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## Original Research Article

## The morphometric analysis of calcaneus and its articular facets

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## ABSTRACT

**Background:** Calcaneus being the key bone of the longitudinal arch forms the posterior pillar. It is responsible for receiving the body weight and transmitting it to the plantar arch below.

**Materials and Methods:** The aim of the present study is to see the variations in articular facets and dimensions of calcaneus. Ninety-eight dry calcaneus were procured from department of Anatomy, Medciti Institute of Medical Sciences, Hyderabad. All the bones were of unknown gender that are housed in the collection at department of Anatomy grossly normal without any physical damage.

**Results:** Among the ninety-eight dry calcaneus, type-B articular facets were seen mostly. Morphometric measurements of calcaneus were similar to that of other studies. Mild variations that were observed might be due to racial or different points taken as reference for measurements.

**Conclusion:** Analysis of morphometric parameters plays key role in reconstruction surgeries and foot rehabilitation procedures.

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## 1. Introduction

Calcaneus is the largest tarsal bone situated below the talus and extends behind the talus. Directed forward and laterally with upward inclination.<sup>1,2</sup> Among the seven tarsal bones calcaneus is the weight bearing tarsal bone present in proximal row. In the longitudinal arches of foot calcaneus forms the posterior pillar of foot.<sup>3</sup> The articular facets of calcaneus take part in movements of ankle and foot, so morphology and morphometric studies plays a vital role.<sup>4</sup> Normally dorsal surface bears three facets, anterior, middle and posterior which articulate with corresponding facets of talus. The anterior and the posterior facets are situated on the body and middle facet lies on the upper surface of sustentaculum tali.<sup>3</sup> The middle facet is separated from the posterior facet by a deep groove called sulcus

calcanei. In articulated foot the sulcus calcanei come in contact with similar groove on talus to form sinus tarsi.<sup>5,6</sup> Talocalcaneonavicular joint is part of anterior and middle facet which reported different variations.<sup>7</sup> Calcaneus forms triplanar, uniaxial joint with the talus the two similarly articulated facets of the anterior talocalcaneal joint on the inferior aspect of the talus are convex, and on the superior aspect of the calcaneus are concave, while the facets for articulation of the posterior talocalcaneal joint on the inferior aspect of the talus are concave, and on the superior aspect of the calcaneus are convex. This articulation is helpful for most inversion and eversion movements of foot.<sup>8</sup>

Classification given by Bunning & Barnett (1965)<sup>9</sup> was followed in the present study. Accordingly, three types type-A, B and C. In Type-A consist of anterior and middle articular facets due to their extent of separation were again divided into four subtypes: A1 - distance between articular facets is less than 2mm, A2- distance between facets 2-

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5mm, A3- distance between facets more than 5mm. A4-only one articular facet is seen. In type B – no separation between anterior and middle articular facets. Based on separation type B divided into two types. B1-seperation incomplete, B2-no separation between facets. In type –C only one facet. Rarely, all three facets on the upper surface of the calcaneus fuse into a single irregular area.<sup>6</sup> The main aim of present study is to know the incidences of variations in calcaneus articular facets and dimensions of calcaneus.

**2. Materials and Methods**

Ninety-eight dry calcaneus were procured from department of Anatomy Mediciti Medical college, Hyderabad. All the bones were of unknown gender that are housed in the collection at department of Anatomy grossly normal without any physical damage. Types of articular facets on calcaneus were assessed by following the classification based on Bunning & Barnett (1963). To know the dimensions of calcaneus bone Vernier callipers was used and parameters were recorded: antero-posterior length- it is the distance between the most anterior point on anterior surface and most posterior point on posterior surface, transverse width- the distance between most medial point on the medial surface and most lateral point on the lateral surface, while the width of the sulcus calcanei was taken as the distance between medial and lateral margins of the sulcus, while the length of the sulcus calcanei was taken as the distance between anterior and posterior margins of the sulcus.

**2.1. Statistical analysis**

The data was analysed in M.S office and measured as mean and standard deviation.

**3. Results**

Using the above classification, the following types of articular facet were observed on calcanei: A1- 2.04%, A2- 7.14%, A3- 8.06%; A4- 2.04%. B1- 27.55%, B2- 53.06% and C -1.02% respectively (Table 1). The most common type of articular facet on calcanei was type B (Figure 1).

The anteroposterior length and transverse width of calcanei were: 76.01± 5.74 mm 45.94 ±4.35 mm respectively. The width and length sulcus calcanei were: 5.63+/- 1.01 mm, 32.81+/-3.78 mm respectively (Table 2, Figure 2).

**4. Discussion**

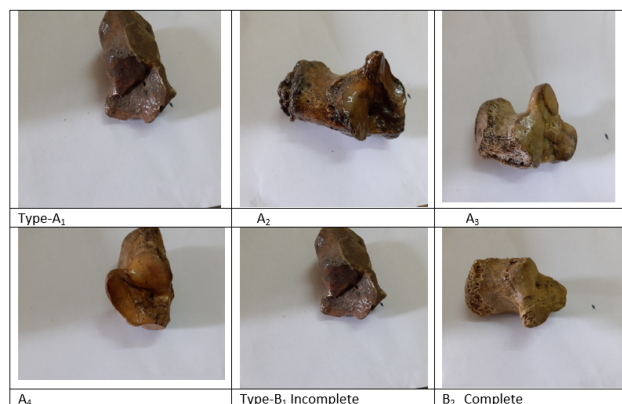
In current study majority of articular facets of calcaneus were type B (B1- 27.55%; B2-53.06%), with the remainder being type A (A1- 2.04%; A2- 7.14%; A3- 8.6%; A4-2.04%) which are inline with earlier studies Sarvaiya et al. (2012)- type B- 68.8%, type A-30.8% and Kullar et, al. (2015)-type B -72.5% and type A-27%.<sup>10,11</sup> The gradual

**Table 1:** Number and % of articular facets of calcaneus

Types of articular facets	Number of bones	%
Type –A1 (less than 2mm)	2	2.04
A2 ( 2-5mm)	7	7.14
A3 (> 5mm)	8	8.06
A4 (only one facet)	2	2.04
B1(incomplete separation)	27	27.55
B2(no separation)	52	53.06
C (single facet)	0	-

**Table 2:** Mean and Std of distance measured on calcaneus

Parameters (mm)	Mean±std
Anteroposterior length	76.01±5.74
Transverse diameter	45.94 ±4.35
Sulcus calcanei length	32.81±3.78
Sulcus calcanei width	5.63±1.01

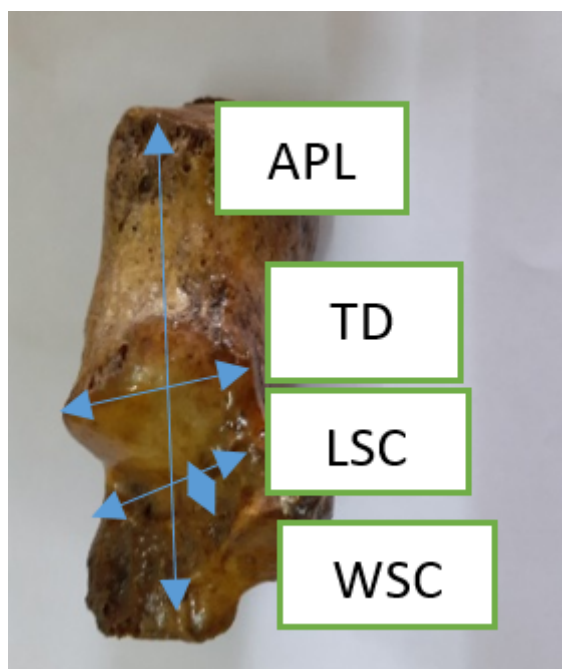


**Fig. 1:** Types of articular facets

evolution of calcaneus is also the reason for variation pattern in articular facets which is responsible for static and dynamic balance of foot.<sup>12</sup>

Morphometric measurements of calcaneus according to Uygur et, al. (2009) were anteroposterior length and transverse width of calcanei were: 77.7±5.65 mm 47.5±4.2 mm respectively. The width and length sulcus calcanei were: 6.15±2.7 mm, 30.4±3.1 mm respectively, these findings are inline with the current study were anteroposterior length and transverse width of calcanei were: 76.01±5.74 mm 45.94±4.35 mm respectively. The width and length sulcus calcanei were: 5.63±1.01 mm, 32.81+/-3.78 mm respectively.<sup>13</sup>

However, width of sulcus calcanei differed from Koshy et.al (2002)- 21.1±2.4 mm, present study it is 5.63±1.01mm. Further width and length of sulcus calcanei also differed from observations of sarvaiya et.al (2012) were width and length sulcus calcanei were: 15.25±1.94 mm, 10.44±1.66 mm respectively. These variations might be due to different reference points taken for measurements and



**Fig. 2:** Morphometric measurements

racial difference.

Calcaneal facets which articulate with talus according to anatomy texts are anterior, middle and posterior. Though anterior and posterior facets are considered separate, middle facet is the extension of anterior facet. Calcaneal fractures are more common among the tarsal bones. Disorders of foot include talocalcaneal arthritis, intra-articular fractures, congenital dysmorphism, flat foot, valgus deformities, while doing surgical procedures the relationship between talus and calcaneus, shape and size should be known.<sup>1</sup> Both racial and individual difference is observed, it appears to be no detailed understanding concerning these differences.<sup>6</sup> Detailed information regarding anatomy helps in treatment procedures, interpret pathogenesis, development in subtalar implants, foot prostheses.<sup>13</sup>

## 5. Conclusion

The most common type of facets on talus are type- B. Although this finding are similar with many previous reports, variations exist in some. Analysis of morphometric parameters plays key role in reconstruction surgeries and foot rehabilitation procedures.

## 6. Conflicts of Interest

Nil.

## 7. Source of Funding

Nil.

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