

A Study of Morphology and Morphometry of Talar Articular Facets of Calcaneum

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Abstract

Background: The weight distribution, locomotion as well as subtalar joint functions depend on the calcaneum. It has superior talar facets that are highly anatomically varied and this affects subtalar stability, with clinical and surgical implications. The objective is to examine the morphology, patterns of facets, distribution of spur and morphometry of the talar facets in the dry calcanei of the Rajasthan region and compare the results with that of earlier works. **Material and Methods:** The facet configuration (Type A/B), Patterns I 5 V, B-subtypes, distribution of spur, and morphometry of 55 adult dry calcanei were measured using a digital verniercaliper (0.01 cm accurate). An analysis of data was done through descriptive statistics. **Results:** The type B morphology was the most dominant (56.4%), followed by B1 subtype that has the highest prevalence (77.4%). Pattern I was the frequentest facet pattern (52.7%). The most common (87.5%), were the plantar spurs. Mean calcaneal length was 7.37 ± 0.42 cm. **Conclusion:** Type B and Pattern I morphology are predominant and include the same pattern as observed consistently in India, and this is very different to that of the Europeans. The importance of these population-specific changes is related to the radiological interpretation and orthopaedic planning.

Keywords: Calcaneum, Talar Facets, Calcaneal Spur, key words.

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INTRODUCTION

The calcaneum is the largest and strongest of the tarsal bones and forms the posterior pillar of the foot. It plays a fundamental role in transmitting body weight from the talus to the ground during standing and locomotion.^[1] Structurally robust and strategically positioned, the calcaneum contributes significantly to posture, balance, and propulsion during gait. Its superior surface articulates with the talus through three distinct articular facets anterior, middle, and posterior which together constitute the subtalar (talocalcaneal) joint.^[2] This joint is biomechanically crucial, as it permits inversion and eversion movements of the foot, enabling adaptability to uneven surfaces and efficient shock absorption during walking and running.^[3] Considerable anatomical variation exists in the morphology of the talar articular facets of the calcaneum. These variations influence the configuration and stability of the subtalar joint. Bunning and Barnett classified the calcaneal facets into three major types: Type A, characterized by three separate anterior, middle, and posterior facets; Type B, where the anterior and middle facets are fused; and Type C, showing complete fusion of all three facets. Subsequent investigators further refined this classification into five morphological patterns (I–V) to better represent the entire spectrum of fusion and separation observed in different populations. These morphological differences may affect joint congruity, subtalar biomechanics, and susceptibility to degenerative changes.^[4,5]

Population-based studies have demonstrated significant

regional and ethnic variation in facet morphology. Research from various parts of India has consistently reported Type B and Pattern I as the most common configurations, suggesting a predominance of partial fusion of anterior and middle facets in the Indian population.^[6-8] In contrast, studies from European populations have documented a higher frequency of Type A, where all three facets remain separate. Such differences highlight the influence of genetic, developmental, and environmental factors on calcaneal morphology.^[9] In addition to facet configuration, calcaneal morphometric parameters such as maximum horizontal length, height, width, and interfacet distance also exhibit population-specific variation. These parameters are clinically relevant, as they influence subtalar load transmission and the biomechanics of the hindfoot.^[10] Variations in calcaneal structure may alter stress distribution patterns and predispose individuals to conditions such as osteoarthritis, flatfoot deformity, or chronic heel pain. The presence of calcaneal spurs, either plantar or dorsal, represents another morphological variation often

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associated with repetitive mechanical traction forces and altered foot mechanics.^[11]

A detailed understanding of calcaneal morphology and morphometry is essential for orthopaedic surgeons, radiologists, and anatomists. Knowledge of these variation aids in accurate interpretation of imaging, planning of fracture fixation, subtalar arthrodesis, corrective osteotomies, and reconstructive foot surgeries. Given the limited data, the present study aims to evaluate the morphological patterns and morphometric parameters of talar facets of the calcaneum in this region and to compare the findings with previously published literature.

MATERIALS AND METHODS

This descriptive osteological study was conducted in the Department of Anatomy, SMS Medical College, Jaipur, using 55 dry adult human calcanei obtained from the departmental bone repository. Only fully ossified adult calcanei were included in the study. Bones that were intact, well preserved, and free from any visible deformity were selected for analysis. Calcanei showing evidence of fracture, erosion, gross deformity, pathological changes, osteophyte distortion affecting facet margins, or damaged articular surfaces were excluded from the study to ensure accuracy of morphological classification and morphometric measurements.

Each calcaneum was carefully examined for the configuration of the talar articular facets present on its superior surface. Based on classical criteria, the bones were initially classified into Type A (three separate anterior, middle, and posterior facets) or Type B (fusion of anterior and middle facets). Type B calcanei were further

subclassified into B1, B2, B3, and B4 subtypes according to the morphological characteristics and extent of fusion between the anterior and middle facets.

In addition, facet morphology was documented according to the expanded five-pattern classification (Patterns I–V) to capture the full range of variations in separation and fusion of the articular facets. The presence and distribution of calcaneal spurs were also recorded and categorized as plantar spur, dorsal spur, both plantar and dorsal spurs, or absent.

Morphometric assessment was performed using a digital vernier caliper with an accuracy of 0.01 cm to ensure precision. The maximum horizontal length of each calcaneum was measured from the most anterior point on the calcaneal tuberosity to the most posterior point of the bone. In Type A calcanei, where anterior and middle facets were separate, the interfacet distance between these two facets was measured as the shortest distance between their adjacent margins. All measurements were taken carefully to avoid parallax error and were recorded in centimeters.

The collected data were tabulated and analyzed using descriptive statistical methods. Frequencies and percentages were calculated for different morphological types, patterns, B subtypes, and spur distribution. Morphometric parameters were expressed as mean values with corresponding descriptive measures. The findings were subsequently compared with previously published studies to identify regional variations in calcaneal morphology and morphometry.

RESULTS

Among the 55 calcanei examined, Type B morphology was more frequent (56.4%) than Type A (43.6%). Within Type B, the B1 subtype predominated (77.4%).

Table 1: Distribution of Calcaneum Types and Subtypes

Classification	Category	Frequency (n=55)	Percentage (%)
Type A / Type B	Type A	24	43.6%
	Type B	31	56.4%
Type B Subtypes	B1	24	77.4%
	B2	4	12.9%
	B3	2	6.5%
	B4	1	3.2%

Based on facet arrangement, Pattern I was the most common configuration (52.7%), followed by Pattern II (41.8%), whereas Patterns III and V were rare. Plantar spurs were the predominant spur type (87.5% among spurred bones), with dorsal spurs observed infrequently. The

horizontal calcaneal length ranged from 6.0–8.5 cm (mean 7.37 ± 0.42 cm), and in Type A calcanei, the anterior–middle interfacet distance was <0.6 cm in 54.2% of specimens.

Table 2: Patterns of Calcaneal Facets, Spur Distribution, and Morphometric Characteristics

Parameter Category	Variable	Frequency	Percentage (%)	Morphometric Value
Facet Patterns	Pattern I	29	52.7%	—
	Pattern II	23	41.8%	—
	Pattern III	2	3.6%	—
	Pattern V	1	1.8%	—
Spur Distribution	Plantar Spur	21	87.5%*	—
	Dorsal Spur	1	4.2%*	—
	Both Spurs	2	8.3%*	—
	No Spur	31	56.4%	—
Horizontal Length (cm)	6–7.5 cm	45	81.8%	—
	7.6–8.5 cm	10	18.2%	—
Morphometric Statistics	Mean	—	—	7.37 cm

	Median	—	—	7.5 cm
	SD	—	—	0.42 cm
	Minimum–Maximum	—	—	6 – 8.5 cm
Interfacet Distance (Type A)	< 0.6 cm	13	54.2%	—
	0.6 – 1.0 cm	11	45.8%	—

*Percentage calculated among spurred calcanei.



Fig.1: Right calcaneum showing Anterior, Middle & Posterior talar facets separate (Type A)
AF-Anterior facet, MF-Middle facet, PF-Posterior facet



Fig.2: Right calcaneum showing fused Anterior & Middle talar facets (Type B1)
AF-Anterior facet, MF-Middle facet, PF-Posterior facet

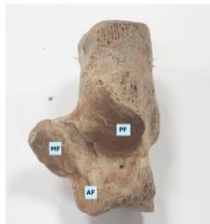


Fig.3: Left calcaneum showing fused Anterior & Middle talar facets with presence of notch between them. Posterior talar facet is separate (Type B2)
AF-Anterior facet, MF-Middle facet, PF-Posterior facet



Fig.4: Right calcaneum showing Middle & Posterior talar facets separate. Anterior talar facets absent (Type B3)
MF-Middle facet, PF-Posterior facet



Fig.5: Right calcaneum showing fused Middle & Posterior talar facets. Anterior is separate (Type B4)
AF-Anterior facet, MF-Middle facet, PF-Posterior facet



Fig.6: Right Calcaneum showing both dorsal and plantar Calcaneal spur.
DS- Dorsal Calcaneal Spur; PS- Plantar Calcaneal Spur

Figure 1: Type A calcaneum with separate anterior, middle and posterior facets. Fig 2: Type B1 showing complete fusion of anterior and middle facets. Figure 3: Type B2 with fused anterior–middle facets separated by a notch. Figure 4: Type B3 showing absence of anterior facet. Figure 5: Type B4 showing fusion of middle and posterior facets. Figure 6: Dorsal and plantar calcaneal spur.

DISCUSSION

The present study evaluated 55 dry adult calcanei and demonstrated that Type B morphology was more frequent (31; 56.4%) than Type A (24; 43.6%). This indicates a predominance of fusion between the anterior and middle talar facets in the studied population. Among the Type B calcanei (n = 31), the B1 subtype was the most common, observed in 24 specimens (77.4%), followed by B2 in 4 (12.9%), B3 in 2 (6.5%), and B4 in 1 (3.2%).

Pattern-wise analysis showed Pattern I in 29 specimens (52.7%) and Pattern II in 23 specimens (41.8%), while Patterns III and V were rare, seen in 2 (3.6%) and 1 (1.8%) specimens respectively. These findings suggest that either complete separation or partial fusion of the anterior and middle facets represents the usual anatomical presentation,

with other configurations occurring infrequently.

The predominance of Type B facets in the present study is comparable with observations made by Koh D et al,^[12] who reported significant morphometric differences in calcaneal dimensions between males and females in a Southeast Asian population. Their mean axial calcaneal length was 72.1 mm overall, with males demonstrating significantly larger measurements than females. This highlights the importance of population-specific morphometric data in surgical planning and implant selection.

Similarly, Boyan N et al,^[13] reported that Type B articular facets were most common in both tali and calcanei in the Anatolian population. The mean calcaneal length was 76.1 ± 5.44 mm on the left and 75.7 ± 6.76 mm on the right side. Their findings reinforce the global predominance of Type B morphology, consistent with the present results.

In an Indian study, Namburu BS et al,^[14] observed that Type 1 facets were most frequent in tali, followed by Type 2, while Type 3 was rare. They attributed variations in facet morphology to racial, genetic, environmental, and occupational factors. Likewise, Garg S et al,^[15] documented Type B as the most common articular facet type in the North Indian population, with calcaneal lengths of 70.61 mm (left) and 71.02 mm (right). These findings align with the predominance of Type B morphology observed in the present study.

Further supporting this pattern, Singh DV et al,^[16] found Type B facets to be the most frequent among 86 calcanei, with a mean anteroposterior length of 78.2 mm. Agarwal P et al,^[17] reported Pattern I in 69.5% of 138 calcanei, paralleling the predominance of Pattern I (52.7%) in the present series. Similarly, Jyotsna G et al,^[18] observed that Type B articular facets were most common among 98 dry calcanei, with morphometric values comparable to other Indian studies.

Outside India, Murerwa R et al,^[19] documented Type 1B as the most frequent configuration in Kenyan calcanei and emphasized that facet variations may influence subtalar biomechanics and predispose to osteoarthritic changes. Their findings further substantiate the widespread predominance of Type B morphology across diverse populations.

Morphometrically, the present study recorded a mean horizontal calcaneal length of 7.37 ± 0.42 cm (range 6–8.5 cm), which is comparable with measurements reported in other populations. The predominance of plantar spurs (21; 87.5% of spurred bones) also indicates the biomechanical impact of traction forces at the plantar fascia insertion. Overall, these findings underscore the clinical relevance of detailed anatomical knowledge of calcaneal morphology and morphometry in subtalar reconstruction, implant design, and foot rehabilitation procedures.

CONCLUSION

This study demonstrates that Type B and Pattern I talar facet

configurations predominate among calcanei in the Rajasthan population. Morphometric parameters and spur patterns correspond with national data. These results underline the importance of recognising population-specific anatomical variations for successful clinical assessment and surgical management of subtalar joint conditions.

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Conflicts of interest

There are no conflicts of interest.

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