Original Article

Squatting Facets and Trochlear Extensions of Talus Bone in Indian Population

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Abstract

Introduction: The talus is a tarsal bone articulated with the tibia, fibula, navicular, and calcaneus bones to form supratalar, pretalar, and subtalar joints, respectively. A squatting facet is a kind of anomaly that forms on the surfaces where the tibia and talus articulate. The squatting facet states the daily activities and living style of society. Squatting is described as the hyperflexion of the hip and the knee and the movement of hyperdorsiflexion between the leg and the ankle. **Materials and Methods:** In the present cross-sectional study, 600 dry adult human tali were taken from the osteology laboratory in the Department of Anatomy, King George's Medical University, UP, Lucknow. Each talus was examined for the presence of various patterns of articular facets on the neck of the talus and extensions of its trochlear surface. Ethical clearance was obtained from the Institutional Ethics Committee, King George's Medical University, Lucknow, as reference code: 121 ECMIIA/P3. **Results:** In our study, we observed that the lateral, medial, and combined squatting faces are 282 (47.64%), 49 (8.28%), and 22 (3.72%), respectively. Lateral, medial, and continuous trochlear extensions are 126 (21.12%), 120 (20.58%), and 31 (5.36%), respectively, in the Indian population. **Conclusion:** Modifications of the neck of the talus (squatting facets and trochlear extensions) are the result of prolonged squatting positions, which is a common habit of the Indian population, and incidences of these variations can be used as an anthropological marker for racial and regional differentiation of unidentified bones.

Keywords: Bone, posture, squatting faces, talus, trochlear extensions

Introduction

The talus is a tarsal bone articulated with the tibia, fibula, navicular, and calcaneus bones to form supratalar, pretalar, and subtalar joints, respectively. A squatting facet is a kind of anomaly that forms on the surfaces where the tibia and talus articulate. The squatting facet states the daily activities and living style of society. Squatting is described as the hyperflexion of the hip and the knee and the movement of hyperdorsiflexion between the leg and the ankle. Anomalies of the skeleton provide information on living conditions, cultural structure, and health problems in ancient societies. A squatting facet is a kind of anomaly that forms on the surfaces where the tibia and talus articulate. The squatting facet states the daily activities and living style of society. Squatting is a lying postural complex that comprises hip, knee, and ankle hyperflexion as well as hyperdorsiflexion.[1] The foot is not commonly dorsiflexed enough during locomotion to make contact between the dorsum of the neck of the talus and the anterior border of the distal end of the tibia. The neck of the talus (squatting facets) and its trochlear surface (trochlear extensions), which characterize the significant pressure and traction stresses on ankle joints in conditions of hyperdorsiflexion, are two areas of the ankle that are altered as a result of habitual squatting in humans.[2] The goal of the current study was to extensively investigate the variations and occurrences of different kinds of changes in the neck of the talus, their relationships to the right and left sides of the body, and their geographical differences in Indians. A transverse ridge of bone without articular cartilage was found to separate or not connect the squatting facet (medial or lateral), which was described as an articular or smooth region present on the dorsum of the

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neck that did not follow the line of curvature of the trochlear surface.[3] The AP diameter facet was often concave, and the actual squatting facet faced upward and somewhat backward. Despite the fact that the squatting facets were continuous with the trochlear surface, they could be distinguished by the sharp transition from the facet's concavity to the surface's convexity. The AP curve (convexity) of the trochlear surface was always continued by the medial or lateral section of the surface, which was sometimes extended anteriorly onto the neck of the talus. Trochlear extension is the extension of the trochlear surface (superior) of the body of the talus bone due to hyperdorsiflexion of the ankle joint. Squatting facets were additional facets on the superior surface of the neck due to the individual's continuous squatting positioning. Although excessive ankle dorsiflexion is the reason for the existence of a facet, the reason for its existence is the same. Thomson[4] claimed that the difference was caused by anthropoid feet not being used for squatting like human feet. However, when orangs, baboons, and a few gorillas used their feet for climbing, an ankle in a hyperdorsiflexed posture supported the weight of the body. As a result, orangs, who are great climbers, have acquired aspects. From a clinical perspective, research on squatting posture is crucial today because prolonged squatting has been linked to a significant increase in the risk of tibiofemoral knee osteoarthritis in elderly people[5] as well as a significant increase in the likelihood of developing common peroneal nerve palsy. In fact, both unilateral and bilateral peroneal nerve palsies have been linked to prolonged squatting. Therefore, forensic science may make use of these features to determine the race of an unidentifiable bone.

Materials and Methods

The present cross-sectional study of 600 (sample size) human tali (right = 249 and left = 351) of unknown age and sex was carried out in the Department of Anatomy, King George's Medical University, Lucknow, from the period of April 2022 to September 2022. Ethical clearance was obtained from the Institutional Ethics Committee, King George's Medical University, Lucknow, through reference code 121 ECMIIA/P3. As far as could be ascertained, samples were free of physical and pathological changes or anomalies. Each talus was checked for the existence of different articular facets on the talus neck and trochlear surface extensions. All 600 tali were numbered and photographed.

Results

In our study, we observed 600 human tali, among them 351 left talus and 249 right talus bones. Table 1 shows the incidences of various modifications of the neck of the talus, such as trochlear extension. The trochlear extensions were classified into medial, lateral, and continuous [Figure 1]. In this study, we observed 126 medial trochlear extensions among the 600 tali (21.12%), of which 62 were in the left talus and 64 were in the right talus, which were significantly similar in number. Similarly, in this study, we observed 120 lateral trochlear extensions among the 600 tali (20.58%), of which 70 were in the left talus and 50 were in the right talus, which shows that the incidence of left-sided lateral trochlear extensions was significantly higher in number. In this study, we observed 31 continuous trochlear extensions among the 600 tali (5.36%), of which 14 were in the left talus and 17 were in the right talus, which shows that the incidence of right-sided continuous trochlear extensions was significantly higher in number. In this study, we observed that 277 is the overall incidence of trochlear extension among the 600 tali. Comparing these modifications of the talus shows that the incidence of left lateral trochlear extension is highest (70) and left continuous trochlear extension is lowest (14). Incidences of lateral trochlear extension were higher on the left side, whereas incidences of medial trochlear extension were higher on the right side.

In our study, we observed 600 human tali, among them 351 left talus and 249 right talus bones. Table 2 shows the incidences of various modifications of the neck of the talus, such as squatting facets. The squatting facets were classified into medial, lateral, and combined [Figure 1]. In this study, we observed 49 medial squatting facets among the 600 tali (8.28%), of which 35 were in the left talus and 14 were in the right talus bone, which shows that the incidence of left-sided medial squatting facets was significantly higher in number. Similarly, in this study, we observed 282 lateral squatting facets among the 600 tali (47.64%), of which 177 were in the left talus and 105 were in the right talus bone, which shows that the incidence of left-sided lateral squatting facets was significantly higher in number. In this study, we observed 22 combine squatting facets among the 600 tali (3.72%), of which 12 were in the left talus and 10 were in the right talus, which shows that the incidence of right-sided combine squatting facets was similar to the left sided. In this study, we observed that 353 is the overall incidence of the squatting facets among the 600 tali. Comparing these modifications of the talus, we find that the

Table 1: Incidences of various modifications of neck of talus such as trochlear extension

Trochlear extension	Frequency (total 600 bones) (percentage of cases)
Medial	126 (21.12)
Lateral	120 (20.58)
Continuous	31 (5.36)
Total	277

Table 2: Incidences of various modifications of neck of talus such as squatting facets

Squatting facets	Frequency (total 600 bones) (percentage of cases)
Lateral	282 (47.64)
Medial	49 (8.28)
Combine	22 (3.72)
Total	353

incidence of left lateral squatting facets is highest (177) and the incidence of right combined squatting facets is lowest (10). Similar to how they were more common on the right side, lateral squatting facets were more common on the left side.

Discussion

The ability of the talar articular facets to stay structurally plastic during ontogeny reflects an adaptation that is crucial to our ability to deal with the significant increases in body weight that take place during our development period. In contrast to the joint facets at the pelvic region, femur, and tibia, which support significance, the talar joint facets are extremely small in relation to the loading environment.[6] The prolonged severe dorsiflexion at the ankle joint when squatting, an activity congruent with the lifestyle of the Indian population, is consistent with the modification of the talus described in the current study.

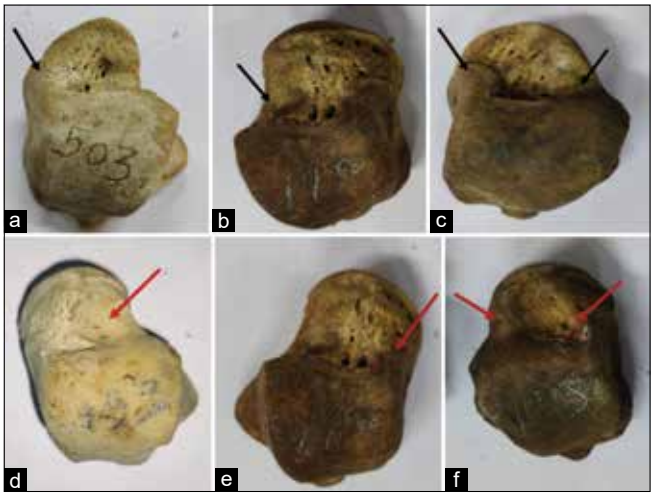

Figure 1: Illustrative photographs showing superior surface of talus which shows (a) Medial trochlear extension, (b) Lateral trochlear extension, (c) Continuous trochlear extension, (d) Lateral squatting facet, (e) Medial squatting, (f) Combine squatting facet

Squatting facet

In our study, the incidence of lateral squatting was 47.7% [Figure 2]. In Dixit *et al*.[7] (Indian population) and Javia *et al*.[8] (Indian population), the incidence of lateral squatting was 65.9% and 51.5%, respectively, which was higher than our study. While Garg R. *et al*.[9] 45.3%, Das *et al*.[10] (40.5%), Jeya Singh *et al*.[11] (43.5%), Oygucu *et al*.[5] (36.7%) that was lower than our study.

When we compared the incidence of various squatting facets (lateral, medial, and combined) in Indian population studies by Dixit *et al*.,[7] Javia *et al*.,[8] Garg *et al*.,[9] Das,[10] Jeyasingh *et al*.,[11] and our study, all showed a higher incidence value of lateral squatting facets, which indicates a change in lifestyle modification in the Indian population.

We are discussing the present study of lateral, medial, and combined squatting facets with recent literature like Shilpi GD *et al*. [7] which shows 65.9%, 8.2, and 2.04%; Javia M. *et al*. [8] which shows 51.5%, 2.7%, and 15.3%; and Garg R. *et al*. [9] which shows 45.3%, 7.7%, and 3.3%, respectively. In our study, we found lateral, medial, and combined squatting facets of 47.7%, 8.2%, and 3.7%.

The incidence rate of lateral squatting facets in the present study is lower than those reported by Mayank Javia *et al*.[8] as 59.84%, Ismail Baykara *et al*.[12] as 72.1%, Shilpi GD *et al*.[7] as 65.9% and Pandey *et al*.[13] 83.2%. These investigations also noted that of all alterations brought on by the squatting position, lateral squatting features were the most common. Sewell and Barnett[6,14] both observed lower incidences in the populations of Egyptians and Europeans, respectively, which indicates that Indians have greater incidences than Egyptians and Europeans. Due to various living circumstances, routine activities, and postures, there is a much greater occurrence of

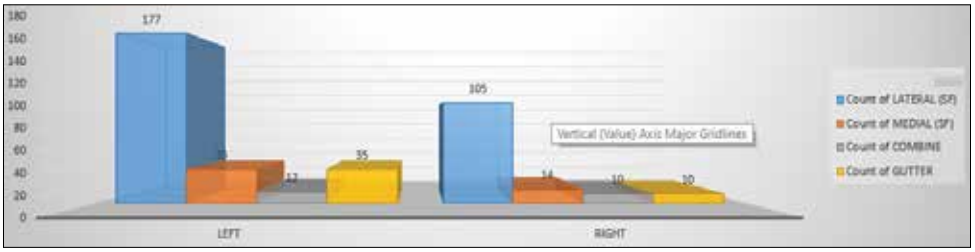

Figure 2: Bar graph showing percentage as well as number of various squatting facet value

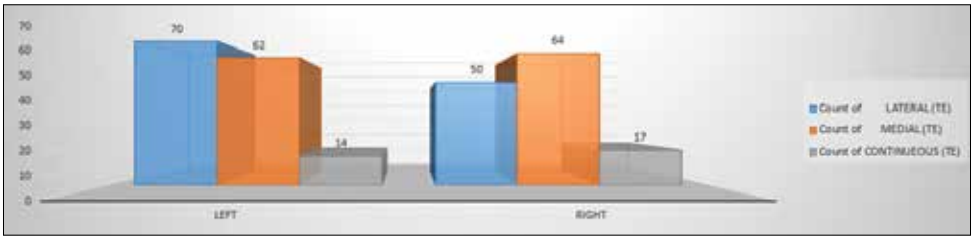

Figure 3: Bar graph showing percentage as well as number of various trochlear extension value

lateral squatting aspects in samples. This may be explained by an unbalanced distribution of body weight, particularly toward the lateral side of the foot.

In the current study, the incidence of medial squatting facet was much lower (8.2%) than that of lateral squatting facet (47.7%) in Table 2. When we discuss the value of the medial squatting facet, recent literature like Shilpi GD *et al*.[7] (8.2%) shows similar incidence, Garg R. *et al*.[9] (7.7%) and Javia M. *et al*.[8] (2.7%) shows lower incidence than our study. The incidence of the combined squatting facet in the our study is (3.7%), which was higher than Shilpi GD *et al*.[7] (2.04%) and Garg R. *et al*.[9] (3.3%), but lower than Javia M. *et al*.[8] (15.3%).

Trochlear extension

In the present study, the lateral trochlear extension was 20.5% (120) in [Figure 3], which is lower than Garg *et al*.[9] (22.3%), Shilpi *et al*.[7] (32.7%) and Khadija *et al*.[15] 34%. Similarly, medial trochlear extension shows 21.1% (126), which is also lower than Garg *et al*.[9] (23.7%) and Dixit *et al*.[7] (27.2%). The incidence of lateral trochlear extension and medial trochlear extension is almost similar in the Indian population, which suggests that the hyperdorsiflexion occurrence in the ankle joint is not tilted unidirectionally due to the farming lifestyle of the Indian population. Our study also shows a continuous trochlear extension of 5.3% (31), which is higher than Garg *et al*.[9] (3.7%) and Dixit *et al*.[7] (4.7%).

In the present study, 20.58% of the talus shows lateral trochlear extension. Singh[11] had a frequency of −24.3%, and Das[10] recorded −24.5%. Dixit *et al*.[7] (32.7%), Jeyasingh *et al*.[11] (71.6%), and Pandey *et al*.[13] (90.8%) observed somewhat greater frequency in Indian populations. The incidence of lateral trochlear extension shows that Barnett *et al*.[6] (17%) and Oygucu *et al*.[5] (8%) reported lower frequencies in Europeans and the late Byzantine population, respectively. In the Pakistani population, 58% was recorded by Khadija *et al*.[16]

In the present study, the incidence of medial trochlear extension was 21.12%, which was similar to Dixit *et al*.[7] 27.2%, Singh *et al*.[11] 24.6%, Das *et al*.[12] 25.5%, and somewhat higher in Jeyasingh *et al*.[13] 37% in the Indian population. According to Khadija *et al*.,[16] 34% of Pakistanis are similar to Charles[9] 47.2% of Punjabis. Pandey and Singh[8] observed that 60.3% observed a much greater prevalence of medial trochlear extension.

The first person to describe the existence of squatting facets on the anterior margin of the distal extremity of the tibia and the upper surface of the neck of the talus was Thomson[4] in 1889. Along with a facet on the front border of the lower extremity of the tibia, he characterized the facet as a smooth, cartilage-covered patch on the top surface of the talus's neck that articulated completely dorsiflexed. Thomson offered his research from a phylogenetic perspective. He noticed that chimpanzees lack the squatting features that are highly pronounced on orangs, baboons, and a few gorillas.

The existence of squatting facets on the dorsal side of the neck of the talus in both fetuses and adults of eastern races, according to Charles[17] in 1894, is proof that acquired traits are passed down through the generations. Squatting traits are more prevalent in fetuses than in adults; Sewell and Barnett[6,12] have also observed them in fetuses. According to Singh,[18] talus modifications brought on by squatting are more frequent in European fetuses than Indian ones and more frequent in Indian adults than European adults because these features can continue to develop in Indian adults who frequently maintain squatting postures. Many Europeans were born with these features, but because there was no additional pressure (like that from squatting), the attachment of the capsule encroached upon them and destroyed them.

The prevalence of squatting facet and trochlear extensions seen in this study was consistent with earlier research on Australians, certain Indians, and the Byzantine population. These were consistent with prolonged severe tali dorsiflexion when squatting, a movement appropriate for the farming lifestyle of the tribe's population. According to Das,[10] farmers in tropical nations, such as Indians, frequently suffer lengthy durations of squatting during harvesting seasons, and the majority of people in the Indian subcontinent are still accustomed to doing their morning rituals in crouching posture.

According to Oygucu *et al*.[5] on the lateral side of the talus neck, Byzantine males nearly exclusively displayed squatting aspects. Inspection revealed a pes valgus deformity, which may have been caused by prolonged standing and walking on an uneven surface (consistent with a Byzantine farmer's way of life). It caused the foot to turn outward at the talo-calcaneal joint, putting the lateral surface of the talus in contact with the inferior end of the tibia's anterolateral margin, indicating that extreme dorsiflexion may not have been the only factor in the modification of the upper surface of the neck of the talus. According to Bunning *et al*.[19] calcanei may articulate with the talus by three different facets (type A), two (type B) or rarely except in a small Veddah series a single facet (type C). According to Peeters K *et al*.[20] none of the global bone dimensions were significantly different between flatfeet and controls, nor were the differences related to the articular surface curvatures for the articular surface dimensions however, the articular surface width was larger in flatfeet in both the ARF (Anatomical Reference Frame) and PCRF (Principal Component Based Reference Frame). According to Gautham K *et al*.[21] data analysed in this study would aid to understand the morphology of the talus, its load bearing patterns and it may also help in foot prosthesis, screw placements in fractures at related areas of foot. According to Goda Jatin B *et al*.[22] the trochlear articular surface is wider in front, measurements of opposite talus bone can be used as a control during talus bone replacement surgery, it may help surgeons to plan pre-operatively the complex talar fracture surgeries, to design accurate talus bone prosthesis and talus implants. According to Ughade HM *et al*.[23] to study the variation in the shape and dimension of the talus bone. To study if there are significant differences in the right and left sided tali. According to Naqshi

BF *et al*.[24] trochlear articular surface of talus is wider in front. Mean values of the present study are different as compared to other studies which may be due to inherent population variations because of environmental and genetic factors.

Conclusion

Indians frequently squat for lengthy periods of time, which leads to changes in the neck of the talus, including trochlear extensions and squatting aspects. The frequency of these variances can serve as an anthropological indicator of the ethnic and geographic diversity of unidentified bones. The conclusion supported by our data is that the incidence of lateral squatting is highest, which suggests lateral tilting during the squatting posture due to the farming lifestyle of most of the Indian population. Data also suggested that the incidence of medial and lateral trochlear extension was similar, that is, hyperdorsiflexion occurs in both the medial and lateral sides of the neck talus simultaneously during long squatting positions in the Indian population.

Long-term squatting positions, a common Indian practice, cause alterations to the neck of the talus (squatting facets and trochlear extensions). These differences in the squatting facets in various populations may be due to habitual squatting positions, may be due to inheritance, or may be due to the migration of certain populations. Variations in the presence of squatting facets in different populations can reveal certain habitual activities that an individual in that population engages in. These differences may be due to habitual squatting positions in certain populations, may be due to inheritance, or may be due to the migration of certain populations.

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Conflicts of interest

There are no conflicts of interest.

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