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Original Research Article

# MORPHOMETRICAL STUDY OF CUBOIDAL ARTICULAR FACET OF THE HUMAN CALCANEUS BONE AND ITS CLINICAL IMPLICATIONS

**Archana Rao K [1], Jyothi K C *[2], Shailaja Shetty [3].**

[1] Intern, M S Ramaiah Medical College, Bangalore, Karnataka, India.

[*2] Assistant Professor, Department of anatomy, M S Ramaiah Medical College, Bangalore, Karnataka, India.

[3] Professor and Head, Department of anatomy, M S Ramaiah Medical College, Bangalore, Karnataka, India.

## ABSTRACT

**Background:** The calcaneus is a weight bearing tarsal bone of the proximal row. Calcaneum has on its upper surface an articular facet for the talus and anterior end presents an articular facet for cuboid bone. Modification on cuboidal articular facet of calcaneum is evolutionary and is important aspect of human bipedal gait.

**Objectives:** To study the morphometric measurements of cuboidal articular facets of calcaneus and classify the facets in to various categories and observe and note for variations.

**Material and Methods:** Present sudy carried out with a 53 dry adult human calcanei, 32 bones of right side and 21 of left side of unknown sex from Department of Anatomy, M S Ramaiah Medical College were used for the study.

**Results**: The cuboidal articular facet on calcaneus was grouped in to four types based on their shape. Wedge as type 1, transversely oval as type 2, irregular as type 3, vertically oval as type 4. Type 1 was the commonest with 54.7%, least was type 4 with 5.4%.

**Conclusion:** A good knowledge of the joint surfaces and measurements would assist better treatment and management options for the calcaneal fractures and for further research efforts.

**KEY WORDS:** Calcaneus, Articular Facet, Cuboid.

**Address for Correspondence:** Dr Jyothi KC, Assistant Professor, Department of Anatomy, M. S. Ramaiah Medical College, MSRIT Post, Bangalore. 560054, Karnataka, India.
Mobile: +919731346464 **E-Mail:** jyothimohankc@gmail.com

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## INTRODUCTION

The calcaneus is the longest, strongest, and largest of all the tarsal bones It is present below and behind the talus forming support to the ankle joint [1]. Calcaneus has on its upper surface an articular facet for the talus. The posterior end is roughened in the lower part for the attachment of tendocalcaneus. The anterior end presents an articular facet for cuboid bone [2]. Calcaneus is designed to withstand the daily stresses of weight bearing The calcaneus is the commonly fractured tarsal bone accounting to about 2% of all fractures and about 70-75% of it are intraarticular. A sound knowledge of anatomy of calcaneus is important in determining the pattern of injury and treatment options [3]. Using certain parameters like degree of separation, fusion and shape, different types of

talar articular facets of calcaneus are described [4]. There are many studies on talar articular facet of human calcaneus, which has showed wide variations in the facet which is due to evolutionary forces as they play a key role in the static and dynamic balance of the foot [5]. The present study was a sincere effort to find the different patterns of cuboidal articular facet on calcaneus bones available in the department as there are very scanty studies reported. The morphology of the articular facets of the calcaneus has been a subject of interest to anatomists hoping to help the Orthopaedic surgeons in diagnosis and treatment of deformities and injuries in the region of foot.

## MATERIALS AND METHODS

53 dry adult human calcanei, 32 bones of right side and 21 of left side of unknown sex from Department of Anatomy, M S Ramaiah Medical College were used for the study. The side of the bones was determined. The outline of cuboidal articular surfaces was marked and the bones were numbered. The greatest vertical and transverse diameters were measured using digital vernier calipers. The calcanei were grouped and classified based on the shape of the cuboidal articular surface, akin to the talar facets. Other accessory features like extra projections; grooves etc. were also observed and noted.

## OBSERVATIONS AND RESULTS

The articular facets were classified into 4 types as follows:

- wedge shaped – Type 1
- transversely oval – Type 2
- Irregular – Type 3
- Vertically oval – Type 4

**Table 1:** Frequency and percentage of different types of facets.

| Types | Frequency | Percentage |
|---|---|---|
| Type 1 (wedge) | 29 | 54.7 |
| Type 2 (transversely oval) | 8 | 15.1 |
| Type 3 (irregular) | 13 | 24.5 |
| Type 4 (vertically Oval) | 3 | 5.7 |
| Total | 53 | 100 |

Type 1 was the most common type which was found. The statistical analysis of measurements on Type 1 facet is shown in Table 2.

**Table 2:** Vertical and Transverse diameters in type 1 facets.

| Type 1 | Minimum Diameter | Maximum Diameter | Range | Mean | Standard Deviation |
|---|---|---|---|---|---|
| Vertical Diameter | 16.6 | 28.4 | 11.8 | 21.98 | 2.97 |
| Horizontal Diameter | 15.03 | 29.26 | 14.23 | 22.61 | 3.32 |

Percentage incidence of different types among right and left side calcanei was tabulated in Table 3.

**Table 3:** Percentage incidence of different types among Right and Left bones.

| Types | Right n (%) | Left n (%) | Total n (%) |
|---|---|---|---|
| Type 1 (wedge) | 15 (51.7) | 14 (48.3) | 29 (100) |
| Type 2 ( transversely oval) | 6 (75) | 2 (25) | 8 (100) |
| Type 3 (Irregular) | 8 (61.5) | 5 (38.5) | 13 (100) |
| Type 4 (vertically oval) | 3 (100) | 0 (0) | 3 (100) |
| Total | 32 (60.4) | 21 (39.6) | 53 (100) |

There was extra projections of the articular surface noted in 18( 34.0%) calcanei.

**Fig. 1:** Showing the different types of Cuboidal articular facets.

a-Type 1(wedge), b- Type 2(transversely oval), c- Type 3 (Irregular), d- Type 4(vertically oval)

## DISCUSSION

Ajay Kumar and others studied the sex differences in 100 (50 male and 50 female) adult

human calcaneus collected from dead bodies in Indian population using discriminant function analysis which will be useful in future for sex determination when an calcaneum bone of unknown sex is found which will help in forensic science in the field of crime [6]. Factors like wearing shoes, squatting habits, genetic and racial differences are the most probable reasons for the variations in the facets on the calcanei in Indians and western series [7].

Finn Bojsen-Moller in 1979 studied the calcaneocuboid joint in ligamentous specimens of 10 human feet, and in skeletons of 2 gorillas, 6 chimpanzees, 3 orangutans and 25 human feet and described the biomechanics involved in movement of foot at calcaneocuboid joint in man [8].

The biometric information about calcaneum, cuboid bone and of calcaneocuboid joint is not given precisely in anatomy text books. 50 calcanei, 30 cuboid dry bones, and anatomical specimens of 21 transverse tarsal joints were studied in 2013. They found several morphological types, which were not identified previously. Calcaneal morphology will explain the results of osteotomy done for the treatment of adult flatfoot [9].

Grover S et al. had conducted morphometric analysis of 25 pairs of human calcanei. They measured the length, breadth and surface area of articular facets and concluded as left sided dominance with highly significant p- value [10].

34 dry human calcanei were studied for morphometry of talar and cuboidal articular facets and to evaluate the incidence of enthesophytes. Type I was the most frequently found pattern of talar articular facet with highest incidence of enthesophytes in this pattern. They have stated that this pattern of articular facet is more prone for subtalar arthritis. Surface area of cuboidal articular facet was more on right sided calcaneum than the left [11]. Fractures of calcaneum with the involvement of calcaneocuboid joint are always associated with severe trauma and worse outcome; hence calcaneocuboid joint should be given more importance during surgery and in future research [12].

## CONCLUSION

There are very few studies conducted on morphometry of cuboidal articular facet of calcaneum. In our study we categorized the facets in to four types based on the shape. Type 1 was the commonest type. Detailed anatomical information will be baseline for advanced treatment procedures. The present data will be very useful for the orthopaedic surgeons for performing corrective surgeries for congenital talipes equinovarus and in ankle reconstruction surgeries. The morphology of calcaneus will explain the results of osteotomy procedure done for the treatment of adult flatfoot. A good knowledge of the joint surfaces and measurements would assist better treatment and management options for the calcaneal fractures and for further research efforts.

**Conflicts of Interests: None**

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