



MORPHOMETRIC STUDY OF DRY HUMAN CALCANEI IN THE POPULATION OF GUJARAT

Dr. Setu Mehta	M.Sc. Medical Anatomy Part-2 Student, Medical College, Baroda
Dr. Abinaya W	1st Yr Anatomy Resident, Medical College, Baroda
Dr. Alka Anand Udainia	M.S Anatomy, Professor & Head, Medical College, Baroda
Dr. Kintukumar Vyas	M.S Anatomy, Associate Professor, Medical College, Baroda

ABSTRACT

The calcaneum is the largest tarsal bone and forms the posterior pillar of the foot's longitudinal arch, playing a vital role in weight transmission and locomotion. Morphometric evaluation of the calcaneum and its sulcus calcanei is essential for orthopaedic reconstruction, fracture management, prosthetic design, and forensic identification. This descriptive osteometric study was conducted on 105 dry adult human calcanei from the Gujarat population, including 51 right-sided and 54 left-sided bones. Only intact and non-pathological specimens were included. The maximum length and width of the calcaneum, along with the length and width of the sulcus calcanei, were measured using a digital vernier calliper and recorded in millimetres. The mean length of the right and left calcanei was 74.95 ± 5.74 mm and 74.19 ± 5.77 mm, respectively, while the mean width was 27.54 ± 5.70 mm on the right and 25.95 ± 3.85 mm on the left. The mean length of the sulcus calcanei was 23.51 ± 2.55 mm on the right and 20.96 ± 2.73 mm on the left, whereas the mean width was 4.37 ± 5.39 mm on the right and 3.96 ± 5.25 mm on the left. The findings provide baseline morphometric data for the Gujarat population and may serve as a valuable reference for orthopaedic surgeons, anatomists, and forensic experts.

KEYWORDS : Calcaneum; Morphometry; Sulcus Calcanei

INTRODUCTION

The calcaneum is the largest part of the tarsal skeleton and acts as the main weight-bearing bone of the hindfoot (1). By forming joints with the talus above, it plays a key role in the mechanics of the subtalar joint and enables movements like inversion and eversion of the foot (1). Due to its strategic position, differences in calcaneal shape can directly affect foot biomechanics and how load is distributed.

Previous investigations have shown that the structural features of the calcaneum, especially the shape of its articular facets and overall size, exhibit measurable variability (2). These differences are not just anatomical details but are clinically significant, as changes in facet arrangement and bone size can influence joint stability and functional alignment (3). From a surgical point of view, precise morphometric knowledge of the calcaneum is essential during the surgical treatment of fractures and reconstructive procedures involving the subtalar region (4).

The sulcus calcanei, located on the upper surface of the bone, forms an important part of the sinus tarsi when combined with the sulcus tali (5). This area contains vital ligamentous and vascular structures; therefore, understanding its precise dimensions is crucial during surgical exposure and fixation procedures (5). Morphometric analysis of both the calcaneal body and its sulcus offers valuable information that goes beyond academic interest and has practical clinical implications.

Comparative morphometric studies conducted in various populations have reported differences in parameters such as calcaneal length, transverse width, and sulcus dimensions (6,7). These differences are believed to reflect influences from genetic background, habitual loading patterns, and environmental factors (7). Besides orthopaedic relevance, the calcaneum has gained significance in forensic and anthropological contexts due to its structural robustness and frequent preservation in skeletal remains (8). Quantitative measurements of the calcaneum have also been used in

methods aimed at individual identification and the estimation of biological characteristics (9).

Morphological deviations of the calcaneum have been further linked to conditions such as spur formation and altered subtalar mechanics, highlighting the importance of region-specific morphometric data (10). Although multiple studies have examined calcaneal parameters across different geographical regions, data from the Gujarat population remain scarce. Establishing baseline morphometric values for this region is therefore crucial to improve clinical decision-making, surgical accuracy, and forensic analysis. Accordingly, the present study was undertaken to assess the morphometric parameters of dry human calcanei from the Gujarat population, focusing on the length and width of the calcaneum and the dimensions of the sulcus calcanei, to generate reliable regional reference data.

MATERIAL & METHODS

This descriptive osteometric study was conducted on 105 dry adult human calcanei, including 51 right-sided and 54 left-sided bones from the Department of Anatomy, Medical College, Baroda. Only intact, fully ossified, and non-pathological specimens were included, while damaged or deformed bones were excluded. All measurements were taken in millimetres with a digital vernier calliper accurate to 0.01 mm. The maximum length of the calcaneum was measured from the most anterior point of the anterior articular surface to the most posterior point of the calcaneal tuberosity. The maximum width was measured as the transverse distance between the most medial and lateral points of the calcaneal body at its middle section. The length of the sulcus calcanei was recorded from the posterior margin of the anterior facet to the posterior end of the sulcus. The width of the sulcus calcanei was measured between its medial and lateral margins at the widest part of the canal. The data were systematically recorded, and descriptive statistics, including the mean and standard deviation, were calculated separately for the right and left calcanei using Microsoft Excel and Jamovi.



Figure 1: Measurement of the Length of the Calcaneum in (mm)



Figure 2: Measurement of the Width of the Calcaneum in (mm)



Figure 3: Measurement of the Length of the Sulcus Calcanei in (mm)



Figure 4: Measurement of Width of Sulcus Calcanei in (mm)

RESULT

A total of 105 dry adult human calcanei were analyzed in this study, including 51 right-sided and 54 left-sided bones. Descriptive statistical analysis was performed separately for right and left calcanei. The mean, standard deviation, and range for all measured parameters, such as calcaneal length, width, and sulcus calcanei dimensions, are shown in Table 1. The values are expressed in millimetres.

Table 1: Mean, SD and Range of all Parameters in (mm)

Sr.No.	Parameter	Mean $\pm$ SD	Range
1.	Rt Calcaneum Length	74.95 $\pm$ 5.73	59.72-88.39
2.	Lt Calcaneum Length	74.19 $\pm$ 5.76	58.71-88.62
3.	Rt Calcaneum Width	27.54 $\pm$ 2.81	20.05-33.15
4.	Lt Calcaneum Width	25.95 $\pm$ 3.85	19.09-40.34

5.	Rt Sulcus Calcanei Length	23.51 $\pm$ 2.55	17.53-29.07
6.	Lt Sulcus Calcanei Length	20.96 $\pm$ 2.73	14.61-28.04
7.	Rt Sulcus Calcanei Width	04.37 $\pm$ 1.13	1.91-7.3
8.	Lt Sulcus Calcanei Width	03.96 $\pm$ 1.10	1.36-6.61

DISCUSSION

The present study evaluated the morphometric parameters of 105 dry adult human calcanei from the Gujarat population. The mean length of the calcaneum was 74.95 $\pm$ 5.73 mm on the right side and 74.19 $\pm$ 5.76 mm on the left side. The mean width measured 27.54 $\pm$ 2.81 mm on the right and 25.95 $\pm$ 3.85 mm on the left. The sulcus calcanei demonstrated mean lengths of 23.51 $\pm$ 2.55 mm (right) and 20.96 $\pm$ 2.73 mm (left), while the mean sulcus width was 4.37 $\pm$ 1.13 mm on the right and 3.96 $\pm$ 1.10 mm on the left. A slight predominance of right-sided measurements was observed for most parameters.

A comparison of the present findings with previously published studies from different populations is summarised in Table 2.

Table 2: Comparison of Morphometric Parameters with Previous Studies

Study	Population	Calcaneum Length (mm)		Remarks
		Right	Left	
Present Study	Gujarat	74.95 $\pm$ 5.73 mm	74.19 $\pm$ 5.76 mm	-
Ukoha et al.	South Eastern Nigerian	7.01 $\pm$ 0.72 cm	7.10 $\pm$ 0.70 cm	Sulcus Calcanei not studied
Jyotsna et al.	Hyderabad	76.01 $\pm$ 5.74		Rt & Lt differentiation not done & Mean length & width of Sulcus Calcanei are greater
Garg et al.	North India	71 $\pm$ 5.1 mm	70.2 $\pm$ 4.5 mm	Mean length and width of Sulcus Calcanei are greater
Deb et al.	West Bengal	73.94 $\pm$ 4.90	74.25 $\pm$ 5.07	Sulcus Calcanei not studied
Kolap et al.	Goa	72.58 $\pm$ 5.77	72.75 $\pm$ 5.44	Mean length and width of Sulcus Calcanei are greater
Singh	Uttar Pradesh	78.2 $\pm$ 5.6		Rt and Lt differentiation not done & Mean Length & Width of Sulcus Calcanei are greater
Laxmi et al.	Punjab	67.6 $\pm$ 6.05	70.28 $\pm$ 5.39	Sulcus Calcanei not studied
Otag et al.	Turkey	76.21 $\pm$ 5.68	76.14 $\pm$ 5.53	Sulcus Calcanei not studied

The slight right-sided predominance observed in the present study may be due to functional dominance and to the distribution of mechanical stress. Since the calcaneum is the main weight-bearing part of the hindfoot, repeated loading might cause minor asymmetry in its size.

From a clinical perspective, precise morphometric knowledge of the calcaneum is crucial for fracture management, subtalar joint reconstruction, and implant placement. Understanding the dimensions of the sulcus calcanei is especially important during surgical exposure of the sinus tarsi region. Additionally, due to its durability, the calcaneum is often used in forensic and anthropological investigations for identification.

CONCLUSION

This study provides baseline morphometric data for dry adult

human calcanei within the Gujarat population. Results show observable side-wise differences, with slightly higher mean values generally on the right side for most parameters. The documented dimensions of the calcaneum and sulcus calcanei offer region-specific reference values that can aid in orthopaedic surgical planning, fracture treatment, and subtalar joint procedures. Additionally, these measurements are relevant for anthropological and forensic work involving skeletal identification. The data from this research can serve as a basis for future studies that include sex-based analysis and radiological comparisons to enhance clinical and forensic applications of calcaneal morphometry.

Acknowledgement

I express my sincere gratitude to Dr. Kintukumar Vyas, Associate Professor at Medical College, Baroda, for his invaluable guidance throughout this study.

REFERENCES

1. Ukoha, U. U., Obazie, I. F., & Onuoha, C. (2017). Study of the morphologic and morphometric patterns of talar articular facets on dry adult calcaneal bones in South-Eastern Nigerian population. *Revista Argentina de Anatomia Clinica*, 9(2), 58–66.
2. Jyotsna, G., & Mamidi, A. (2022). The morphometric analysis of calcaneus and its articular facets. *Indian Journal of Clinical Anatomy and Physiology*, 9(1), 22–24. <https://doi.org/10.18231/ijcap.2022.006>
3. Garg, S., Verma, U., Suri, A., Aulakh, K. K., Aneja, P. S., & Kaur, N. (2022). Morphometric analysis and types of articular facets on human dry tali and calcanei of North Indian origin. *Biomedicine*, 42(1), 28–32. <https://doi.org/10.51248/v42i1.959>
4. Deb, H., Gosavi, S. N., Sharma, D., & Ojah, M. (2024). Morphometric & morphological study of dry human calcanei. *African Journal of Biomedical Research*, 27(1s), 1558–1571. <https://doi.org/10.53555/AJBR.v27i1S.1415>
5. Kolap, S. M., Prabhu, S. P., & Kudalkar, U. N. (2023). Morphometric study of sulci tali and calcanei and its clinical significance: A cross-sectional analytical study. *International Journal of Anatomy, Radiology and Surgery*, 12(5), AO24–AO27. <https://doi.org/10.7860/IJARS/2023/60821.2933>
6. Singh, D. V. (2023). Assessment of morphometric study of calcaneus and its articular facets. *International Journal of Academic Medicine and Pharmacy*, 5(1), 801–803. <https://doi.org/10.47009/jamp.2023.5.1.166>
7. Laxmi, V., Mehra, R., Sharma, R., Neki, N. S., & Singh, J. (2018). A morphological and morphometric study of human calcanei and their articular facets. *Annals of Geriatric Education and Medical Sciences*, 5(1), 28–32. <https://doi.org/10.18231/2348-7240.2018.0007>
8. Perumal, A., & Anand, A. (2013). Morphometric study of spur formation in dry adult human calcaneae. *International Journal of Current Research and Review*, 5(7), 93–97.
9. Otag, I., Tetiker, H., Tastemur, Y., Sabanciogullari, V., Kosar, M. I., & Cimen, M. (2017). Morphometric measurements of calcaneus: Boehler's angle and bone length estimation. *Cumhuriyet Science Journal*, 38(2), 256–263. <https://doi.org/10.17776/cumuscij.291995>
10. Anbumani, T. L., Sridharan, R., & Selvi, A. T. (2017). An anatomical study of morphology and morphometric analysis of calcaneum and its talar articular surfaces. *International Journal of Anatomy and Research*, 5(3.2), 4223–4229. <https://doi.org/10.16965/ijar.2017.291>