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Original Research Article

Anatomical Correlation Between the Number of Calcaneal Facets and the Presence of Squatting Facets in the Patna Region

Hema Narayan[1], Barun Kumar[2]

[1]Associate Professor, Department of Anatomy, Netaji Subhas medical College and Hospital, Bihta, Patna, Bihar, India

[2]Professor and HOD, Department of Anatomy, Netaji Subhas medical College and Hospital, Bihta, Patna, Bihar, India

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Corresponding Author: Dr. Hema Narayan

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Abstract:

Background: The talus plays a pivotal role in weight transmission and foot biomechanics, lacking muscular attachments and possessing limited vascularity, making it susceptible to injury and degeneration. Morphological variations such as articular facet types and squatting facets can influence talar function and biomechanics.

Aim: The study aimed to explore and describe the morphological types of articular facets on the talus and correlate squatting facets with angular parameters especially angles of inclination and deviation.

Methodology: The project involved an anatomical descriptive, cross-sectional study of dry human tali (75 total, 39 right side and 36 left side) from Netaji Subhas medical College and Hospital, Bihar. The articular facets were classified and squatting facets were recorded. Inclination and deviation angles were, then, measured using a goniometer. Comparisons were made statistically between specimens with squatting facets and without squatting facets.

Results: Type II articular facet was most common (44%), followed by Type III (33.33%). Squatting facets were present only laterally in 42.7% of specimens, more frequently on the right. Inclination angles were significantly higher in tali with squatting facets (right: 124.5°, left: 117.2°) compared to those without. Deviation angles showed minimal differences. Significant side-based asymmetry was also observed, with the right talus showing higher inclination.

Conclusion: This study highlights the morphological variability of the talus and its correlation with functional adaptations. The presence of squatting facets is associated with increased inclination angles, suggesting a biomechanical response to habitual postures like squatting. These findings have implications in clinical, anthropological, and surgical fields.

Keywords: Articular Facets, Anatomical Variation, Deviation Angle, Foot Biomechanics, Inclination Angle, Squatting Facet, Talus.

Introduction

The foot is an extraordinary structure, anatomically and functionally specialized to achieve optimal performance during bipedal movement. This specialization results in major evolutionary and biomechanical selection pressures demanding stability and mobility be simultaneously achieved and maintained. The foot must support the entire body weight while standing and provide sufficient acceleration during walking, running and jumping actions while simultaneously accommodating many surfaces and different foot movements. [2] One of the bones of the foot that is in a critical anatomical position is the talus because of its unique role in weight transfer. The talus is the bone in between the lower leg and foot passing load from the tibia and fibula down to the calcaneus and tarsal bones. By being centrally located it has to bear considerable mechanical load throughout the day during different weight-bearing activities like walking, standing and other dynamic movements.

The talus is a fundamental bone of the locomotor system, and its integrity is important for the effective mechanical function of the locomotor system [3] . Loss or injury to the talus will significantly impede balance, gait, and mobility. Unlike other bones in the foot, the talus is distinct primarily due to the absence of muscular attachments. It is important to consider this is an unusual anatomical arrangement. The talus is only supported via ligaments and joint capsules, and not with muscular support. Additionally, in part due to the way in which the blood supply is arranged, the talus is prone to avascular necrosis (or bone death) from fractures or injury [4] . The blood supply to the talus is tenuous and mostly supplies from small arterial branches, which complicates the healing process and leads to additional considerations for the clinician managing trauma. These unique characteristics define the manner in which the talus contributes to the biomechanical efficiency of human locomotion and yield a number of foot pathologies.

The talar angles consist of the neck angle (NA), vertical angle (VA) and torsion angle (TA) [5]. The NA has been defined as the outer angle subtended between the axis of the head and neck of talus and an imaginary plane drawn across the superior articular surface through the mid-points of the tibial and fibular articular surfaces on either side of the body of talus. The VA is the angle between the axis of the head of the talus and the line connecting the summit of the medial talar articular surface to the tip of the posterior tubercle. The TA is measured as the angle between the transverse axis of the articular surface of the head of southerly talus and an imaginary transverse axis that corresponds to the plane above the superior articular surface of the talus [6].

Squatting is a rest posture complex characterized by hyperextension at the hip and knee with dorsiflexion at the ankle and sub talar joint [7]. Lower limb skeletal morphology is known to be subject to changes through the stress that is placed upon it. The anterior border of the lower end of the Tibia is bevelled as a result from extreme ankle dorsiflexion, and the lower end of the Tibia articulates with the facet or facets on the or facets on the dorsal aspect of the neck of the Talus, lateral or medial, and usually the lateral one is often continuous with the trochlear articular surface. [8]

The limited vascularity and the absence of muscle attachment makes the talus susceptible to injury while rendering joints unstable, with the possibility of developing Osteoarthritis, Pseudoarthrosis, and Neurosis. To evaluate the precision of reduction and avoid malunion, it is vital to visualize the talar neck position, radiographically and also direct intra operatively, along with the angles with respect to the body. These angles are also critical to kinesiology and anthropology. This study focuses on the morphometry of the squatting facet of the talus if in fact it has any anatomically coordinates with neck angles namely: inclination and declination, while no data currently exists regarding this correlation.

Methodology

Study Design: This was a descriptive, cross-sectional anatomical study carried out to examine the different types of calcaneal facets on the talus, and to correlate squatting facets with angular measurements.

Study Area: The study was conducted in the Department of Anatomy at Netaji Subhas medical College and Hospital, Patna, Bihar, India for one year

Sample Size: A total of 75 dry human tali were included in the study, comprising 39 right-sided and 36 left-sided specimens. The bones were obtained from the osteology section of the Department of Anatomy, NSMCH, Patna

Inclusion and Exclusion Criteria

Inclusion Criteria:

- Dry, intact human tali irrespective of sex.
- Bones with clearly visible articular facets and identifiable anatomical landmarks.

Exclusion Criteria:

- Damaged or deformed tali.
- Tali with obscured or indistinct articular surfaces.

Procedure: Each dry talus specimen was carefully examined, focusing on the inferior articular surface to identify and classify the types of calcaneal facets present. The facets were categorized based on their morphological variations as observed visually and through careful palpation. The articular surface was inspected to detect the presence or absence of accessory facets commonly referred to as squatting facets, which are indicative of certain habitual postures.

To quantify angular variations, the angle at the neck of the talus was measured precisely. Two specific angles were recorded for each specimen: the angle of inclination and the angle of declination. These measurements were obtained using a standard Goniometer, ensuring accuracy and reproducibility. The Goniometer was aligned carefully with anatomical landmarks on the talus to measure the angles consistently across all specimens.

Following the identification of the facets and measurement of angles, specimens were grouped into two categories—those with accessory squatting facets and those without. A comparative analysis was then carried out to examine the relationship between the presence of accessory facets and the variations in the angles of inclination and declination. This involved statistically analyzing the differences in angular measurements between the two groups to evaluate any significant correlations.

Statistical Analysis: Collected data were tabulated and analyzed using appropriate statistical software version 27. Descriptive statistics such as mean, standard deviation, and frequency distribution were computed. Comparative analysis between right and left-sided specimens was performed using [specify tests, e.g., Chi-square test, t-test] with significance set at $p < 0.05$.

Result

Table 1 presents the incidence of different types of articular facets on tali among 75 specimens (39 right-sided and 36 left-sided). Type II was the most common, observed in 44% of total specimens, with a nearly similar distribution on the right (46.15%) and left (41.67%) sides. This was followed by Type III, found in 33.33% of cases (35.90% right, 30.56% left). Type I was relatively rare, accounting for only 6.67% overall, with a higher occurrence on the left (11.11%) than the right (2.56%). Type IV appeared only on the left side (5.56%), while Type Va was exclusive to the right side (2.56%). Type Vb was observed in 12% of specimens, with a slightly higher frequency on the right (12.82%) compared to the left (11.11%). Overall, the data indicate a predominance of Type II and Type III facets, with some asymmetry in the distribution of rarer types.

Table 1: Incidence of types of articular facets on tali

Facets	Right (N=39)	Left (N=36)	Total (N=75)
Type I	1 (2.56%)	4 (11.11%)	5 (6.67%)
Type II	18 (46.15%)	15 (41.67%)	33 (44%)
Type III	14 (35.90%)	11 (30.56%)	25 (33.33%)
Type IV	0 (0%)	2 (5.56%)	2 (2.67%)
Type Va	1 (2.56%)	0 (0%)	1 (1.33%)
Type Vb	5 (12.82%)	4 (11.11%)	9 (12%)

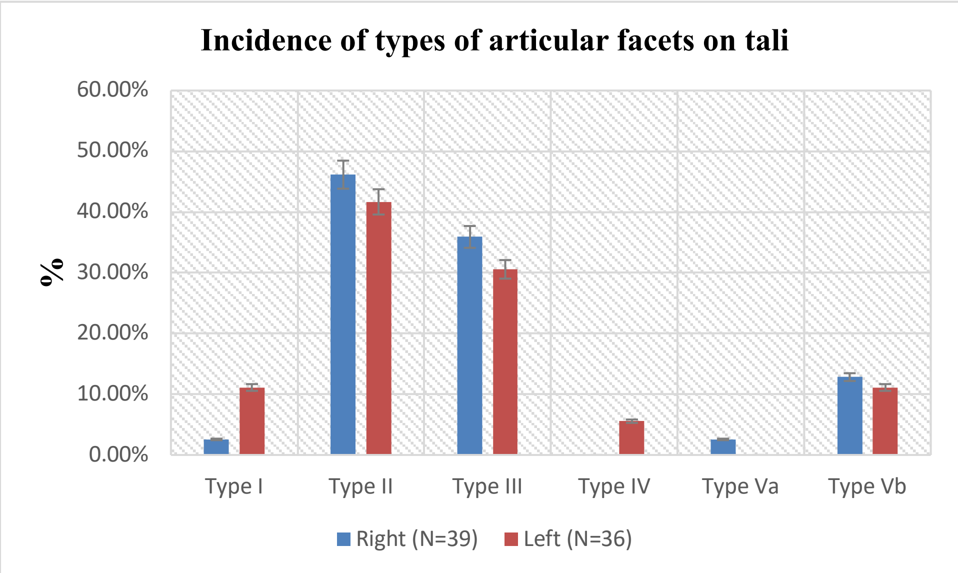

Figure 1: Incidence of types of articular facets on tali

Table 2 presents the distribution of squatting facets on the tali, categorized by side. Among the 75 specimens examined, squatting facets were entirely absent on the medial side. On the lateral side, squatting facets were present in 32 specimens (42.7%), with a higher prevalence on the right side (46%) compared to the left (38.4%). Overall, the majority of tali (57.3%) lacked squatting facets entirely. This suggests a greater tendency for the absence of squatting facets, and when present, they are more likely to occur on the lateral side, particularly on the right talus.

Table 2: Squatting facets on tali

Side	Present (Medial)	Present (Lateral)	Squatting Facet Absent	Total
Right	0 (0%)	18 (46%)	21 (54%)	39
Left	0 (0%)	14 (38.4%)	22 (61.6%)	36
Total	0 (0%)	32 (42.7%)	43 (57.3%)	75

Table 3 presents the comparison of angle of inclination and angle of deviation between right-sided (N=39) and left-sided (N=36) tali. The mean angle of inclination was significantly higher on the right side (124 ± 4°) compared to the left side (111 ± 6°), with a highly significant p-value of 0.001, indicating a statistically significant difference. In contrast, the mean angle of deviation showed a slight difference between the right (25.4 ± 3.3°) and left (24.6 ± 2.4°) sides, but this difference was not statistically significant (p=0.08). This suggests that while the inclination angle varies notably between sides, the deviation angle remains relatively consistent.

Table 3: Angle of Inclination and Deviation			
Angles	**Right (N=39)**	**Left (N=36)**	**p-value**
Inclination (M±SD)	124 ± 4	111 ± 6	0.001
Deviation (M±SD)	25.4 ± 3.3	24.6 ± 2.4	0.08

Table 4 shows the comparison of angle of deviation and inclination between specimens with and without a squatting facet. For deviation angles, on the right side, specimens with a squatting facet had a lower mean deviation (25.1° ± 2.5) compared to those without (27.2° ± 2.8), whereas on the left side, specimens with a squatting facet had a higher mean deviation (27.6° ± 3.1) than those without (25.3° ± 2.9). Regarding inclination angles, specimens with a squatting facet exhibited notably higher mean inclination on both sides—right side (124.5° ± 3.6) and left side (117.2° ± 2.5)—compared to those without the facet, which had lower means of 96.3° ± 4.8 (right) and 99.1° ± 3.0 (left). This indicates that the presence of a squatting facet is associated with increased inclination angles and variable effects on deviation angles depending on the side.

Table 4: Angle of deviation and inclination with or without squatting facet		
Angles	**Squatting facet + (M ± SD)**	**Squatting facet – (M ± SD)**
Deviation		
Right	25.1 ± 2.5	27.2 ± 2.8
Left	27.6 ± 3.1	25.3 ± 2.9
Inclination		
Right	124.5 ± 3.6	96.3 ± 4.8
Left	117.2 ± 2.5	99.1± 3.0

Discussion

The study revealed that Type II articular facets were the most common among the tali examined, present in 44% of specimens with a fairly balanced distribution between the right and left sides. This predominance is consistent with previous anatomical findings, which often highlight Type II as the typical configuration of talar facets, suggesting its functional importance in foot mechanics. Type III was the second most frequent type, again showing similar proportions bilaterally, indicating a consistent pattern of facet morphology across both sides. The less common Type I facet showed a notably higher occurrence on the left side compared to the right, while rarer types such as Type IV and Type Va appeared exclusively on one side, indicating subtle anatomical asymmetries that may be influenced by genetic or developmental factors. In our study, variants of Type II articular facets were the most common type they found without any difference between the right and left side with 24, and 20 patients respectively. The second highest was Type III articular facets or the talus without any differences with the right and left sides with 18 and 14 patients respectively. Type IV and Type V were the least common types of Talar articular facets. Our finding is comparable with the study conducted by Bilodi [9] and Garg et al [10] who reported 50% and 43.7% respectively. However, Arora et al [11] reported the highest incidence of type I facets 78% and Kaur et al [12] 24%.

Regarding squatting facets, these were absent medially and appeared only on the lateral side in about 43% of the specimens. Their higher prevalence on the right talus compared to the left suggests a possible lateral dominance that could be linked to habitual postural or functional demands. The fact that most tali lacked squatting facets emphasizes that this feature is not universal and may vary according to lifestyle or population-specific activities. The lateral side predominance of squatting facets aligns with some anatomical literature, although the complete absence on the medial side contrasts with other studies, hinting at variability that might reflect environmental or behavioral influences. The mean TSA from this study was 9.7 ± 3.3 degrees. Other studies have recorded TSA values of 9.9 to 11.87 degrees [13]. The contour and alignment of the trochlear surface is important for the role it plays regarding smooth movement of the joints and imparting stability to the ankle [14] . Earlier research has attempted to assess the trochlear groove utilizing linear parameters and the talar dome ratio [15].

The angular measurements demonstrated a significant difference in the angle of inclination between right and left tali, with the right side having a higher mean value. This side-to-side asymmetry could influence foot biomechanics, potentially affecting how weight is distributed during movement. In contrast, the angle of deviation remained relatively similar on both sides, indicating less variability in this parameter. When considering the presence of squatting facets, specimens exhibiting these facets showed substantially greater inclination angles compared to those without, suggesting a morphological adaptation linked to habitual squatting behavior or load-bearing requirements. The deviation angle showed side-specific variation related to squatting facets, decreasing on the right side but increasing on the left, possibly reflecting compensatory biomechanical adjustments or asymmetrical functional demands. The prevalence of medial squatting facet (33, 34.4%) in the present study was higher than reported by Pablos et al. (1,0.6%) in 2013, and Das (4%) in 1959 but lower than the reporting of Singh (46, 17.6%) in his study. Further, Barnet 1954 reported comparatively lower prevalence than Singh (74, 24.6%) in his study on Indians.

Overall, these findings shed light on the variability and asymmetry in talar morphology and highlight the relationship between structural features and functional adaptations. Such knowledge can contribute to clinical understanding of foot mechanics and pathologies, as well as provide insight into anthropological interpretations of habitual postures and locomotor patterns in different populations.

Conclusion

This anatomical report sheds light on ways in which the talus can vary in structure, particularly with regards to the types of articular facets presented and the relationship between our squatting facets and the angular measurement of those facet. The most common type of articular facet was Type II, followed by Type III, which indicates a typical morphological pattern necessary for our foot function. In terms of the squatting facets, they were only lateral and present in 42.7% of the specimens and more frequently on the right side. The right-side predominance could imply a tendency towards dominance due to habitual posture. A significant correlation was observed for squatting facet presence to higher inclination angles, suggesting that structural adaptability exists in response to functional use such as squatting. Angles of deviation appeared relatively stable, while angles of inclination displayed more asymmetry between sides and with regard to facet presence. These findings illustrate the role of talar morphology on biomechanics, surgical exploration, and anthropological assessments, helping to demonstrate an enhanced appreciation of posture-related skeletal adaptations and variability in human locomotion.

References

1. Harcourt-Smith WE, Aiello LC. Fossils, feet and the evolution of human bipedal locomotion. Journal of anatomy. 2004 May;204(5):403-16.
2. Harcourt-Smith WE, Aiello LC. Fossils, feet and the evolution of human bipedal locomotion. Journal of anatomy. 2004 May;204(5):403-16.
3. Hegazy MA, Khairy HM, Hegazy AA, Sebaei MA, Sadek SI. Talus bone: normal anatomy, anatomical variations and clinical correlations. Anatomical Science International. 2023 Jul;98(3):391-406.
4. Gray H, Standring S, Ellis H, Berkovitz BK. Gray's anatomy: the anatomical basis of clinical practice. (No Title). 2008.
5. Flury A, Viehöfer AF, Hoch A, Vlachopoulos L, Wirth SH, Imhoff FB. Talar neck angle correlates with tibial torsion—guidance for 3D and 2D measurements in total ankle replacement. Journal of Orthopaedic Research®. 2021 Apr;39(4):788-96.
6. Mahato NK, Murthy SN. Articular and angular dimensions of the talus: Inter-relationship and biomechanical significance. The foot. 2012 Jun 1;22(2):85-9.
7. Oygucu IH, Kurt MA, Ikiz I, Erem T, Davies DC. Squatting facets on the neck of the talus and extensions of the trochlear surface of the talus in late Byzantine males. The Journal of Anatomy. 1998 Feb;192(2):287-91.
8. Frazer JE, Breathnach AS. Frazer's anatomy of the human skeleton. J. & A. Churchill; 1965.
9. Bilodi AK. Study of calcaneal articular facets in human tali. Kathmandu university medical journal. 2006 Jan 1;4(1):75-7.
10. Garg R, Babuta S, Mogra K, Parashar R, Shekhawat S. Study of variations in pattern of calcaneal articular facets in human tali in the population of rajasthan (India). PJSR. 2013 Jul; 6(2):19-23.
11. Arora AK, Gupta SC, Gupta CD, Jeyasingh P. Variations in calcanean facets in Indian Tali. Anatomischer Anzeiger. 1979 Jan 1; 146(4): 377-80.
12. Kaur M, Kalsey G, Laxmi V. Morphological classification of tali on the basis of calcanean articular facets. PB Journal of Orthopedics. 2011;12(1):57-60.
13. Siegler S, Toy J, Seale D, Pedowitz D. The Clinical Biomechanics Award 2013--presented by the International Society of Biomechanics: new observations on the morphology of the talar dome and its relationship to ankle kinematics. Clinical biomechanics. 2014 Jan 1;29(1):1-6.
14. Parr WC, Chatterjee HJ, Soligo C. Calculating the axes of rotation for the subtalar and talocrural joints using 3D bone reconstructions. Journal of biomechanics. 2012 Apr 5;45(6):1103-7.
15. Wiewiorski M, Hoechel S, Wishart K, Leumann A, Müller-Gerbl M, Valderrabano V, Nowakowski AM. Computer tomographic evaluation of talar edge configuration for osteochondral graft transplantation. Clinical anatomy. 2012 Sep;25(6):773-80.
16. Pablos A, Martínez I, Lorenzo C, Gracia A, Sala N, Arsuaga JL. Human talus bones from the Middle Pleistocene site of Sima de los Huesos (Sierra de Atapuerca, Burgos, Spain). Journal of Human Evolution. 2013 Jul 1;65(1):79-92.
17. Das AC. Squatting facets of the talus in UP subjects. J Anat Soc India. 1959;8:90-2.

18. Barnett CH. Squatting facets on the European talus. Journal of anatomy. 1954 Oct;88(Pt 4):509.