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MORPHOMETRIC STUDY OF TALUS BONE IN SOUTH COASTAL POPULATION

Anatomy

Rameswarapu Suman Babu	Professors, Department Of Anatomy, Narayana Medical College, Chinthareddypalem, Nellore.
Lattupalli Hema*	Professors, Department Of Anatomy, Narayana Medical College, Chinthareddypalem, Nellore. *Corresponding Author
Kasukurthi Asha Latha	Professors, Department Of Anatomy, Narayana Medical College, Chinthareddypalem, Nellore.
Madala Venkateswara Rao	Professors, Department Of Anatomy, Narayana Medical College, Chinthareddypalem, Nellore.

ABSTRACT

Background: The talus bone is the second-largest tarsal bone. Morphometric study of right and left talus is necessary to know the right–left symmetry for the radiologists and orthopaedic surgeons for planning the surgeries of talus and implants during injuries and fractures . Hence, this study was done to observe the facets of the inferior surface of the talus and to measure the morphometric parameters of the talus. **Methodology:** This cross-sectional study was carried out on a total of 100 dry adult human tali (47 of the right side and 53 of the left side). Morphologically, the types of articular facets on the head of the talus were assessed and classified as done by Boyan et al. as -Type A1, Type A2, Type A3, Type A4, Type B, and Type C. Morphometric evaluation of talus was done with the help of digital vernier caliper, and anteroposterior distance (length), maximum transverse width, vertical height of talus, length of sulcus tali, width of sulcus tali and depth of sulcus tali were measured. Statistical analysis was performed, and data were expressed as mean, minimum, maximum values, and standard deviation. **Results:** In the present study, Type A1 facet was found in 28.43% of the talus, in 28.43% of Type A2, in 0.98% of Type A3, in 14.71% of Type A4, in 4.90% of Type B, and Type C facet in 22.55% were found. The mean length, width, and height of the talus were 54.18 ± 4.14 mm on the right side and 54.34 ± 3.97 mm on the left side, 38.80 ± 3.51 mm on the right side and 38.77 ± 2.86 mm on the left side, 29.25 ± 2.61 mm on the right side and29.89 ± 3.80 mm on the left side. The width, length, and depth of sulcus tali were 7.20 ± 2.10 mm on the right side and 7.34 ± 1.93 mm on the left side, 18.14 ± 3.20 mm on the right side and 18.51 ± 2.89 mm on the left side, 5.96 ± 1.32 mm on the right side and 6.94 ± 1.25 mm on the left side respectively. HNL of talus was 26.00 ± 2.41 mm on the right side and 25.25 ± 2.56 mm on the left side. **Conclusion:** There are a minimal difference in the values width of the talus, head neck length and also the depth of the sulcus tali of the talus bone. Hence, the measurement of this study may help the surgeons to choose the appropriate size of the prosthesis for talus implantation surgeries.

KEYWORDS

Articular facets of the talus, Talus bone, Sinus tarsi, Sulcus tali.

INTRODUCTION

The skeleton of foot helps in locomotion, with standing tensile forces and maintains the walk cycle. The skeleton of foot is otherwise called as Tarsus. Tarsus is made up of tarsal bones, metatarsal bones and phalanges. The talus is the second largest bone amongst all the tarsal bones. It rests over the superior aspect of calcaneus. Talus is a latin word means ankle bone. The shape of talus resembles the Tortoise. There are no muscular attachments to this bone. It participates in the formation of three joints i.e. talocrural (ankle) talocalcaneal (subtalar) and talocalcaneonavicular. Talus has got a head, neck and body. The head is directed forwards and medially. Plantar surface of the neck medially is narrow and called as sulcus tali. It opposes the sulcus calcanei of calcaneus to form sinus tarsi.

It forms joint between the foot and leg. Above, it articulates with the inferior surface of the lower part of the tibia and on sides by medial and lateral malleolus and forms the ankle joint. Below, it forms the subtalar joint with the calcaneum, and anteriorly it forms talonavicular joint with the navicular bone[1]. The talus forms the keystone of the medial longitudinal arch of the foot, which helps in the distribution and transmission of weight to the plantar arch[2]. The inferior surface of the head of the talus has three articular areas separated by ridges. Posterior articular area is largest and articulates with the middle facet on the sustentaculum tali of calcaneus. Medial facet articulates with spring ligament (plantarcalcaneonavicular) ligament. Anterolateral facet articulates with the anterior facet of calcaneus. Neck of the talus is a constriction between head and body

Talus forms an axis for the movement at the ankle joint[3].During locomotion, several different forces applied over the talus. Hence, the patterns of stress over the talus influence the morphometric dimensions and articular surface areas[4]. Hence, morphometric analysis of both sides of the talus is necessary to know the right–left symmetry and may help in prosthesis design and also help the surgeons to choose the appropriate size of the prosthesis for talus implantation surgeries[4].

MATERIAL METHODS:

This cross-sectional study was conducted on 100 talus bones in the department of anatomy Narayana Medical College, Chinthareddypalem, Nellore. Bones which are damaged and abnormal pathology were excluded from the study.

Articular facets on the inferior surface of the head of the talus were assessed and classified as done by Boyan et al[6]. Anterior and middle articular facets were observed n 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.[6]

Morphometric evaluation of talus was done with digital Vernier caliper with an accuracy of 0.01 mm. Following measurements were taken in the study by Sumati and Phatak[7] in Gujarati population in India[7,8].

Anteroposterior distance (talus length-TL) - was measured from the most anterior point to the most posterior point of the talus [7]. The maximum transverse width (talus width-TW) - was measured from the most medial point to the most lateral point of the body of the talus[7].

The vertical height of talus (talus height-TH) was measured from the most superior to the most inferior points of the talus body[7] [Figure 1 Singh A, Singh A. [20]]

The length of sulcus tali (STL) was measured from its medial margin to the lateral margin[6]. The width of sulcus tali (STW)was measured from anterior margin to posterior margin[6]. The width of sulcus tali (STW) was measured from the margin of the sulcus to its floor [6]. [Figure 2 Singh A, Singh A. [20]]

Head–neck length (HNL) was taken from the most anterior point of the head to the midpoint on the anterior margin of the trochlear surface [7]. [Figure 3 Singh A, Singh A [20]]

Statistical Analysis

The collected data were tabulated in Microsoft Excel worksheet, and analysis was performed using software SPSS. All data were expressed in mean, minimum, maximum values, and standard deviation. Student's t-test was applied to know the significant differences exist, if any, in between the right and left mean measurements, and $P < 0.05$ was taken as significant.

RESULTS

In the present study, out of 47 right side and 53 left sided talus bones Type A1 facet was found in 28.43% of the talus, in 28.43% of Type A2, in 0.98% of Type A3, in 14.71% of Type A4, in 4.90% of Type B, and Type C facet in 22.55% were found.

The mean length, width, and height of the talus were 54.18 ± 4.14 mm on the right side and 54.34 ± 3.97 mm on the left side, 38.80 ± 3.51 mm on the right side and 38.77 ± 2.86 mm on the left side, 29.25 ± 2.61 mm on the right side and29.89 ± 3.80 mm on the left side. The width, length, and depth of sulcus tali were 7.20 ± 2.10 mm on the right side and 7.34 ± 1.93 mm on the left side, 18.14 ± 3.20 mm on the right side and 18.51 ± 2.89 mm on the left side, 5.96 ± 1.32 mm on the right side and 6.94 ± 1.25 mm on the left side respectively. HNL of talus was 26.00 ± 2.41 mm on the right side and 25.25 ± 2.56 mm on the left side. (Figure 4 Table 1)

Type A1

Type A2

Type A3

Type A4

Type B

Type C

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

Fig 2 (a) length (b) breadth and (c) depth of talus

Table 1: Types Of Facets Present On The Inferior Surface Of The Head Of The Talus

Parameters (mm)	Number	Percentage (%)
Type A1	29	28.43%
Type A2	29	28.43%
Type A3	01	0.98%
Type A4	15	14.71%
Type B	05	4.90%
Type C	23	22.55%

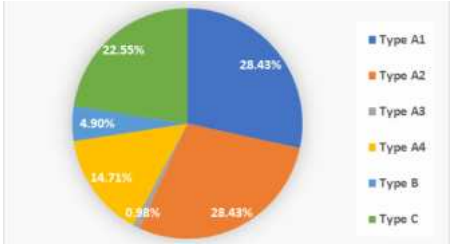

Table 2: Minimum, Maximum, And Mean Values Of Measured Parameters Of The Talus

Parameters (mm)	Minimum	Maximum	Mean ± SD
STD	3.00	10.00	6.47 ± 1.37
STL	12.00	25.00	18.33 ± 3.03
STW	4.00	14.00	7.28 ± 2.01
TH	20.00	40.00	29.58 ± 3.28
TL	45.00	64.00	54.27 ± 4.03
TW	31.00	46.00	38.78 ± 3.17
HNL	19.00	32.00	25.61 ± 2.50

Table 3: Minimum, Maximum, And Mean Values Of Various Morphometric Parameters Of Both The Sides Of The Talus And T-value And P Value (n=33)

Measured Parameters (mm)	Side						t-value	p-value
	Left (n=53)			Right (n=47)				
	Minimum	Maximum	Mean ± SD	Minimum	Maximum	Mean ± SD		
STD	5	10	6.94 ± 1.25	3	9	5.96 ± 1.32	-3.869	0.0002
STL	12	25	18.51 ± 2.89	12	25	18.14 ± 3.20	-0.609	0.544
STW	4	14	7.34 ± 1.93	4	14	7.20 ± 2.10	-0.339	0.735
TH	20	40	29.89 ± 3.80	23	35	29.25 ± 2.61	-0.987	0.326
TL	46	62	54.34 ± 3.97	45	64	54.18 ± 4.14	-0.194	0.846
TW	33	45	38.77 ± 2.86	31	46	38.80 ± 3.51	0.035	0.972
HNL	19	32	25.25 ± 2.56	21	31	26.00 ± 2.41	1.532	0.129

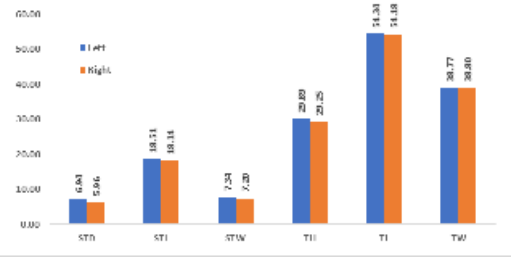

Figure 1: Comparison of mean values of various morphometric parameters between both the sides of the talus

DISCUSSION:

It is of utmost importance to know the anatomical features of talus bone as its anatomical features are of utmost importance in clinical aspects of talus like injuries, fractures and implants to prevent secondary pathologies and morbidity.

Type A1 facet was found in 28.43% of the talus, in 28.43% of Type A2, in 0.98% of Type A3, in 14.71% of Type A4, in 4.90% of Type B, and Type C facet in 22.55% were found in the present study. In a study by Singh A, Singh A. [20] in 51.5% of the talus, Type A1 facet was found; in 28.8% of talus, Type A2 facet was present; in 12.1% of cases, Type A3. facet was found; in 1.5% of talus, Type A4 facet was noted; and type B was found in 6.1%. Bilodi[9] reported Type A1 in 5%, Type A4 in 10%, Type B in 66.6%, and Type C in 18.4% of talus; Lee et al. [10] in the Korean population reported Type A1 facet in 9.2%, Type A4 in 30.3%, and Type B in 60.5% of the talus. Boyan et al. [6] in the Turkish population observed Type A2 facet in 1.7% and Type B in 98.3% of talus. In the present study, Type A1 facet was observed in a very high percentage, while other researchers reported Type B facet as more common in their studies[5,6,9-11]. (Table – 1)

In the present study length of the talus was 54.18 ± 4.14 mm on the right side and 54.34 ± 3.97 mm on left side. In the Singh A, Singh A.[20] study, the length of the right talus was 52.81 ± 4.67 mm and the left talus was 52.67 ± 4.17 mm. There was no significant difference in the length of talus of the right and left sides. Almost similar values were reported by Koshy et al.,[12] Lee et al.,[13] Boyan et al.,[6] Omar et al.,[13] Aparna et al., [15] and Gautham et al. [8] whereas Kavya et al. [18] (radiological study) and Otag[17] reported higher values for talar length.

In the present study the mean width was38.80 ± 3.51 mm on the right side and 38.77 ± 2.86 mm on the left side, total mean width was 38.78 ± 3.17 mm. the values are higher compared to Singh A, Singh A. [20] the mean width of the right talus was 31.19 ± 2.79 mm and of left side width was 31.7 ± 2.7 mm, and the total mean width was 31.45 ± 2.74 mm. Kavya et al.,[16] reported that the mean width of the talus of the right side was 30.83 ± 4.08 mm and on the left side was 30.99 ± 4.23 mm (in the radiological study), which is less compared to the present study.

In the present study the mean height of the talus was, 29.25 ± 2.61 mm on the right side and29.89 ± 3.80 mm on the left side. In the study by Singh a, Singh a. [20] the mean height of the talus on the right side was 26.15 ± 2.81 mm, and of the left side, it was 25.72 ± 2.47 mm. we had higher values similar to that of Kavya et al., [16] Otag,[17] Omar et al., [14] and Aparna et al.[15]

In the present study, the width, length, and depth of sulcus tali were 7.20 ± 2.10 mm on the right side and 7.34 ± 1.93 mm on the left side, 18.14 ± 3.20 mm on the right side and 18.51 ± 2.89 mm on the left side, 5.96 ± 1.32 mm on the right side and 6.94 ± 1.25 mm on the left side respectively. In the study of Archana Singh et. al. the parameters were 5.9 ± 1.02 mm, the length of sulcus tali was 21.88 ± 3.07 mm, and the mean depth of sulcus tali was 5.52 ± 1.25 mm width and depth of sulcus tali are more compared to length which is less compared to Singh A, Singh A.[20]

In the present study, HNL of talus was 26.00 ± 2.41 mm on the right side and 25.25 ± 2.56 mm on the left side. Our values are higher compared to that of Singh A, Singh A [20] which are 15.72 ± 2.73 mm. our values are also higher compared to Bidmos and Dayal et al. [18] in south African talus, Sakaue [19] in Japanese, Lee et al. [13] in Korean, and Sumati and Phatak [7]

CONCLUSION

In the present study, the incidence of Type A articular facets present on the inferior surface of the head of the talus was more, and there was Type B and also Type C articular facet observed, but other authors reported Type B facet with a higher incidence. This usually is due to racial, genetic, climatic, environmental, and nutritional differences. In morphometry of talus, there were no significant differences found between the parameters of both the right and left sides. These measurements will help the orthopaedic surgeons to determine the use of prosthetics and implants in the injuries and fractures of talus bone.

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