Original Article

Morphometric Analysis of the Talar Facet in Dry Adult Human Fibulae

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Abstract

Background: The fibular facet for the talus plays a crucial role in ankle stability and function. Understanding its morphometric variations is essential for clinical and surgical applications. This study aims to analyze the morphometric parameters of the talar facet in dry adult human fibulae and assess potential differences between the left and right sides. **Material and Methods:** A morphometric analysis was performed on dry adult human fibulae, assessing key parameters, including anteromedial and posteromedial distances, and the height and width of the talar facet. Statistical comparisons between the left and right sides were performed to determine significant differences. **Results:** The morphometric analysis revealed no significant differences between the left and right talar facets. The anteromedial distance (left: 19.14 ± 1.98 mm, right: 18.98 ± 1.21 mm, p = 0.6167) and posteromedial distance (left: 19.98 ± 1.95 mm, right: 19.54 ± 1.93 mm, p = 0.245) showed minor variations but no statistical significance. The height (left: 21.09 ± 1.54 mm, right: 21.08 ± 1.94 mm, p = 0.977) and width (left: 18.22 ± 2.05 mm, right: 17.94 ± 2.12 mm, p = 0.491) were nearly identical. These findings suggest that the talar facet exhibits a symmetrical anatomical configuration, which may be relevant for surgical and clinical applications. **Conclusion:** The findings suggest that the morphology of the talar facet in the fibula is largely symmetrical, which may have clinical relevance in orthopedic procedures, implant designs, and reconstructive surgeries. These results contribute to the anatomical understanding of the fibula and support its functional consistency in relation to the talus.

Keywords: Talar facet, fibula, morphometry, anatomical symmetry, orthopedic anatomy, talocrural joint, surgical implications, dry bone study.

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Introduction

The ankle is one of the most commonly injured joints in the human body, and it is a complex combination of bones and ligaments that provide stability and mobility. The tibio-fibular syndesmosis of the ankle is composed of the central value of the joint, the distal end of the fibula, which shapes the lateral malleolus and is critical in providing the foot with a stable state. This syndesmosis, along with the distal tibia, forms the mortise that lines with the mortise of the talus at the tibio-fibular joint.[1,2] Little research has been devoted to the finer morphometry of the articular surfaces of the bones that comprise the tibio-fibular mortise. The literature gap presents difficulties in both reconstructive surgery and the design and fabrication of implants, where accurate anatomical information is essential to achieve the best results.[3] So does the increasing number of ankle fractures, which high-speed motorcycle accidents, high-energy traumas, etc, can cause. The role of the fibula in tibio-fibular syndesmosis is crucial in the context of these clinical problems.[4,5] Some enhanced understanding of the displacement patterns of the lateral malleolus, talus, and medial malleolus has already led to more successful management of these injuries.[6] The correct preoperative planning and postoperative assessment of talocrural fracture patterns are dependent on an accurate appreciation of the distal fibular anatomy. Thus, this study has been conducted to fill the gap in forensic investigation and anthropological research by providing a credible skeletal network. This study aims to add useful information to the anatomical body of knowledge by measuring the main anatomical parameters, including the size of the lateral malleolus and the fibular notch. Finally, this will result in the findings being used to support better clinical interventions, optimize implant design, and refine surgical planning for ankle joint reconstructions.

Materials and Methods

The current study was conducted on dry adult human fibulae obtained from the bone collection of the Department of Anatomy, Government Medical College (GMC), Srinagar. One hundred and sixty undamaged fibulae (53 right and 53 left) were randomly picked irrespective of age and sex. The fibulas were assigned serial numbers for identification and recordkeeping. Fibulae with clean and intact features were only used; damaged and deformed fibulae, and those with any form of pathological variation, were removed to obtain proper morphometric measurements. The standardized instruments were used to measure morphometrics

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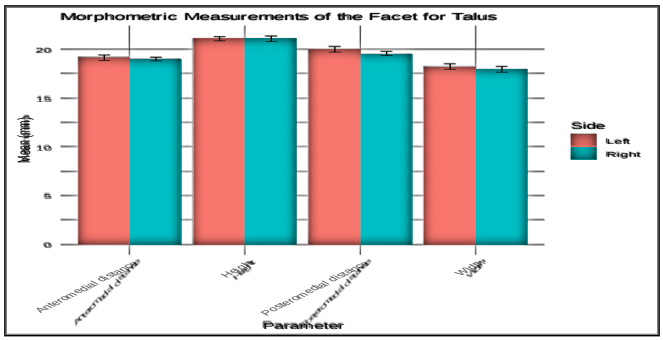
to ensure accuracy. Linear measurements were made with a vernier caliper (0 to 200 mm, 0.01 mm precision). The observations were performed twice by the same observer to reduce error and improve reliability. The recorded values were documented systematically in a structured pro forma. The parameters detected in each fibula were: the anteromedial distance of the talus facet, the posteromedial distance of the talus facet, the highest amount of the talus facet, and the widest amount of the talus facet. The collected data were analyzed using descriptive statistics and presented as mean, standard deviation (SD), and standard error of the mean (SEM). The comparative analysis was conducted using an independent t-test, provided the underlying statistical assumptions were met. Interpretation and tabulation of the results were conducted systematically. Institutional regulation on the treatment and analysis of human skeletal remains was strictly adhered to.

Results

We observed that in the case of the anteromedial distance, the left and right sides had a mean of 19.14 and 18.98, correspondingly (SD 1.98 mm and 1.21 mm, respectively, and SEM 0.272 mm and 0.166 mm, respectively), and the p-value of the difference was 0.6167, which is not significant. In the posteromedial distance, the left side had a mean of 19.98 (SD 1.95mm, SEM 0.268mm) and the right side had a mean of 19.54 (SD 1.93mm, SEM 0.224mm); the p-value of 0.245 was also insignificant. The average height for the left side was 21.09mm (SD=1.54mm, SEM=0.212mm) and for the Right side, it was 21.08mm (SD=1.94mm, SEM=0.266mm), with the p-value (0.977), revealing an insignificant difference. And lastly, the average width on the left side was 18.22(SD=2.05 mm, SEM=0.288 mm), and on the right side, it was 17.94 (SD=2.12 mm, SEM=0.291mm), with the p-value of 0.491, showing a significant difference.

Table 1: Morphometric Measurements of the Facet for Talus in Dry Adult Human Fibulae

Parameter	Side	Mean (mm)	SD (mm)	SEM (mm)	p-value
Anteromedial distance	Left	19.14	1.98	0.272	0.6167
	Right	18.98	1.21	0.166	
Posteromedial distance	Left	19.98	1.95	0.268	0.245
	Right	19.54	1.93	0.224	
Height	Left	21.09	1.54	0.212	0.977
	Right	21.08	1.94	0.266	
Width	Left	18.22	2.05	0.282	0.491
	Right	17.94	2.12	0.291	



Discussion

The fibular end is a crucial part of the ankle joint's integrity, forming the lateral malleolus that attaches to the talus and tibia, thereby providing ankle stability. A variety of clinical and orthopedic applications, such as reconstructive procedures, implant design, and forensic identification are impossible without morphometric evaluation of the fibular aspect of the talus.

The anteromedial dimension of the talar facet is an important parameter that determines the congruence between the fibula and talus and thus modulates ankle biomechanics. The mean values of 19.14 ± 1.98 mm on the left and 18.98 ± 1.21 mm on the right were reported in the current study and are close to those in previous studies but show slight differences. The dimensions reported by Naidoo et al. (2015) in a South African group (19.18 ± 2.27 mm in males and 18.39 ± 2.22 mm in females) are similar to the present study, especially with males, which suggests that the dimensions remain identical in all populations; the small differences could be due to ethnic and genetic heterogeneity, and the differences in environmental and biomechanical stresses that affect fibular development.7 In an Indian population, Labbai et al. (2019) found higher mean values of 19.87 ± 2.10 mm on the left side and 19.71 ± 1.85 mm on the right-hand side, which are slightly higher than the present study results.5 This could be explained by the fact that the sample size in the Indian study was larger, or variability in bone morphology between individuals. Variations in dimensions may also reflect minor differences in measurement methods.

Table 2: Comparison of Anteromedial Distance of the Facet for Talus

Study	Year	Country	Mean (in mm)
Present study	2025	India	Left: 19.14±1.98 Right: 18.98±1.21
Naidoo N et al.	2015	South Africa	Male: 19.18 ± 2.27 Female: 18.39 ± 2.22
Labbai J et al	2019	India	Left: 19.87 ± 2.10 Right: 19.71 ± 1.85

Table 3: Comparison of Posteromedial Distance of the Facet for Talus

Study	Year	Country	Mean (in mm)
Present study Naidoo N et al.	2025 2015	India South Africa	 Left: 19.98± 1.95 Right 19.54± 1.93 Male: 19.18 ± 2.27 Female: 18.39 ± 2.22
Labbai J et al	2019	India	Left: 20.44 ± 2.05 Right: 19.91 ± 1.81

A morphometric parameter that influences the stability and articulation of the ankle joint is the posteromedial dimension of the talar facet. The differences in this parameter reading have clinical consequences on orthopedic surgery, forensic identification, and implant design. In the current study, the mean values were 19.98±1.95 mm on the left side and 19.54±1.93 mm on the right side, which are similar to previous values but show some differences. Our findings are similar to those of Naidoo et al. (2015), who reported mean values of 19.18±2.27 mm and 18.39±2.22 mm for male and female skeletal structures, respectively, in a study conducted in South Africa.7 The margin of difference in measurements also somewhat explains the fact that the skeletal morphology varies across ethnicities and among different populations due to hereditary and evolutionary factors. Moreover, these differences could be due to differences in lifestyle and biomechanical loading patterns, as habitual activities affect lower-limb development. Similarly, Labbai et al. (2019) presented the mean values, including 20.44 ± 2.05 on the left side and 19.91 ± 1.81 on the right, in an Indian population, which are also generally consistent with our somewhat lower study findings, possibly due to the difference in sample size, regional heterogeneity of the Indian population, and methodological differences in measurement methods.5 Such small differences may also be caused by individual differences in the morphology of the bones that result from nutrition and mechanical stress. The fact that we were able to confirm our results with existing research supports the validity of our morphometric variables, in addition to pointing out the need to consider clinical practice nuances

Table 4: Comparison of Maximum Height of the Facet for Talus

Study	Year	Country	Mean (in mm)
Present study Shirishkumar et al.	2025 2014	India India	 Left: 21.09± 1.54 Right 21.08± 1.94 Left: 19.94 ± 1.81 Right: 20.07 ± 1.9
M.S. Patil et al.	2012	India	Radiological: 27.2 Bone: 23.7
Raza HKT et al.	2015	India	Left: 23.7 ± 2.2 Right: 23.7 ± 2.2
Labbai J et al	2019	India	Left: 20.6 ± 2.10 Right: 20.6 ± 1.60

Tibio-talar facet height is a critical parameter in orthopaedic practice, both in ankle reconstructive surgery and in prosthetic implant design. It plays a major role in load distribution and joint congruency, and thus, orthopaedic applications require precise measurement. The average maximal height was also found to be 21.09 mm with a standard deviation of 1.54 on the left side and 21.08mm with a standard deviation of 1.94 on the right side in the current study, and these are more or less similar to the previous investigations, though there were slight differences. The latter are consistent with the results of Shirishkumar et al. (2014), who reported a mean height of 19.94 ± 1.81mm right minus left side and 20.07 ± 1.90 mm left minus right side in an Indian study.[8] The differences in the characteristics of the sample, such as skeletal strength and the genetic diversity in the region, can explain the slightly increased values of this study. In addition, minor discrepancies could be due to methodological variations in measurement methods, especially the use of different anatomical landmarks in the measurement. According to Labbai et al. (2019), the mean width was 20.6 ± 2.10 mm on the left side and 20.6 ± 1.60 mm on the right, which are also very close to the present study.[5] These minor differences might be due to the morphology of the skeleton subject to the pattern of mechanical loading and other lifestyle-related conditions, including habitual squatting and physical activity, which affect lower-limb bone formation. However, Raza HKT et al. (2015) reported significantly higher bilateral values of 23.7mm ± 2.2 mm, and M.S. Patil et al. (2012) reported a radiological measurement of 27.2mm and a direct bone measurement of 23.7mm.[4,9] The high values in these studies could be due to the difference in the methods used in the measurement process, and high values in radiological measurements are more likely to occur due to the presence of soft tissue. Also, sample selection differences (varying sex ratios and skeletal strength) can contribute to these differences. The similarity of our results to those of previous researchers suggests that this parameter may be comparatively stable across Indian populations. Yet there are slight differences that support the idea that population-specific data are vital in clinical work. The high scores in some studies indicate the need to have standardized methods of measurement to ensure that morphometric measurements are correct.

Table 5: Comparison of Maximum Width of the Facet for Talus

Study	Year	Country	Mean (in mm)
Present study Naidoo N et al.	2025 2015	India South Africa	Left:18.22±2.05 Right:17.94±2.12 Male: 18.77 ± 2.27 Female: 17.14 ± 1.50
Labbai J et al	2019	India	Left: 18.07 ± 2.14 Right: 18.03 ± 1.98

The maximum width of the talar facet is a crucial morphometric characteristic that contributes to the ankle joint's structure and articulation. The implications of this measurement for orthopaedics and forensic medicine would be of high importance, as any width variations could alter joint biomechanics and predispose to certain ankle pathologies. We observed a mean maximum width of 18.22 ± 2.05 mm on the left side and 17.94 ± 2.12 mm on the right side, which are generally consistent with previous studies, though there are slight differences. We find that our results are quite similar to those of Labbai et al. (2019), who reported a mean width of 18.07 ± 2.14 mm on the left side and 18.03 ± 1.98 mm on the right side in the Indian population.[5] These similarities are the reason to believe that there is a level of consistency in morphometric features within this demographic group. Any slight differences can be explained by heterogeneous sampling and methodological variation. Naidoo et al. (2015) reported that the mean values for males were 18.77 ± 2.27 mm and 17.14 ± 1.50 mm for females in a South African population, which are relatively lower than the male mean and relatively higher than the female mean in our study.[7] The differences can be due to genetic, ethnic, and environmental factors, which determine skeletal morphology. Moreover, there may be sex differences in the anatomy of the fibulas, which could account for the observed differences, as males generally have larger skeletal sizes than females.

Conclusion

The morphometric evaluation of the talar facet in dry adult human fibulae did not show any significant differences between the right and left sides for any of the parameters measured, including anteromedial and posteromedial distances, height, and width. The results indicate a relatively symmetrical anatomic arrangement, confirming the uniformity of fibular morphology relative to the talus. These findings are relevant to existing literature and can help provide a better understanding of the fibula's anatomy, potentially with clinical and surgical practice implications.

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Conflicts of interest

There are no conflicts of interest.

References

1. van den Bekerom MP. Diagnosing syndesmotic instability in ankle fractures. World J Orthop. 2011 Jul 18;2(7):51-6. doi: 10.5312/wjo.v2.i7.51. PMID: 22474636; PMCID: PMC3302043.
2. Sreedevi G, Sangam MR. Morphometric study of human fibular incisura in dry bones. National Journal of Clinical Anatomy. 2018 Apr 1;7(2):69-73.
3. Shishirkumar, Satheesha N, Kumar A, Patil GV. Morphometric study of the Articular Surfaces of Bones Forming the Tibio-Fibular Mortise in South Indian Population. Journal of Evidence Based Medicine and Healthcare 2014; 1(4): 190-197.
4. Raza HKT, Raza SMG, S. Upadhyay. Anthropometry of the Lateral Malleolus. International Journal of Recent Scientific Research 2015; 6 (6): 4821-4826.
5. Labbai J, Tapiyawala K. Morphometric Analysis of the Distal End of Dry Adult Human Fibulae. Int J Cur Res Rev| Vol. 2019 Jun;11(12):7.
6. Calek AK, Hodel S, Hochreiter B, Viehöfer A, Fucentese S, Wirth S, Vlachopoulos L. Restoration of the patient-specific anatomy of the distal fibula based on a novel three-dimensional contralateral registration method. Journal of Experimental Orthopaedics. 2022 May 20;9(1):48.
7. Naidoo N, Ishwar Kumar S, Lazarus, Pillay P, Satyapal K.S. Osteometry and morphology of the human fibula: A South African study. Int. J. Morphol 2015; 33(3):1071-1077.
8. Shishirkumar, Satheesha N, Kumar A, Patil GV. Morphometric study of the Articular Surfaces of Bones Forming the Tibio-Fibular Mortise in South Indian Population. Journal of Evidence Based Medicine and Healthcare 2014; 1(4): 190-197
9. Patil MS, Raza SM, Nayeem A. Anthropometric measurements of ankle mortise for evaluating mortise fracture reductions to develop contoured implants. Al Ameen J Med Sci 2012; 5(4): 381-387.