

Study of Pattern of the Talar Articular Facets in 150 Dried Adult Human Calcanei of North Karnataka Population

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ABSTRACT

Introduction: Calcaneus and talus are bones of the hind foot. Calcaneus being the largest of tarsal bones has three facets on its superior surface for articulation with the talus namely anterior, middle and posterior talar facets. Proper alignment of these two bones is essential for maintenance of the arches of foot. Variations in the talar facets of calcanei are important because they influence subtalar joint stability. In many diseases of foot such as the talocalcaneal arthritis and coalition, intra-articular fracture etc, the size, shape and relation of talus and calcaneus with each other and other bones of the foot must be considered for the external and internal fixation and for other surgical procedures.

Objectives: The present work is intended to study different patterns of talar articular facets on the calcaneum to have a better understanding of anatomical elements contributing to subtalar joint stability and to correlate findings of the present study with existing literature.

Materials and Methods: 150 dry adult undamaged and non-pathological human calcanei of unknown sex were obtained from museum section of department of Anatomy of various medical colleges in North Karnataka. The pattern of talar articular facets with reference to their shape and number was studied and interfacet distance between anterior and middle talar facets was measured using sliding vernier callipers. The data was subjected for statistical analysis.

Results: Based on notable characteristic features, calcanei were grouped into five types: 73.3% of calcanei belonged to Type I, 22% to Type II, 2% to Type III, 2% to Type IV and 0.7% to type V.

Conclusion: Unique feature of the present study was that all the five types of calcanei were found. Type I being the commonest (73.3%) and Type V which is the rarest type and has been scarcely reported in the literature was also seen in one calcaneum. Pattern of talar articular facets on calcaneum exhibits racial differentiation which could be probably genetically determined.

KEY WORD: Articular, Calcaneus, Facets, Talus.

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INTRODUCTION

Calcaneum is a cancellous, subcutaneous, weight bearing bone. It is the largest and strongest bone of the foot. It lies inferior to the talus, thus its superior surface has articular facets

for this bone. Superior surface of calcaneus is divisible into 3 parts. Posterior third is rough and covered with the fibrofatty tissue between the calcanean tendon and ankle joint. Middle

third carries an oval posterior talar facet. Anterior to this facet, a rough depression narrows into a groove on the medial side, the "sulcus calcanei", which completes the sinus tarsi with talus. In the anterior third, there are 2 facets (middle and anterior) for articulation with the head of talus [1], the incidence of which varies with sex and race.

Talocalcaneonavicular or Subastragaloid or subtalar joint is a large region of articulation between the talus above and calcaneum and navicular below and in front [2]. The important movements of inversion and eversion of foot takes place at this joint.

Using the parameters such as degree of separation, fusion, and shape of talar articular facets, several workers have described types and preponderance of articular facets on the calcaneum. This unique pattern of talar articular facet configuration on the calcaneum may be used as a useful indicator for racial differentiation.

Variations in the talar facets of calcanei are important because they influence subtalar joint stability. In many diseases of foot such as the talocalcaneal arthritis and coalition, intra-articular fracture, congenital dysmorphology, flat foot, valgus deformities etc, the size, shape and relation of talus and calcaneus with each other and other bones of the foot must be considered for the external and internal fixation, and for other surgical procedures.

OBJECTIVES

1. To study the pattern (shape and fusion) of talar articular facets on the calcaneum.
2. To study the degree of separation of facets (anterior and middle) on anterior third of the calcaneum.

MATERIALS AND METHODS

The present study was undertaken on 150 dry adult undamaged and non-pathological human calcanei of unknown age and sex, obtained from the museum section of Department of Anatomy, M. R. Medical college, and KBN Medical college, Gulbarga. Bones were numbered and talar articular facets on the calcanei were outlined using a black marker pen. Boundaries of all the facets on the calcaneum were traced on

tracing paper and finally impressions on the tracing paper were copied onto a white paper using a carbon sheet. Number of facets were noted and interfacet distance between the anterior and middle talar facet was measured using sliding vernier callipers. According to literature analysis, calcanei were classified into following five types [3]:

Type I: A single facet present on the anterior third of calcaneum resulting from the confluence of anterior and middle talar facets. It was further sub classified into two sub types depending on shape of the facet;

Type IA: Shape of the facet was constricted because of incomplete separation of anterior and middle talar facets.

Type IB: Shape of the facet was non constricted, as there was no separation between anterior and middle talar facets.

Type II: Three facets present on the superior surface of calcaneum (anterior, middle and posterior talar facets). Depending on the interfacet distance between anterior and middle talar facets, it was further sub classified into three sub types;

Type IIA: Presented with narrow interfacet distance of less than 5mm.

Type IIB: Presented with moderate interfacet distance of 5-10mm.

Type IIC: Presented with wide interfacet distance of more than 10mm.

Type III: There was no anterior facet. A single well defined facet was present on the sustentaculum tali.

Type IV: A single facet was situated on the sustentaculum tali which was extending on to the anteromedial corner of distal part of calcaneum, proximally this facet was continuous with posterior talar facet.

Type V: In this type, middle and posterior talar facet were fused.

The results hypothesized were tabulated and analyzed statistically. Descriptive statistical analysis was carried, Results on continuous measurements are presented on Mean \pm SD (Min-Max) and results on categorical measurements are presented in Number (%). Microsoft excel sheet have been used for statistical analysis.

OBSERVATION AND RESULTS

Out of 150 calcanei studied, 79 (52.7%) belonged to left side and remaining 71 (47.3%) were of right side.

In Type I, constricted facet (IA) was found with a higher percentage (46%) when compared to Type IB. In Type II, subtype A with narrow interfacet distance (<5mm) was found with higher percentage (15.3%) and subtype C with interfacet distance(>10mm) was found with least percentage

Out of 110 calcanei in Type I, 69 (62.7%) were having a constricted facets (IA) and 41(37.3%) were having non-constricted facet (IB). In Type II, subtype IIA(<5mm interfacet distance) was found with higher percentage(69.7%),subtype IIB(5-10mm interfacet distance) was found in 24.2% and subtype IIC (>10mm interfacet distance) was found with least percentage of about 6.1%.



TYPE III



TYPE IV



TYPE V



Figures: Various types of Calcanei

Table 1: Incidence and percentage of different types of calcanei according to talar articular facet configuration on the calcaneum.

Type	Number (150)	Percentage
TYPE I	110	73.3
I A	69	46
I B	41	27.3
TYPE II	33	22
II A	23	15.3
IIB	8	5.3
IIC	2	1.3
TYPE III	3	2
TYPE IV	3	2
TYPE V	1	0.7

Table 2: Comparison Types of calcanei with other studies

	Type I	Type II	Type III	Type IV	Type V	Type I
Present study	73.3	22	2	2	0.7	-
Gupta. S. et al [4]	67	26	5	2	0	0.177
K.C.Chen et al [5]	57	42	1	0	0	<0.001**
Shailaja Shetty et al [6]	76.5	23.5	0	0	0	0.001**
Mujde Uygur et al [7]	58	39.3	0	2.2	0	<0.001**
Wajid Hussain Bakri et al [8]	62.9	28.6	0	8.6	0	<0.001**
Muthukumaravel N. et al [3]	65.82	33.33	0	0.42	0.42	0.003**
Bunning & Barnett [9]						
Indian cases	78	22	0	0	0	0.443
British cases	33	67	0	0	0	<0.001**
Nigerian cases	63	36	0	1	0	<0.001**
Francine Drayer [10]	64.6	26.7	18.8	0	0	<0.001**

** highly significant

DISCUSSION

The calcanei have been classified into 5 distinct types on the basis of talar facets present on their superior surface. The incidence of this types have been studied by various authors in different populations.

Findings of few are tabulated in Table 2.

A comparison of adult African, Indian and European calcaneal bone by Bunning and Barnett 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 Indian and European populations. The racial differences which were observed in adult bone were also present on foetal calcanei, thus indicating that they were probably genetically determined and were not developmental responses to physical activities [3-9]. Thus, the association of genetic factors with variations of the calcaneal facets were indirectly established.

The findings of Francine Drayer-Verhagen, suggest that the talar facet morphology of calcaneum is an important factor in subtalar joint stability [10]. This findings were consistent with Bruckner's hypothesis, which stated that the subtalar joints formed by calcanei which had pattern 2 configuration were comparatively more stable and had less chances for developing arthritis [11].

There are two separate facets, anterior and middle, on the anterior third of the calcaneum with pattern 2 configuration. These two facets along with posterior facet provides an osseous tripod for the talus to sit on and to prevent excess motion of talar head. Thus, the subtalar joint with this tripod support is less likely to suffer trauma or biomechanical is also less in such cases [11].

The data presented by Francine Drayer-Verhagen supports this theory and of the 191 calcanei which were analysed, arthritic changes (lipping etc) were present only in 35.29% of calcanei with Type II facet configuration, but the same changes were found in 65.38% of calcanei with Type I pattern and 50% of Type III calcanei. The same study by Francine Drayer-Verhagen supported another theory which explained the increased mobility of talar head in subtalar joints formed by calcanei with Type I facet configuration as the articular surface is continuous, flat and smooth, giving less impediment to the medial rotation of talar head. Eventually, this configuration can cause laxity of the spring ligament and other supporting muscles due to continuous and excessive pressure which is exerted by the talar head. This laxity of

ligaments and muscles is thought to be responsible for the unstable subtalar joint, thus leading to osteoarthritis [10].

The two theories which have been explained above imply that people from North Karnataka may be are at a greater risk of developing subtalar arthritis since they predominantly have Type I calcanei.

It is well known that the treatment choices of complex foot deformities are osteotomy, anatomic reduction and relaxation of the soft tissue to obtain a normal sized, painless and functional foot. It would be helpful to know the anatomy of foot so that some structurally based treatment plan could be formulated [6].

In many diseases of foot, such as talocalcaneal coalition or arthritis, intra articular fractures, congenital dysmorphology, flat foot, valgus deformities etc, the size and shape of bones, relationship of talus and calcaneus with each other and other bones of the foot must be considered for internal and external fixation and surgical procedures [12-14].

Knowledge of talar facets of 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 interval between anterior and middle facet is important for the exact placement of retractor, since the line of osteotomy usually passes through the same interval and even graft patching is done in this interval [15,16].

This technique is suitable for Europeans who predominantly have calcanei with Type II facet configuration for the tali. Type I is found to be predominant in Indians, the surgeons here have to be careful while applying this technique or a suitable modification may be required. It establishes that awareness about the variations in talar articular facets of calcaneum is vital in surgical management of foot deformities.

In the triple arthrodesis procedure to correct deformities of flat foot, articular facet

configurations of calcaneum should be clearly kept in mind in order to safely denude the surface of subtalar joint of all the articular cartilage [15].

Three dimensional computerized imaging techniques may present facet surfaces of talus and calcaneus. So by using this techniques, In cases of talocalcaneal subluxation, coalition and many dysmorphologies, success rate of diagnosis and treatment will increase and talocalcaneal joint implants and prosthesis may be developed [13,17].

CONCLUSION

The present study done on 150 dry human calcanei brings out a wide spectrum of variants among the talar articular facets in a group of north Karnataka subjects. Based on the observations and analysis, it was found that Type I was commonest type, Type II being the second commonest. North Karnataka population may be at a greater risk of developing subtalar arthritis due to dominance of Type I. Type V which was noted in the study is the rarest type and is scarcely reported in literature. Pattern of talar articular facets on calcaneum exhibits racial differentiation, the knowledge of which is vital for the orthopaedic surgeons in India when they perform calcaneal osteotomy. Modification of surgical procedures described in European literature is mandatory to suit the Indian scenario.

Conflicts of Interests: None

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