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# A Morphometric Study of Various Dimensions of the Articular Facets of Talus and their Clinical Implications – An institutional Study.

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**Abstract**

**Background :** The skeleton of the foot has seven bones, and the talus is one of the largest tarsal bones after calcaneum. It looks like a tortoise. It has three parts: head, neck, and body. It forms joint between the foot and leg. 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. **Material and Methods:** Morphometric analysis of talus included measurement of length; breadth and height of individual bone were measured. Anatomical measurements were done using vernier calliper after making necessary digital correction. 24 tali were of right side and 26 were from left side after consulting with anatomists in the same department . **Results:** On superior articular surface, mean values of medial, central and lateral length were 3.1cm, 3.0cm, 2.9cm on right side and 3.0cm, 2.9cm, 3.0cm on left side. Mean of anterior, central and posterior widths were 2.8cm, 2.7cm, 2.6cm on right side and 2.9cm, 2.7cm, 2.7cm on left side. Lateral articular surface**Conclusions:** The morphometric parameters will be a useful tool for reconstruction surgeries of hind –foot deformities and foot rehabilitation procedures. The measurements of opposite talus bone can be used as a control during talus bone replacement surgery.

Keywords: - articular facet, talus , morphometry, rehabilitation, bone replacement.

## Introduction

Talus is a Latin word meaning “ankle bone”. The skeleton of the foot has seven bones, and the talus is the second largest tarsal bones after calcaneum. There is no muscular attachment to this bone. It participates in the formation of three joints i.e. talocrural (ankle), talocalcaneal (subtalar) and talocalcaneonavicular. It has three parts: head, neck, and body[1]. Head is directed forwards, downward and medially and has two surfaces – anterior and inferior. Anterior surface is oval and convex to articulate with the concavity of navicular bone. Inferior surface has 3 articular areas separated by ridges[2] –

a) Posterior articular area is the largest and articulates with the middle facet of calcaneus. b) Medial facet articulates with the spring (plantar calcaneonavicular) ligament. c) Anterolateral facet articulates with the anterior facet of calcaneus. Neck is the constriction between head and body. Its long axis forms an angle of 150̊ with the long axis of the body.[3] Distal part of its dorsal surface provides attachment to dorsal talonavicular ligament and capsular ligament of ankle joint. Proximal part of dorsal surface is intracapsular. Laterally, there is attachment of anterior talofibular ligament. Plantar surface medially, is narrow known as sulcus tali and opposes the sulcus calcanei of calcaneus to form sinus tarsi.[4] Plantar surface of neck provides attachment to two ligaments, interosseous talo-calcanean(medially) and cervical(laterally). Body has five surfaces (superior, inferior, medial, lateral and posterior). Superior surface bears trochlear articular surface which is convex from anterior to posterior and concave from side to side.[5] The articular surface is broader anteriorly and narrower posteriorly and participates in the formation of ankle joint. Inferior surface is entirely articular and is oval and concave in appearance. It articulates with the posterior facet of calcaneus to form subtalar joint. Medial surface is articular above and non-articular below.[6] Its articular area is comma shaped to

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articulate with medial malleolus. Deep part of deltoid ligament is attached to the non-articular part. Lateral surface shows a triangular articular area which articulates with lateral malleolus. Its anterior border gives attachment to anterior talofibular ligament and lower end forms the apex of the triangle also called the lateral process of talus.[7] Posterior surface also called posterior process of talus. Tendon of flexor hallucis longus grooves the posterior surface and is bounded by the medial and lateral tubercles. Deltoid ligament's superficial fibers are attached to the medial tubercle while as posterior talofibular ligament is attached to lateral tubercle. Os trigonium is the name given to the lateral tubercle when it is separate bone. Os trigonium is one of the examples of atavistic epiphysis.[8] Morphometric analysis entails measuring the length, width, height, and angles of the articular facets to gather data on their variability, symmetry, and congruence. It typically involves using callipers, goniometers, and digital techniques such as 3D scanning and reconstruction.

**Aims and Objectives**

The 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 and also facilitate orthopedicians in planning surgeries for subtalar implants and foot prostheses.

**Material and methods**

The study was conducted in the Department of Anatomy, Government Medical College, Srinagar from November 2023 to January 2024 on 50 dry adult human talus. Morphometric analysis of talus included measurement of length; breadth and height of individual bone were measured. Anatomical measurements were done using vernier calliper after making necessary digital correction. 24 tali were of right side and 26 were from left side after consulting with anatomists in the same department .Also mean, standard deviation were calculated. Following parameters were taken:

1.Medial(ml), Central(cl) and Lateral length(ll) on Trochlear surface

2.Anterior(aw), Central(cw) and Posterior width(pw) on Trochlear surface

3.Average central height(ch) and width(cw) on Lateral articular surface

4.Average central height(h) and width(w) on Medial articular surface

**Inclusion criteria** un-fractured bones having all surfaces and facets intact were included.

**Exclusion criteria:** fractured and bones with deformity were excluded .

**Result**

On superior articular surface, mean values of medial, central and lateral length were 3.1cm, 3.0cm, 2.9cm on right side and 3.0cm, 2.9cm, 3.0cm on left side. Mean of anterior, central and posterior widths were 2.8cm, 2.7cm, 2.6cm on right side and 2.9cm, 2.7cm, 2.7cm on left side. Lateral articular surface: Mean of central height on the lateral articular surface was 2.7cm on the right side and 2.5cm on the left side. Mean of central width on the lateral articular surface was 2.6cm on the right side and 2.4cm on the left side (Table 2) (Fig 1c). Medial articular surface: Mean of central height on the medial articular surface was 1.5cm on the right side and 1.6cm on the left side. Mean of central width on the medial articular surface was 2.6cm on the right side and 2.3cm on the left side (Table 2) (Fig 1d).

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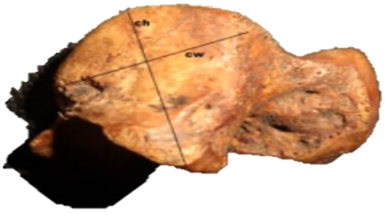
**Superior articular surface**
**fig. 1(a)**


**Superior articular surface**
**fig. 1(b)**




Triangular facet on lateral surface Fig. 1(c)


Triangular facet on medial surface
fig. 1(d)

| Parameters | Left side | Right side |
|---|---|---|
| Trochlear surface | mean±S.D(cm) | mean±S.D(cm) |
| Medial length(ml) | 3.0±0.15 | 3.1±0.13 |
| central length(cl) | 2.9±0.17 | 3.0±0.16 |
| Lateral length(ll) | 3.0±0.13 | 2.9±0.16 |
| Anterior width(aw) | 2.9±0.22 | 2.8±0.20 |
| Central width(cw) | 2.7±0.2 | 2.7±0.23 |
| Posterior width(pw) | 2.7±0.2 | 2.6±0.18 |

Table 1. shows the measurements on trochlear surface of talus

| Parameters | | Left Side(26) | Right Side(24) |
|---|---|---|---|
| Lateral Articular Surface | | Mean±S.D(cm) | Mean±S.D(cm) |
| | Central height(ch) | 2.7±0.2 | 2.7±0.2 |

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| | | | |
|---|---|---|---|
| | **Central height(cw)** | **2.4±0.1** | **2.6±0.1** |
| **Medial Articular** | **Central height(ch)** | **1.6±0.1** | **1.5±0.2** |
| | **Central(cw)** | **2.3±0.17** | **2.6±0.17** |

Table2: Showing the measurements on Lateral and Medial Articular surface of talus

**Discussion**

The talus sits above the heel bone (calcaneus) and below the tibia and fibula, the bones of the lower leg. It is uniquely shaped, having a dome that articulates with the ankle and a broader, body part that connects to the calcaneus. The complexity of the talus lies in its multiple articulations and lack of muscular attachments, receiving its blood supply passively through diffusion from surrounding tissues, which makes healing challenging. An intricate balance of stability and flexibility provided by this bone is essential for walking, running, and most weight-bearing activities.

The present study shows measurement of trochlear articular surface is wider in front. The measurements taken on the superior articular surface of the body of Talus were compared between right and left tali were found almost similar. The parameters are comparable with the study done by Goda Jatin B except for central width of lateral articular surface[9]. Gautham K found in his study the mean maximum transverse width on the body of Talus was 37.94mm on the right side and 36.80mm on the left side which was higher compared to present study. Mean Trochlear length was 30.62mm on right side and 30.44mm on the left side[10]. Ilhan Otag found that mean values of trochlear length and talar width were 33.45mm and 40.79mm on right side and 34.12mm and 43.39mm on left side respectively and these values were observed to be higher than the findings of the presentstudy[11]. The measurements done by Berjina Farooq were similar to the present study except for central width of medial and lateral articular surface[12].The findings of the present study are similar to the studydone by Veenatai J and Janaki V.[13].In the study done by Shishirkumar in South Indian population, the medial length, central length and lateral length of talus was found to be more as compared to the present study. The anterior, central and posterior widths calculated in this study were similar to the present study.[14].The measurements of anterior and posterior widths done by Roshi Daud et al., in European population were on higher side as compared to the present study.[15].Also, the anterior, central and posterior widths measured by Andrea Hayer et al., in American population was also on higher side.16.The difference in the mean values compared to previous studies may be due to climate, nutrition genetic and environmental factors in the inherent population.

**Conclusion:** -

The morphometric study of the talus bone's articular facets yields comprehension vital for various applications, from anthropological insights to clinical implications. Such knowledge enhances the precision of surgical interventions and the overall comprehension of ankle joint biomechanics. Potential variations across populations signify the need for customized approaches in treatment and prosthesis manufacturing. Continued research is encouraged for better clinical outcomes and advancements in orthopaedic medicine.

**Clinical importance:**

Indications for Talus Bone Replacement Surgery: - A talus replacement's primary indications are severe trauma, such as from a car accident, avascular necrosis (loss of blood supply leading to bone

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death), and debilitating arthritis. When traditional treatments like immobilization, bone grafts, or arthrodesis (joint fusion) fail or are deemed unsuitable, a total talus replacement may be considered.

Surgical Procedure**:** -The surgery involves removing the damaged talus and replacing it with an artificial implant. A thorough understanding of ankle anatomy is vital when performing the procedure, as surgeons must navigate complex joints, ligaments, tendons, and nerves. Maintaining muscular and ligamentous structures' integrity surrounding the talus is essential for postoperative stability and function.

Role of Anatomy in Prosthesis Design**:** -Anatomical accuracy is paramount in the design of talus prostheses. The artificial component must be tailored to mirror the patient's skeletal structure for optimal fit and function. This is usually achieved with the aid of CT or MRI scans and high-precision CAD (Computer-Aided Design). Advances such as 3D printing now allow for the creation of patient-specific implants that match the exact shape and size of the individual's talus.

Recovery and Rehabilitation: -Post-surgery, a clear comprehension of anatomy influences rehabilitation strategies. The goal is to preserve the range of motion and re-establish strength without overstressing the new joint. Physical therapists employ techniques suited to the unique architecture of the ankle, promoting healing and function.

**Limitations:** The talus bone count was the only limitation in this case. More precise results would have been obtained if there had been a greater number of bones.

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