

Human Calcaneal Facets for the Talus: Patterns and Clinical Implications

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ABSTRACT

Background and Objectives: Calcanei with certain talar facet patterns predispose to subtalar arthritis. Knowledge about variations in the talar facets of the calcanei is essential for orthopaedic surgeons while correcting foot deformities like pes planus. This study was undertaken after finding a scarcity of such data in the South Indian population. The objective was to identify the patterns of the talar facets of calcanei and their clinical implications.

Methods: Calcanei (n = 237) from the southern part of India were utilized. The literature describes five patterns of calcaneal facets for the talus. Pattern III (absent anterior facet) was not found in the present study. Only four patterns were described as follows: Pattern I: Fusion of the middle and the anterior facets, Pattern II:

The middle and the anterior facets separate, Pattern IV: Fusion of all the three facets, Pattern V: Fusion of the middle and the posterior facets.

Results: Pattern I was predominant (65.82%), followed by Pattern II in 33.33% of the bones. In the Pattern II, the subtype A with less than 5mm separation was the commonest. Rare cases of pattern IV and pattern V were found in 0.42% of the cases in each type.

Interpretation and Conclusion: There is a dominance of pattern I calcanei in Indians as compared to the Europeans who present pattern II commonly. This fact necessitates the orthopaedic surgeons in India to modify the surgical techniques when they perform calcaneal osteotomy. South Indians may be at a greater risk of developing subtalar arthritis due to the dominance of Pattern I calcanei.

Key Words: Calcaneum, Facets for the talus, Pattern, Southern India, Variation

KEY MESSAGE

- Racial differences in the facet pattern of calcanei necessitate modifications of the western surgical techniques to suit the Indian scenario.

INTRODUCTION

The largest tarsal bone of the foot, the calcaneum, articulates superiorly with the talus to form the subtalar joint. In the middle 1/3 rd of the superior surface of the calcaneum, there is an oval shaped posterior facet for articulation with the body of the talus. In the anterior 1/3 rd of the calcaneum, there are middle and anterior facets for articulation with the head of the talus [1]. The literature on the morphology of the posterior calcaneal facet for the talus confirms that this facet does not show much variation. But, there are divergent views regarding the anterior and the middle facets. The variations in the anterior and the middle calcaneal facets for the talus are correlated with race [2]. Studies in different population groups also confirm it [3-5]. Certain morphological variations of calcaneal facets for the tali may predispose to the development of arthritic changes in the subtalar joint [6]. Bruckner [7] hypothesised that variations in the talar facets of calcaneum are important because they influence subtalar joint stability. Knowledge about the variations in the talar facets of calcanei is essential for orthopaedic surgeons while correcting foot deformities like pes planus [8]. Therefore, this study was carried out after finding a scarcity of data on the variations of the calcaneal facets for the tali in the south Indian population. The objective of the present study was to identify the patterns of the talar facets of calcanei and their clinical implications

in the population of Tamil Nadu and Pondicherry, the southern states of India.

MATERIALS AND METHODS

This study was conducted by utilizing 237 dry calcaneal bones which belonged to the bone banks of different medical colleges of Tamil Nadu and Pondicherry states of India. Adult bones, irrespective of the sex and sides, were included for this study. Calcaneal bones with pathological changes or with anomalies were excluded. The patterns of the talar articular facets of calcanei were observed with the naked eye and by using a hand lens. A sliding vernier caliper was used to measure the separation between the facets. Literature analysis revealed that five patterns of talar facets were found in the calcanei. Pattern III with the absence of the anterior facet was not found in the present study. Only four patterns were described as follows: Pattern I showed the fusion of the middle and the anterior facets; Pattern II, the middle and the anterior facets were separate; Pattern IV, there was fusion of the anterior, middle and the posterior facets. Pattern V showed the fusion of the middle and the posterior facets. Depending on the degree of separation between the anterior and the middle facets, pattern II was subtyped into three varieties as A (<5mm), B (5 to 10mm) and C (>10mm), based on the description of Saadeh [9].

RESULTS

A total number of 237 calcaneal bones were studied. 4 patterns of the facets for the talus were seen [Table/Fig-1].

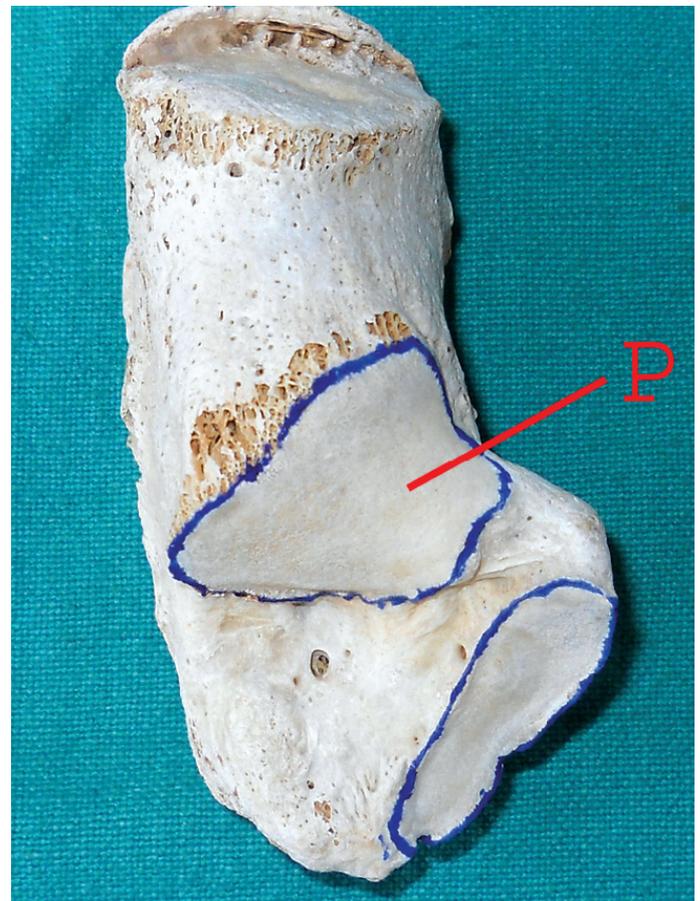
Pattern I with fused middle and anterior facets [Table/Fig-2] was found in 156 bones (65.82%). Pattern II with separate middle and anterior facets [Table/Fig-3] was found in 79 bones (33.33%). No calcaneum with pattern III (absence of the anterior facet) was found. Pattern IV with fused anterior, middle and posterior facets [Table/Fig-4] was seen in one bone (0.42%). Fused middle and posterior facets (pattern V) was observed in one bone (0.42%) [Table/Fig-5].

There were 3 subtypes in Pattern II [Table/Fig-6].

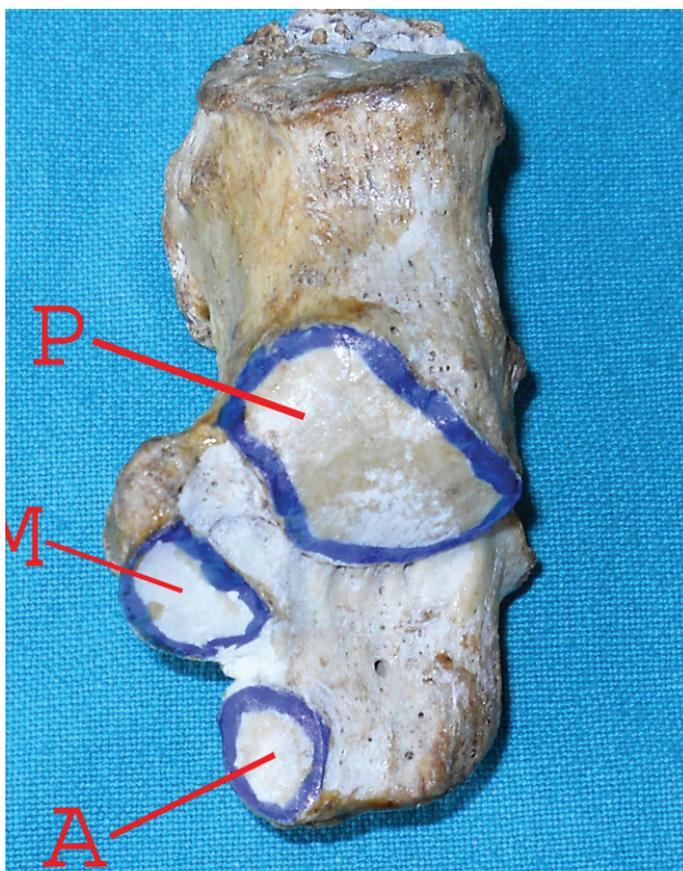
Subtype A with middle and anterior facet separation of less than 5mm was seen in 64 bones (27%). Subtype B with middle and anterior facet separation of 5-10mm was seen in 12 bones (5.06%). Subtype C with middle and anterior facet separation of more than 10 mm was seen in 3 bones (1.26%).

Patterns of calcaneal facets	n	%
Pattern I: M & A fused	237	65.82
Pattern II: M & A separate	237	33.33
Pattern III: A absent	237	0
Pattern IV: A, M & P fused	237	0.42
Pattern V: M & P fused	237	0.42

[Table/Fig-1]: Patterns of calcaneal facets for talus observed in the present study
 A – anterior facet; M – middle facet; P – posterior facet
 n – total number of observations
 % - percentage of particular pattern observed out of total number of bones (237)



[Table/Fig-2]: Shows right calcaneum with pattern I (middle and anterior facets fused)
 P – Posterior facet.



[Table/Fig-3]: Shows left calcaneum with pattern II (middle and anterior facets separate). A – Anterior facet, M – Middle facet, P – Posterior facet.

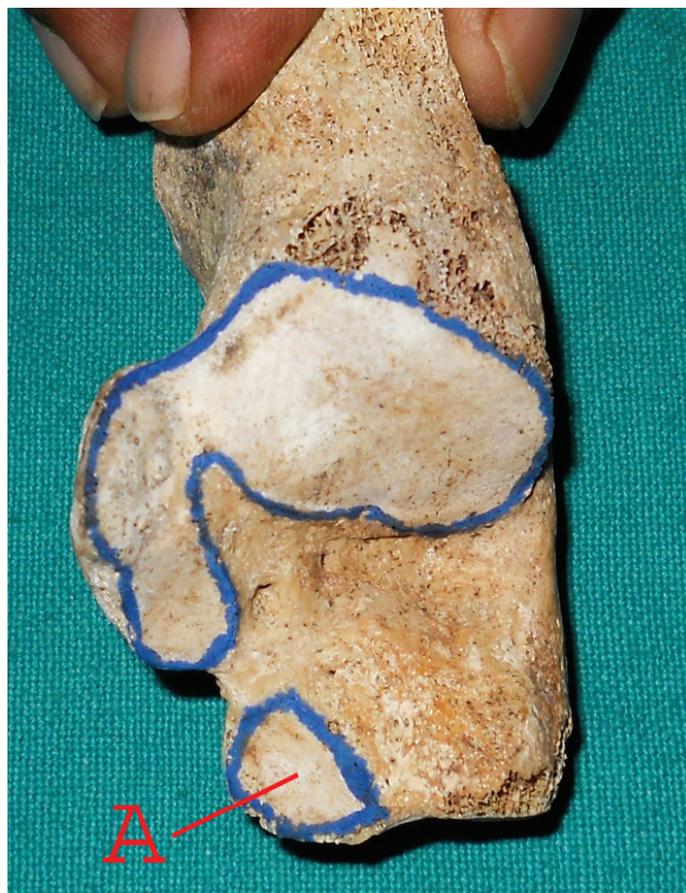


[Table/Fig-4]: Shows left calcaneum with pattern IV (anterior, middle and posterior facets fused)

DISCUSSION

In the present study, in pattern II, the subtype A (<5mm) was the commonest one. This finding coincided with the finding of the south Indian study by Priya Ranganath [10]. But in the Egyptian study by Saadeh [9], the subtype B (5-10mm) was found to be the most frequent one in pattern II.

Pattern I calcaneal type [Table/Fig-2] was found to be dominant in the present study. Our findings confirmed the observations of other Indian studies [5, 10]. In African studies [3, 9] also, Pattern I was common. But pattern II [Table/Fig-3] was predominant in



[Table/Fig-5]: Shows left calcaneum with pattern V (middle and posterior facets fused)
A – Anterior facet.

Subtypes of pattern II calcaneal facets	n	%
A: <5mm	237	27.00
B: 5-10mm	237	5.06
C: >10mm	237	1.26

[Table/Fig-6]: Subtypes in pattern II calcaneal facets
n – total number of observations
% - percentage of particular subtype observed out of total number of bones (237)

Study, year	Country/n = sample size	Pattern I (%)	Pattern II (%)	Pattern III (%)	Pattern IV (%)	Pattern V (%)
Bunning & Barnett, 1965	Britain / n=194	33	67	–	–	–
Gupta SC et al, 1977	India / n=401	67	26	5	2	–
Francine Drayer- Verhagen, 1993	U.S.A / n=191	54.45	26.7	18.85	–	–
Saadeh FA et al, 2000	Egypt / n=300	63	30.3	4.7	2	–
Priya Ranganath et al, 2006	South India / n=71	67.6	25.35	7.04	–	–
Present study, 2011	South India / n=237	65.82	33.33	–	0.42	0.42

[Table/Fig-7]: Comparison of results of different calcaneal studies including the present study

Europeans [4, 11], whereas in Americans, pattern I with fused anterior and middle facets was commoner than pattern II [6]. All these findings indicated that there was a correlation between the calcaneal facet pattern and race [Table/Fig-7]. The most peculiar feature of the present study was that no calcaneal bone was found with the pattern III facet for the talus.

The rare pattern IV [Table/Fig-4] which was found in other studies was also found in the present study (0.42%). But the unusual feature of the present study was the finding of one calcaneum with the pattern V talar facet, which was the rarest pattern which has been rarely reported in the literature. In pattern V [Table/Fig-5], the middle and the posterior facets are fused and a distinct anterior facet is seen.

A comparison of the adult African, Indian and European calcaneal bones by Bunning and Barnett [4] revealed a distinct racial difference for which no functional explanation can readily be offered. These findings were compared with those which were derived from the study of the corresponding foetal calcaneal bones of African, Indian and European populations. The racial differences which were observed in adult bones were also present in foetal calcanei, thus indicating that they were probably genetically determined and were not developmental responses to physical activities. Thus, the association of genetic factors with variations of the calcaneal facets were indirectly established. References are not readily available to establish a specific association of the calcaneal variations with genetic or functional factors like squatting habits.

The findings of Francine Drayer- Verhagen [6] suggest that the talar facet morphology of the calcaneum is an important factor in subtalar joint stability. This finding was consistent with the hypothesis of Bruckner [7], which stated that the subtalar joints formed by calcanei which had the pattern II facet configuration were comparatively more stable and had less chances for developing arthritis. There are two separate facets, anterior and middle, in the anterior 1/3 rd of the calcaneum with the pattern II facet configuration. These two facets along with the posterior facet provide an 'osseous tripod' for the talus to sit on and to prevent excess motion of the talar head. Thus, the subtalar joint with this tripod support is less likely to suffer trauma or biomechanical stress and the incidence of osteoarthritis is also less in such cases. The data presented by Francine Drayer-Verhagen [6] support this theory. Of the 191 calcaneum which was analyzed, arthritic changes (flipping, etc.) were present only in 35.29% of calcanei with the pattern II facets. But the same changes were present in 65.38% of calcanei with the pattern I facets and in 50% of the calcanei with the pattern III facets.

The same study by Francine Drayer-Verhagen [6] supported another theory which explained the increased mobility of the talar head in the subtalar joints formed by the calcanei with the pattern I facet configuration. In calcanei with the pattern I facet configuration, the articular surface is continuous, flat and smooth giving less impediment to the medial rotation of the talar head. Eventually, this

configuration (pattern I) can cause laxity of the spring ligament and other supporting muscles due to the continuous and excessive pressure which is exerted by the talar head. This laxity of the ligaments and the muscles is thought to be responsible for the unstable subtalar joints, thus leading to osteoarthritis.

The two theories which have been explained above imply that south Indians may be at a greater risk of developing subtalar arthritis, since they predominantly have pattern I calcanei. An elaborate calcaneal study to evaluate this risk factor in south India can be planned in future.

Knowledge of the talar facets of the calcaneum is essential for the orthopaedic surgeons who perform 'Lengthening-distraction wedge calcaneal osteotomy and interposition bone graft', to correct the deformities in Pes planus. In this procedure, the identification of the interval between the anterior and the middle facets is important for the exact placement of the retractor, since the line of osteotomy usually passes through the same interval [8]. This technique is suitable for Europeans who predominantly have calcanei with pattern II facets for the tali (with separate middle and anterior facets). Since pattern I calcanei (with fused middle and anterior facets) are found to be dominant in Indians, the surgeons here have to be careful while applying this technique or a suitable modification may be required. It establishes that the awareness about the variations in the talar facets of the calcaneum is vital in the surgical management of foot deformities.

In the 'triple arthrodesis' procedure to correct the deformities of flatfoot, the articular facet configurations of the calcaneum should be clearly kept in mind in order to safely denude the surfaces of the subtalar joints of all the articular cartilages [8].

The gender and the symmetry of the calcaneum were not taken into account in the present study. Future studies involving these factors in live patients by using imaging techniques, has been recommended.

CONCLUSION

In the present study, the data which was collected from 237 normal dry calcaneal bones from two states in the southern part of India were analyzed. There was a dominance of the pattern I calcanei in

Indians as compared to the Europeans who presented pattern II calcanei commonly. These racial differences in the calcanei were probably genetically determined. This knowledge on the racial differences is vital for orthopaedic surgeons in India when they perform calcaneal osteotomy. In spite of blindly following the surgical techniques described in European literature, modifications to suit the Indian scenario are mandatory. South Indians may be at a greater risk of developing subtalar arthritis due to the dominance of the pattern I calcanei in them. In pattern II, the subtype A is more common in south India as compared to Egypt where the subtype B is more common. The pattern II calcanei form more stable subtalar joints, with less chances for developing arthritis. Pattern III calcanei (with absent anterior facet) were conspicuously absent in the present study. The pattern V calcaneum which was noted in the present study was unique and has been scarcely reported in the literature.

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DECLARATION ON COMPETING INTERESTS:

No competing Interests.

Date of Submission: **Jun 08, 2011**
Date of Peer Review: **Jun 22, 2011**
Date of Acceptance: **Jul 02, 2011**
Online First: **Jul 15, 2011**
Date of Publishing: **Aug 08, 2011**