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Talar Morphometry – A Study in West Bengal Population with Literature Review

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Abstract: *Background:* Talus, one of the seven tarsal bones, has been topic of interest for anatomist, anthropologist and forensic-medicine for several years. It has been considered as an important bone for locomotor function. Till date few anthropometric data is available from the eastern India specifically from Bengal. *Objective:* Measurement of different morphometric parameters of dry human tali from West Bengal. *Methods:* In the present study authors measured different parameters in 100 available tali in Anatomy Departments of different medical colleges of Kolkata over last six months. Measurement of length, width, height, trochlear-length of talus and length, width and depth of sulcus tali were taken by slide-calipers. *Result:* Present study revealed mean values of length 53.37 ± 3.69 mm, width 38.62 ± 2.91 mm, height 30.85 ± 4.11 mm, trochlear length 33.48 ± 3.58 mm, length of sulcus tali 29.27 ± 3.91 mm, width of sulcus tali 15.49 ± 3.13 and depth of sulcus tali 6.23 ± 1.04 mm. *Conclusion:* Measurement of different parameters of talus can be useful for surgical intervention, prosthetic invention, medico-legal aspect and in anthropometry. In addition to the anthropometric data available for population from other zones of India, this study adds the data from Eastern India.

Keyword: Talus, Trochlear surface, Sulcus tali, Morphometry.

Introduction

Talus, the connecting link between the bones of foot and the leg, is situated on the superior surface of anterior 2/3rd of calcaneus. This bone is articulated with tibia, fibula, calcaneus and navicular, forming supratalar, subtalar and pretalar joints respectively. It is an important bone for weight transmission and act as key bone of medial longitudinal arch of foot [1]. Head, neck and body are the three parts of this bone, head being anteriorly and body being posteriorly placed. Inferior surface of neck presents a groove- sulcus tali, which along with sulcus calcanei forms sinus tarsi; through which axis of inversion and eversion passes. This is one of the important bone out of seven tarsal bones which is devoid of any muscular or tendinous attachment [1-2].

Flat foot, varus and valgus deformities of foot, intra-articular fractures of sub- talar and adjacent joints, congenital dismorphology, arthritis and coalition of ankle and adjacent joint, and in other pathologies of foot different surgical procedures are being undertaken worldwide. Morphological and morphometric variation of talus necessary to keep in mind during planning of surgical management [3-5]. In designing talar body prosthesis , alignment of bones in the treatment of CTEV or in any other congenital deformity, treatment of talar neck fracture due trauma or any other pathology, various dimension and morphological features of talus should be in concern for successful outcome of surgery [6].

So far the literature has been searched for, till date though data available for different talar morphometrics in different territories of India population; but there is scarcity of data, found in the eastern Indian population. The present study aimed to describe bilateral morphological and morphometric variations

of different parameters of talus like its length, width, height, trochlear length, length-breadth-depth of sulcus tali; in the population of West Bengal for both understanding of pathology as well as during surgical intervention of ankle and joints around, and to the anthropologist during working on talus.

Material and Methods

With due permission from Institutional Ethics Committee and the Director of IPGME&R, under guidance of the Head of the Department, this Institution based cross-sectional observational study was undertaken in the Department of Anatomy of IPGME&R Kolkata for six months duration from December 2020 to May 2021. The dry adult human tali of unknown age and sex were collected from the museums of Anatomy departments.

Head of the Departments of Anatomy of other medical teaching Institutes of Kolkata were also approached for their kind permission to access tali kept in the respective departmental museums; presuming the bones were disarticulated from the skeletons of donated cadavers belonging to population of West Bengal. Thus in 52 of right side and 48 of left sided tali, in total 100 specimens were included in study by the convenient method of non-randomised sampling. Malformed, non-ossified or broken bones were excluded.

Measurements were taken in millimetre with the help of Vernier calliper (with precision 0.02 mm), osteometric board, white paper, lead pencil. We took measurement of each data three times by two observers and finally took the mean value of each data to avoid observational bias (Fig 1- 4).

Fig-1: Antero-posterior length of talus measurement by Vernier calliper

Fig-2: Width of talus measurement by Vernier calliper

Fig3: Height of talus measurement by Vernier calliper

Fig-4: Trochlear length measurement by Vernier calliper

Parameters measured were:

i) Antero-posterior length of talus (APLT): linear distance between anterior most point of head of talus and posterior most point of body of talus (Figure:1)

ii) Width of talus (WT) : most medial and most lateral point of body of talus (Figure:2)
iii) Height of talus (HT) : maximum distance between most superior and inferior point of body of talus (Figure:3)
iv) Trochlear length (TL) : most anterior and most posterior point over Trochlear articular surface of talus (Figure:4)
v) Length of sulcus tali (LST): maximum distance between the two ends of sulcus tali
vi) Width of sulcus tali (WST) : maximum distance between two edges of sulcus tali
vii) Depth of sulcus tali (DST) : distance between margin and the floor of sulcus tali

Results

Mean, SD and p values of different parameters were measured. Student t test was done between the right and left values of each data to note wheather the difference were significant or not. The p value we got for length, width, height and trochlear length of talus were 1.0000, 0.2143, 0.1247, 0.0001. For sulcus tali length, breadth and depth were, 0.0078, 0.0975 and 0.0001 respectively. Result showed significant bilateral difference in length of sulcus tali. Difference in trochlear length and depth of sulcus tali for right and left sides were highly significant.

As a whole, length (53.37 ± 3.69 mm), width (38.62 ± 2.91 mm) and height (30.85 ± 4.11 mm) of talus were found to have insignificant variation to laterality. Width of sulcus tali also had no significant bilateral difference, with mean value of 15.49 ± 3.13 as a whole (Table 1).

Table-1: Morphometric parameters of adult dry human tali in Bengali population (mm) [N=100, R=52, L=48]

Serial no	Parameters	Side	Mean (mm)	SD	Range	Students' t test p value for laterality comparison
1	Antero-posterior length of talus (APLT)	Right	53.37	3.46	43.32- 60.4	1.0000
		Left	53.37	3.96	43.24- 60.00	
		As a whole	53.37	3.69	43.24- 60.4	
2	Width of talus (WT)	Right	38.97	2.75	32.78- 45.44	0.2143
		Left	38.25	3.01	31.4- 44.98	
		As a whole	38.62	2.91	31.4- 44.98	
3	Height of talus (HT)	Right	31.46	3.04	24.09- 36.96	0.1247
		Left	30.20	4.97	22.64- 39.70	
		As a whole	30.85	4.11	22.64- 39.70	
4	Trochlear length (TL)	Right	31.81	2.75	25.00- 38.00	0.0001
		Left	35.28	3.49	28.00- 40.96	
		As a whole	33.48	3.58	25.00- 40.96	
5	Length of sulcus tali (LST)	Right	30.26	3.91	22.20- 39.54	0.0078
		Left	28.20	3.67	16.54 – 35.70	
		As a whole	29.27	3.91	16.54- 39.54	
6	Width of sulcus tali (WST)	Right	14.99	2.79	08.00- 19.00	0.0975
		Left	16.03	3.38	10.42- 27.90	
		As a whole	15.49	3.13	8.00-27.9	
7	Depth of sulcus tali (DST)	Right	6.61	0.90	5.34- 9.32	0.0001
		Left	5.82	1.04	3.8- 8.54	
		As a whole	6.23	1.04	3.8- 9.32	

Discussion

We measured different parameters of dry human tali with the help of Vernier calliper, collected from the population of West Bengal. The available dry tali in the Department of Anatomy of different medical colleges in Kolkata, were presume to be from donated cadavers of West Bengal population.

In our study we have found statistically significant bilateral variations in length and depth of sulcus tali and also in measurement of trochlear length. This variation might be due to bones were collected from different individual with different stature. The specimen of both sides we measured, was not from same person, so variation were obvious.

Previous studies by various authors across India have already established different morphometric studies on talus, though there is scarcity of data in Bengali population.

Table-2: Comparison datasheet for different studies till date available in literature in different states of India; for talar morphometric parameters

State	Authors	APT			WT			HT			TL		
		R	L	W	R	L	W	R	L	W	R	L	W
Maha-rastra	Ughade HM et al [6]	51.3 ± 5.2	52.6 ± 5.6	--	38.7 ± 3.4	38.5 ± 3.1	--	--	--	--	29.1 ± 3.5	30.1 ± 3.0	--
Bihar	Omar S et al [9]	53.1 ± 3.7	53.1 ± 3.4	-	40.2 ± 2.4	40.2 ± 2.6	-	29.3 ± 2.2	29.3 ± 2.4	-	-	-	-
Kerala Karna-taka	Gautham K et al [7]	52.32 ± 3.99	52.90 ± 4.48	-	37.9 ± 3.52	36.8 ± 3.15	-	-	-	-	30.6 ± 2.37	30.44 ± 2.63	-
Andhra Pradesh	Namburu BSP et al [8]	53.7 ± 2.1	50.0 ± 4.7	53.3 ± 4.6	37.9 ± 2.9	40.0 ± 3.1	37.9 ± 3.0	25.1 ± 2.1	30.0 ± 2.0	25.2 ± 2.0	-	-	-
Kerala	Motagi MV et al [10]	54.22 ± 4.48	53.35 ± 4.47	-	36.21 ± 3.43	37.77 ± 2.99	-	-	-	-	29.57 ± 2.85	30.0 ± 2.52	-
Tamilnadu	Mahato NK et al [11]	55.82 ± 2.92	55.70 ± 3.36	55.76 ± 3.63	30.33 ± 1.61	29.91 ± 2.50	30.11 ± 2.08	-	-	-	--	-	-
West Bengal	Present study	53.37 ± 3.46	53.37 ± 3.96	53.37 ± 3.69	38.97 ± 2.75	38.25 ± 3.01	38.62 ± 2.9	31.46 ± 3.04	30.2 ± 4.97	30.85 ± 4.11	31.81 ± 2.75	35.28 ± 3.49	33.48 ± 3.58

[Measurements are expressed in mm]

Comparing with different studies, value of antero-posterior length (APL) of talus as whole was almost same to that of the value of study done in population of Andhra Pradesh by Namburu BSP et al [8]. They found larger mean value for right ,where in present study it was almost same for both sides, similar to study in population of Bihar by Omar et al in 2015 [9] (Table 2).

Mean value of width in present study was very close with the value found in population of Maharashtra [6], and almost same bilaterally. In study by Omar et al [9] we could also find bilateral symmetry with higher value of width than present study (Table 2).

Bilateral symmetry in height of talus was found in Bihari population, but there was side to side variation in height in Bengali , where right shown higher value that left, just reverse from that found in study by Namburu et al. (Table 2) [8]. As trochlear length concerned, we found larger value in left side like that was established among Marathi [6] and Keralian population [10], but Gautham K et al found bilateral symmetry in trochlear length [7] (Table 2) .

The value got by the several authors in different studies done all over India differed largely from that of Bengali regarding length

and width of sulcus tali. We found maximum value off length and width of sulcus tali, compared to the other zones of India [6-7, 10] (Table 3).

Table-3: Comparison datasheet for different studies till date available in literature in different states of India; for sulcus tali morphometric parameters (mm)

State	Authors	LST			WST		
		R	L	W	R	L	W
Maharastra	Ughade HM et al [6]	19.9 ± 4.1	19.6 ± 4.1	--	8.0 ± 3.0	7.3 ± 3.1	-
Kerala Karnataka	Gautham K et al [7]	20.12 ± 2.98	20.44 ± 3.07	-	6.88 ± 1.77	6.76 ± 1.84	-
Kerala	Motagi MV et al [10]	18.95 ± 3.14	17.55 ± 3.37	-	7.20 ± 1.40	7.27 ± 1.43	-
West Bengal	Present study	30.26 ± 3.91	28.2 ± 3.67	29.27 ± 3.91	14.99 ± 2.79	16.03 ± 3.38	15.49 ± 3.13

There is scarcity of data on depth of sulcus tali among Indian population. A study done on Anatolian population in 2016 by Boyan et al [12 found almost equal value of depth of sulcus tali on left side with that of present study, but lower value for right side in comparison to our study. Regarding length and width of sulcus tali, Anatolian population has much less value than Bengali.

Conclusion

In our study we found data for talar morphometry in Bengali population for the first time in literature. Variations of morphometric parameters of talus among different zones in India can be attributed to the ethnicity, genetic, racial and environmental diversity. Although the limitation of our study was scarcity of human talus in department of Anatomy of different medical colleges in Kolkata, this limitation gives way to further study based on living population on surface Anatomy and radiography.

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