	0.083	0.681	48	0.499	0.7308	1.07322	-1.42705	2.88865
LtLHI	0.075	0.786	1.285	48	0.205	-1.3812	1.07523	-3.54309	0.78069

Table 5: Coefficient of correlation for Talar indices in North Indian males and females.

Gender	Pairs	Sides	Correlation	Significance
Males	Pair 5	RLBI & LtLBI	0.071	0.735
	Pair 6	RLHI & LtLHI	-0.215	0.301
Females	Pair 5	RLBI & LtLBI	0.104	0.62
	Pair 6	RLHI & LtLHI	0.059	0.779

The results are depicted in tables 1, 2, 3, 4 and 5. The mean values and related parameters for talar indices in north indian males and females are depicted in table 1.These indices provide a baseline value which can be utilized to identify the north indians. The table 2 indicates the confidence interval values for talar indices in north indian males and females. For example if we consider the right length breadth index in males then 95% of the values calculated lie between 70.07 and 74.65 mms respectively.

Table 3 depicts the statistical significance for the right and left side indices in same sex. When the indices as measured for right and left sides were compared they were found to be insignificant in males and statistically significant in females ($p<0.05$).The incongruity in results for sexes is an important indicator that the dimorphic potential is not strong for these indices in north indians. When the indices as measured in sexes were compared (table 4) only the left length breadth index was found to be statistically significant ($p<0.05$).This strongly refutes the existence of statistically significant sexual dimorphism for talar indices in north indian population.

The correlation coefficient values (depicted in table 5) between different parameters as measured on right and left sides indicate that it is improbable to predict a parameter on one side when the same parameter on the other side is known. The correlation coefficients are partially positive for some pairs and partially negative for other pairs. This suggests that when we know talar index for one side we cannot predict the value for the other side in north indians.

DISCUSSION

A number of bones have been utilized to quantify sexual dimorphism [7].Amongst the tarsals the talus and first cuneiform are regarded as most dimorphic[8].The talus has a unique structure designed to channel and distribute body weight [9]. It is the most commonly fractured bone of the foot which takes part in formation of many inter-tarsal joints [10]. Arthritis is the most common complication following talar fractures [11] .As such the morphology of the talus needs to be studied in detail and the present pioneer study quantifies the talar indices in north indians.

The talus in all populations has demonstrated sexual dimorphism in size and weight [12].This observation is important as talus is a dense bone which is often recovered intact [13].The talar indices are specific for the north indian population. So, it is expected that these too would demonstrate dimorphic propensity.But this is not the case with north indian population as established in the present study.The authors hope that the present study will stimulate similar studies in other populations to compare the results in different populations.

In the present study when the different indices as measured for the talus on right and left sides were compared for the same sex they were

found to be statistically insignificant for males. The same does not hold true for females .When the 'unpaired t test' was utilized the indices as measured for the same side in females were found to be statistically significant .So, our results for indices are different in males and females. Previously, work on parameters length, breadth and height for south indians [14], north Indians, northern Italians[15] ,Koreans[16], Prehistoric Polynesian tali[17] of New Zealand has indicated that the morphometric profile of talus exhibits a definitive sexually dimorphic predisposition.

The indices describe a ratio between two quantitative measures. These quantitative factors are individually dimorphic but the ratio is not dimorphic.This mathematic perplexicity we demonstrated is pathbreaking and difficult to explain. We started our study with 100 tali and gradually increased the number to 500 tali(keeping male female ratio 1:1).For every block(100 tali,200 tali,250 tali) the individual parameters were dimorphic but the dimorphic propensity and propensity was negative for the indices. This we feel is an important milestone in characterization of talar morphometric profile in north Indians.We implore authors to carry out similar studies for other populations so that it can be ascertained whether these findings are unique for north Indian population or are they a part and parcel of the morphometric design for the Talus? There are studies which have demonstrated a higher reliability and reproducibility of measurements taken directly on the bones [18] and hence we conclude that such direct methods are more reliable than ratios for sex determination and estimation.

CONCLUSION

Only the Left length breadth index was found to be statistically significant in sexes ($p<0.05$). This pioneer study depicts baseline data for these indices in the North Indians. The study depicts Confidence interval values. The individual parameters are statistically significant for the sexes but the same is not true for all indices which demonstrate lack of dimorphic potential.Also It is improbable to predict an index on one side when same index on other side is known.The Talar indices are population specific and do not demonstrate dimorphic dichotomy in North Indian population. The authors feel that the direct methods are more reliable than ratios for sex determination and estimation.

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Conflicts of Interests: None

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