

# **Bilateral Symmetry Of Human Tali**

**Dr. Shri Om Kesarwani,**  
*PG Student,*

**Dr. Nishtha Singh,**  
*Associate Professor Department Of Anatomy,*

**Dr. Badal Singh,**  
*Associate Professor Department Of Anatomy.*  
*Affiliation: MLN Medical College, Prayagraj U.P.*

---

Date of Submission: 01-03-2025

Date of Acceptance: 11-03-2025

---

## **I. Introduction:**

The very unique disposition of the articular surfaces associated with the talus and its constituent components (body and the head) are in specialised spatial orientation. The force subjected to the talus in load bearing not only dictates the resultant shapes and dimensions of the articular surfaces acquired by the bone, stress on the talus also probably decides the outcome of the angular orientation of the bone in conjunction with configuring the overall architecture of the bone. Morphometric analysis of both sides of talus is necessary to know the right-left symmetry for implant design and for mechanical testing for surgeons and orthopaedics.

The talus is one of the seven tarsal bones. It is the link between the foot and leg, through the ankle joint. It forms the key bone of the longitudinal arch and responsible for receiving the body weight and transmitting it to the plantar arch below. It is the only tarsal bone which has no muscular and tendinous attachment.

The talus has three articulating surfaces; Large oval surface on its most posterior aspect, articulating with sustentaculum tali of calcaneum, A flat surface on its anterolateral surface articulating with upper surface of calcaneum on its anteromedial surface and medial to the above two facets is the third facet articulating with spring ligament which is covered by articular cartilage.

Morphometric data analysed in this study would aid to understand the morphology of the talus, its load bearing patterns and it may also help in foot prosthesis, screw placements in fractures at related areas of foot.

## **II. Materials And Methods:**

The present study was done on dry human ossified adult tali of unknown sexes. 50 (34 right and 16 left) tali were collected from the bone room of the department of Anatomy of MLN Medical College Prayagraj Human talus which is apparently normal, free from any gross congenital or acquired deformity was included in the study. Deformed and unossified tali were excluded. A total of 14 bony markers were selected for the measurements. All dimensions of articular surfaces were recorded using vernier calliper's. Neck-body angle was measured using a protractor. The following parameters were recorded for the present study:

1. Anterio-posterior length (TL)-It is the linear distance between the most anterior point on the head and most posterior point on the body of the talus.
2. Transverse width (TW)-It is the linear distance between the most medial and most lateral points on the body of the talus.
3. Talus height (TH)--vertical height of talus measured from superior to the inferior end of the body of talus
4. Length of the sulcus tali (STL): It is the maximum distance between the two ends of the sulcus tali.
5. Width of the sulcus tali (STW): It is the distance between the edges of the sulcus tali at its maximum width.
6. Depth of sulcus tali (STD)- -measured from the margin of the sulcus to its floor at the maximum depth.
7. Neck-body angle (NBA): It is the angle between the longitudinal axis of the neck and the longitudinal axis of the body. The longitudinal axis of the neck divides the neck and is parallel with the lateral edge of the neck. The longitudinal axis of the body divides the body and is parallel with the medial border of the trochlear surface. It is measured by using two straight sticks kept parallel to the longitudinal axis of the neck and the longitudinal axis of the body, and then by measuring the angle between them using a protractor.

Data were subjected to statistical analysis in order to assess the bilateral differences in the bony markers.

Articular facets on the inferior surface of the head of the talus were assessed and classified as done by

Boyan et al. Anterior and middle articular facets were observed in Type A, and according to the extent of their separation, it was classified into four subtypes:

- If the distance is  $<2$  mm: Type A1, if the distance is between 2 and 5 mm: Type A2, if the distance is  $>5$  mm: Type A3, if only one facet is there: Type A4, if there is no separation in between two facets: Type B, and in Type C anterior, middle and posterior facets were not separated.

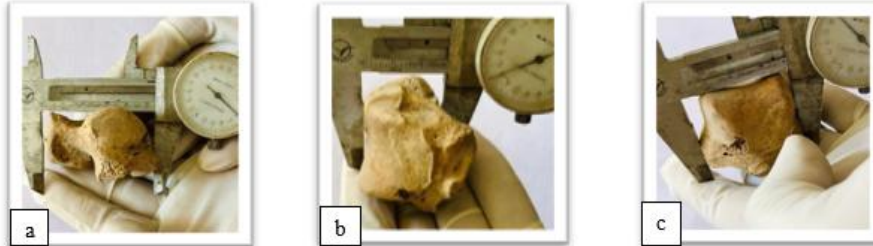


Figure 1 Various measurement of talus. (a) Anteroposterior TL, (b) TW, (c) Vertical TH. TL: Length of talus, TW: Width of Talus, TH: Height of talus

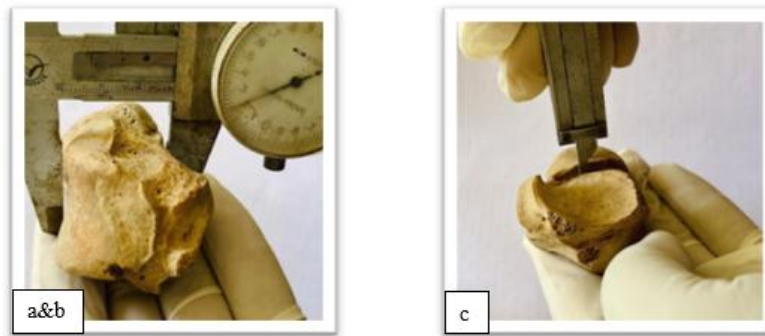


Figure 2 (a) Width, (b) Length, and (c) Depth of sulcus tali



Figure 3 The types of articular facets present on the inferior surface of head of talus

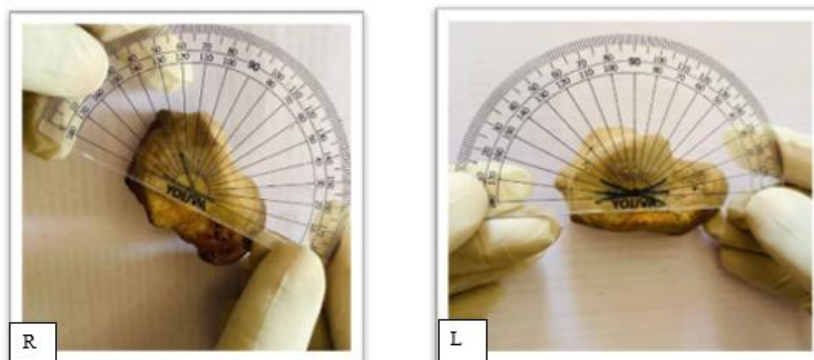


Figure 4 Head-neck length of talus & Neck-body angle

**III. Results:**

In the present study, the following metrical variations are noted:

- a) The TL ranged from 4.26 cm to 6.10 cm and had a mean of 5.08 cm on the right side, 4.24 and 5.61 on the left side mean 5.06 cm.
- b) The TW ranged from 1.91 cm to 3.76 cm and had a mean of 3.05 cm on the right side was 2.61 and 3.50 on the left side mean of 3.07 cm.
- c) The TH ranged from 1.64 cm to 2.83 cm and had a mean of 2.35 cm. and 2.0 cm to 2.84 c and mean 2.32cm on left side.
- d) The STW ranged from 0.61 cm to 1.11 cm and had a mean of 0.76 cm. The mean on the right side was 0.49 and 1.20 on the left side was 0.77 cm.
- e) The STL ranged from 1.6 cm to 2.34 cm and had a mean of 1.89 cm. Mean on the right side was 1.64 and 2.84 on the left side mean 1.94 cm.
- f) The STD ranged from 0.47cm to 0.95 and mean on right side was 0.71cm and 0.51cm to 1.01 and mean 0.698cm on left side.
- g) The neck-body angle had a mean of 150.47 on the right side and 150.37 on the left side with a 't' value of 2.024 and a 'p' value of 0.046.

**IV. Discussion:**

**Table 1. Types of facets present on the inferior surface of the head of the Talus**

Type	n-50 (%)
A1	36 (72%)
A2	8 (16%)
A3	2 (04%)
A4	0 (00%)
B	4 (08%)
C	0 (00%)

**Table 2. Minimum, Maximum, and mean values of measured parameters of the Talus**

Parameter (mm)	Minimum	Maximum	Mean ± SD
TL	42.68	61.04	50.85 ± 4.60
TW	19.13	37.68	30.57 ± 4.03
TH	16.47	28.32	23.55 ± 3.05
STW	6.14	11.16	7.63 ± 0.99
STL	16.12	23.47	18.91 ± 1.96
STD	4.57	9.58	7.16 ± 1.31

TL= Talus length; TW= Talus width; TH= Talus height; STW= Sulcus talus width; STL= Sulcus talus length; STD= Sulcus talus depth.

**Table 3. Minimum, maximum, and mean values of various morphometric parameters on both sides of Talus, as well as t-value and p-value. (n= 50)**

Measured Parameter (mm)	Right Min	Right Max	Right Mean ± SD	Left Min	Left Max	Left Mean ± SD
TL	42.68	61.04	50.85 ± 4.60	42.44	56.12	50.61 ± 4.00
TW	19.13	37.68	30.57 ± 4.03	26.14	35.02	30.72 ± 2.74
TH	16.47	28.32	23.55 ± 3.05	20.14	28.14	23.24 ± 2.56
STW	6.14	11.16	7.63 ± 0.99	4.98	12.02	7.78 ± 2.11
STL	16.12	23.47	18.91 ± 1.96	14.14	28.42	19.45 ± 3.17
STD	4.57	9.58	7.16 ± 1.31	5.12	10.12	6.98 ± 1.40
NBA	-	-	150.47°	-	-	150.37°

TL = Talus length; TW= Talus width; TH= Talus height; STW= Sulcus tali width; STL= Sulcus tali length; STD= Sulcus tali depth; NBA= Neck-body angle; SD= Standard deviation.

**Table 4. Percentage of type of articular facets on the inferior surface of the head of Talus reported by different authors.**

Authors	N (total)	Type A1	Type A2	Type A3	Type A4	Type B	Type C
Arora et al 1979 (Indians)	500	3	0	0	16	79	2
Bilodi 2006 (Nepalese)	240	5	0	0	10	66.6	18.4
Lee et al 2012 (Korean)	76	9.2	0	0	30.3	60.5	0
Jung et al 2015 (Korean)	118	Type A (not classified in subtypes)	11	46.6	42.4	-	-
Boyan et al 2016	57	0	1.7	0	0	98.3	0

(Turkish)							
Archana & Arun Singh 2022 (Indians)	66	51.5	28.8	12.1	1.5	6.1	0
Present study (Indians)	50	72	16	4	0	8	0

**Table 5. Mean length, width, and height of the Talus measured by different authors.**

Measured Parameters (mm)	Koshy et al 2002 (Indians) (n=70)	Lee et al 2012 (Korean) (n=76)	Boyan et al 2016 (Turkish) (n=57)	Omar et al 2015 (Indian) (n=40)	Aparna Vedapriya et al 2019 (Indian) (n=250)	Gautham et al 2013 (Indian) (n=100)	Archana & Arun Singh 2022 (Indian)	Present Study (Indian) - Right	Present Study (Indian) - Left
TL	52.8 ± 5.8	53.92 ± 3.20	51.78 ± 4.09	53.1	53.1	53.4	52.32	52.81 ± 4.67	50.85 ± 4.60
TW	37.9 ± 3.5	40.48 ± 2.46	39.41 ± 3.3	40.2	38.3	38.3	37.94	31.19 ± 2.79	30.57 ± 4.03
TH	-	29.3	29.3	28.8	28.8	-	26.15 ± 2.81	23.55 ± 3.05	23.24 ± 2.56

In the present study, the mean width of the right talus was 30.57±4.03 mm and of left side width was 30.72 ± 2.74 mm, and the total mean width was 30.65 ± 3.78 mm, which was smaller than the values reported by other authors.

In the present study, the mean height of the talus on the right side was 23.55 ± 3.05 mm and of the left side 23.24 ± 2.56mm. Higher values for height were reported by Otag, Omar, and Aparna et al.

In the present study, the mean value of the width of sulcus tali was 7.63±0.99 mm, the length of sulcus tali was 18.91±1.96 mm, and the mean depth of sulcus tali was 7.16±1.31 mm. Various measurements of sulcus tali of the present study were almost similar to the values of studies conducted Koshy, Boyan, Gautham and Jung et al. [Table 6].

The mean value of HNL of talus was measured as 17.04 and 16.84 m in the present study, which was smaller than the measured value of Bidmos and Dayal et al, South African talus, Sakauel Japanese, Lee et al Korean, and Sumati and Phatak Indian talus. [Table 7]. On the right side, neck-body angle of talus was 150.47° and on the left 150.37° in the present study, which was smaller to values reported by Gautham et al. [Table 6]. There was no significant difference between the right and left side angles. It was higher on the right side, which may be due to different walking habits and lifestyle patterns.

The knowledge of the anatomical features of the talus is very important, because restoration of the normal anatomy is very important during injuries of the talus to prevent the development of secondary pathology and morbidity.

**Table 6. Various measurements of sulcus tali and neck-body angle of the talus reported by different studies.**

Measured Parameters (mm)	Koshy et al 2002 (Indians) (n=70)	Boyan et al 2016 (Turkish) (n=57)	Gautham et al 2013 (Indian) (n=100)	Archana & Arun Singh 2022 (Indian)	Present Study (Indian) - Right	Present Study (Indian) - Left
STW	27.8 ± 4.4	5.65 ± 1.57	6.76	5.35	7.63 ± 0.99	7.78 ± 2.11
STL	38.0 ± 4.1	21.36 ± 3.19	20.12	20.44	18.91 ± 1.96	19.45 ± 3.17
STD	6.9 ± 1.05	5.69 ± 1.18	-	5.37 ± 0.92	7.16 ± 1.31	6.98 ± 1.40
NBA	-	153.6°	155.2°	154.94° ± 3.84	150.47°	150.37°

**Table 7. Head-neck length of the Talus reported by different studies**

Authors	Male (mm)	Female (mm)
Bidmos and Dayal 2004 (South African Blacks)	20.85	19.56
Sakaue 2011 (Japanese)	21.8 (right), 22.2 (left)	19.6 (right), 19.9 (left)
Lee et al 2012 (Korean)	20.99	19.28
Sumati and Phatak 2018 (Indian)	25.3	21.6
Archana & Arun Singh 2022 (Indian)	16.12 (right)	15.39 (left)
Present Study (Indian)	17.04 (right)	16.84 (left)

**V. Conclusion:**

In the present study, the incidence of Type A articular facets present on the inferior surface of the head of the talus is more than Type C articular facet, but other authors reported occurrence of Type B facet more than facet A and C this finding may be due to racial, genetic, climatic, environmental, and nutritional differences.

In morphometry of talus, there were no significant differences found between the parameters of right and left sides except neck- body angle, which was higher on the right side. Hence, this may help orthopedic

surgeons to choose the correct size for the talus during constructive surgeries and prosthetic surgeries.

**References:**

- [1] Standing S. Churchill Livingstone. In: Gray's Anatomy: The Anatomical Basis Of Clinical Practice. 40\* Ed. London: Elsevier; 2008. P. 1434- 6.
- [2] Sinnathamby C. Churchill Livingstone. In: Last's Anatomy Regional And. Applied. 12" Ed. London: Elsevier; 2011. P. 156.
- [3] Turley K, Frost SR. The Shape And Presentation Of The Catarrhine Talus: A Geometric Morphometric Analysis. *Anat Rec (Hoboken)* 2013; 296:877-90.
- [4] Islam K, Dobbe A, Ko Meili A, Duke K, El-Rich M, Dhillon S, Et Al. Symmetry Analysis Of Talus Bone: A Geometric Morphometric Approach. *Bone Joint Res* 2014;3:139-45.
- [5] Arora AK, Gupta SC, Gupta CD, Jayasinghe P. Variations In Calcanean Facets In Indian Tali. *Anat Anz* 1979;146:377-80.
- [6] Boyan N, Ozsahin E, Kizil Kanat E, Soames R, Oguz O. Morphometric Measurement And Types Of Articular Facets On The Talus And Calcaneus In An Anatolian Population. *Int J Morphol* 2016;34:1378-85.
- [7] Sumati, Phatak AG. Sex Determination From Talus Among Gujarati Population Of Anand Region By Discriminant Function Analysis. *JCDR* 2018, 12; AC01-5.
- [8] Gautam K, Clarisa MQ, Sheela N And Vidyashambhava P. Morphometric Analysis Of The Human Tali. *Cibtech J Surg Online Int J* 2013;2:64-Available From: [Http://www.Cibtech.O Rg/Cjs.Htm](http://www.cibtech.org/Cjs.htm). [Last Accessed On 2022 Sep 27].
- [9] Bilodi AK. Study Of Calcaneal Articular Facets In Human Tali. *Kathmandu Univ Med J (KUMJ)* 2006;4:75-7.
- [10] Lee JY, Jung MH, Lee JS, Choi BY, Cho BP. Types Of Calcaneal Articular Facets Of The Talus In Korean. *Korean J Phys Anthropol* 2012;25:185-92.
- [11] Jung MH, Choi BY, Lee JY, Han CS, Lee JS, Yang YC, Et Al. Types Of Subtalar Joint Facets. *Surg Radiol Anat* 2015;37:629-38.
- [12] Koshy S, Vettivel S, Selvaraj KG. Estimation Of Length Of Calcaneum And Talus From Their Bony Markers. *Forensic Sci Int* 2002;129:200-4.
- [13] Lee UY, Han SH, Park DK, Kim YS, Kim DI, Chung IH, Et Al. Sex Determination From The Talus Of Koreans By Discriminant Function Analysis. *J Forensic Sci* 2012;57:166-71.
- [14] Omar S, Alam M, Gupta RB, Alam KM. Bilateral Symmetry Of The Talus: A Study On 40 Dry Adult Tali In Bihar. *Int J Sci Res* 2015;6:3404-5.
- [15] Aparna Vedapriya K, Bharathi S, Kalpana S. A Morphometric Study Of Bilateral Symmetry Of The Human Talus. *Int J Sci Res* 2019;8:1838-40.
- [16] Kavya, Panju S, Kumar A. Symmetrical Analysis: An X - Ray Study Of Talus With Its Physiological Correlation. *Int J Adv Res* 2019;7:1091- 95.
- [17] Otag I. Morphometric Measures Of Talus Bone In Skeleton Remains Belonging To Anatolian Geography. *Indian J Appl Res* 2013;3:530-1.
- [18] Bidmos MA, Dayal MR. Further Evidence To Show Population Specificity Of Discriminant Function Equations For Sex Determination Using The Talus Of South African Black J *Forensic Sci* 2004;49:1165-70.
- [19] Sakaue K. Sex Assessment From The Talus And Calcaneus Of Japanese. *Bull Natl Mus Nat Sci* 2011