

Non-metrical study of the pattern of talar articular facets in south Indian dry calcanei

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Abstract

Objective Tarsal coalitions are common in the middle talocalcaneal joints and prognosis of intracapsular fractures in the region is bad. So this study was done to know the size, shape and number of talar articular facets and the distance between the two anterior facets.

Materials and methods A total of 300 (154 right and 146 left) dry human calcanei of unknown sex were studied. The articular facets were marked with marker pen; the distance between the smaller anterior and middle facets was measured using a vernier calipers and they are classified into four types.

Results After classification of the calcanei, we found that Type-1 was 67%, Type-2 was 28.66%, Type-3 was 3%, and Type-4 was 1.33%.

Conclusion In our study, Type-1 was common followed by Type-2. Race appears to play a part in the determination of the type of facets and hence this study will be useful for the orthopedics surgeons during various surgical procedures.

Keywords Calcaneus · Talar articular facets · Tarsal coalition

Introduction

The calcaneus is the longest and largest of the tarsal bones. It articulates with the overlying talus to form the

talocalcaneal joint which together with the talocalcaneonavicular joint are clinically referred to as the subtalar joint where the important movements of inversion and eversion of the foot occur. The middle third of the superior surface of the calcaneus carries the posterior talar facet for articulation with the body of the talus. In the anterior third of the calcaneus, distal and medial to the sulcus calcanei, an articular area covers the sustentaculum tali. This facet articulates with the head of the talus, and may be divided in about half the cases by a non-articular zone creating middle and anterior talar facets the incidence of which varies with race and sex [17]. This morphological variability of the facets could result from differences in the gait or other habits influencing these articular areas or it could be indicative of genetically determined variations.

The morphology of the articular facets of the calcaneus has been a subject of interest to anatomists. The articular facets of the sustentaculum tali have a variety of configurations and are functionally important because they influence subtalar joint stability [5].

In various diseases of foot, such as the talocalcaneal arthritis and coalition, intraarticular fractures and congenital dysmorphology, flatfoot, valgus deformities, the size and shape of the bones, the relationships of the talus and calcaneus with each other and other bones of the foot must be considered for the internal and external fixation and surgical procedure [19].

Materials and methods

The study was done on 300 normal adult human dry calcanei of unknown sex of which 154 were of right side and 146 were of left. The numbering of bones was done on the superior surface posteriorly. Each bone was marked

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with a marker pen by outlining the superior articular facets. A tracer paper was placed over the facets and was traced such that the topography of the facets and the distance between all the facets were maintained. From the tracer paper, facets were copied onto a white sheet using a carbon paper. All bones were classified into four groups based on the number of talar articular facets present on each calcaneus:

Type 1 Two articular facets present with anterior one either constricted or non-constricted. This was further subdivided into:

- 1a: If the anterior facet was non-constricted.
- 1b: If the anterior facet was constricted

Type 2 Three articular facets present, the distance between anterior and middle facet was measured with help of vernier calipers. This was further subdivided into:

- 2a: If the distance was <2 mm.
- 2b: If the distance was between 2 and 5 mm.
- 2c: If the distance was >5 mm and the size of the anterior facet was large.
- 2d: If the distance was more than 5 mm but the size of the anterior facet was quite small.

Type 3 Two articular facets present with anterior one restricted to sustentaculum tali

Type 4 One facet

Results

The facets on the superior surface of the calcaneus were classified into four types:

Type-1 had two facets (67%).

Type 1a was seen in 16.6% of cases (Fig. 1).

Type 1b was seen in 50.3% of cases (Fig. 1).

Type-2 had three facets (28.6%). Two facets were for the head of the talus, anterior and middle. However, the distance between these two facets was variable. It was measured and sub classified into four groups as below.

Type 2a was seen in 5.3% of cases (Fig. 2).

Type 2b was seen in 13.6% of cases (Fig. 2).

Type 2c was seen in 7.3% of cases (Fig. 2).

Type 2d was seen in 2.3% of cases (Fig. 2).

Type-3 (3%) had two facets but the anterior one was on the sustentaculum tali (Fig. 3).

Type-4 (1.3%) had a single fused facet (Fig. 4).

Discussion

The number and arrangement of the articular facets on the superior surface of the calcaneus designated to carry the head of the talus have been described variously by different authors (Table 1). The result of our study was consistent

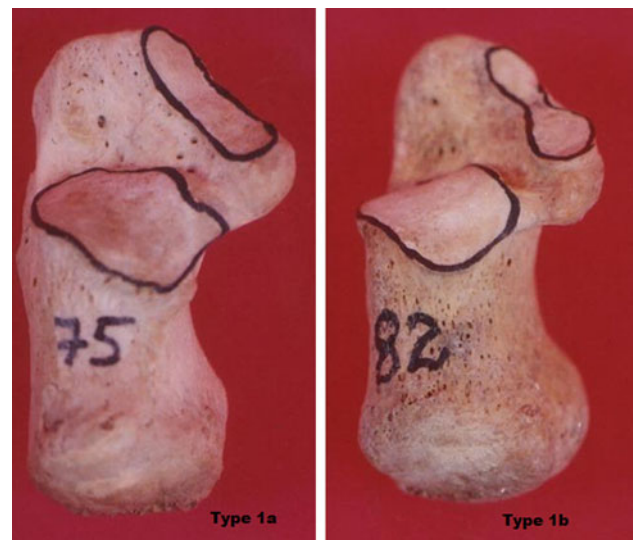


Fig. 1 Showing two facets on the calcaneum. *Type 1a* The anterior facet was non-constricted. *Type 1b* The anterior facet was constricted

with the studies done previously. For all studies, the first two types type 1 (201), type 2 (86) constitute the two most common varieties of facets for the articulation with the talus. The facets on the sustentaculum tali may be of equal sizes but if the anterior facet is very small, it can be totally overlooked.

The embryology of subtalar joint is very important for the facets to be formed on calcaneum for the talus. The first constitutive features of the subtalar joint start to clarify from the eighth week. At this stage, the talus and calcaneus look as cartilaginous precursors separated by mesenchymal tissue whose cells are rounded, packed and not yet positioned. At the ninth week, cavitation of the subtalar joint occurs with rarefaction of the mesenchymal cells at the forthcoming articular surfaces but does not include the entire joint equally. The cavitation of the posterior aspect of the joint proceeds more rapidly than at the anterior aspect. At the 10th week, the posterior surface of the subtalar joint is well formed. The anterior and medial articular surfaces of the subtalar joint seem more developed. At the 11th week, the cavitation process of the subtalar joint is shown to be developing differently in three regions, anterior, middle, and posterior. The articular surfaces are easily obvious at this time. At the 14th week, all the articular and capsulo-ligamentous structures of the subtalar joint and the sinus tarsi are clearly obvious. The anterior and posterior subtalar joints, well cavitated, have their proper articular capsule and a distinct sinus tarsi and tarsal canal where the extensor retinaculum, the cervical ligament and the interosseous ligament can be observed [15].

Shahabpour et al. have done a MRI study to look for variations of the subtalar and talocalcaneonavicular joints.

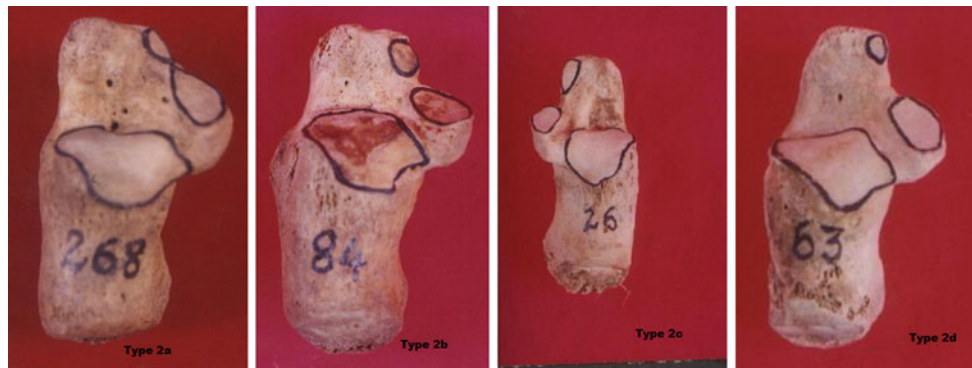


Fig. 2 Showing three facets. Two facets were for the head of the talus, anterior and middle. *Type 2a* The distance between these 2 facets was $< 2\text{ mm}$. *Type 2b* The distance between these two facets was between 2 and 5 mm. *Type 2c* The distance between these two

facets was more than 5 mm but the anterior facet was large. *Type 2d* The distance between these two facets was more than 5 mm but the anterior facet was small



Fig. 3 Showing two facets but the anterior one was on the sustentaculum tali *Type-3*

They found that 18 (36.7%) of the subjects had 3 distinct facets on the calcaneus which in our study we found in 28.6% of cases [18].

Bunning and Barnett [1] reported that the incidence of Type 1 is significantly higher than Type 2 in both Sudanese & Indian series. El-Eishi found Type-3 to a greater extent in Egyptians, which suggests that the facets are genetically determined as mentioned by Bunning and Barnett [2, 6]. Type-4 facet is common in Nigerians and Veddah but in a very small sample. Type-4 may, therefore perhaps be used as a ethnical characteristic [3].



Fig. 4 Showing single fused facet *Type-4*

In all the Indian studies done including the present one, Type-1 facets occurred in 62–67% of calcanei. In western studies also 60–70% of the calcanei showed the occurrence of Type-1 facets. In Egyptians and Spanish, Type-1 facets are found in only 50% of the calcanei, whereas, only about 30% of the European calcanei show this facet.

In Indians and most of western population percentage of Type-2 facets is just about half of the Type-1 facets. On the other hand, in Egyptians and the Spanish, the occurrence of Type-1 and 2 facets is approximately same, while in Europeans, Type-2 facets are almost twice as common as Type-1 facets. This appears to be an interesting ethnic characteristic. Many such factors as wearing of shoes, squatting habits, genetic and ethnic differences are the

Table 1 Comparison between the present findings and those of other authors as regards with the types of facets on the superior articular surface of the calcaneus

Authors	Type 1	Type 2	Type 3	Type 4	Total
Bunning and Barnett [1]					
European	130 (67%)	64 (32.9%)	0	0	194
Nigerian	312 (63.4%)	176 (35.7%)	0	4	492
Indian	61 (78.2%)	17 (21.7%)	0	0	78
Veddah	6 (60%)	4 (40%)	0	0	10
El-Eishi (Egyptian) [6]	98 (49%)	80 (40%)	22 (11%)	0	200
Gupta et al. [7]	268 (66.8%)	104 (25.9%)	21 (5.2%)	8 (1.9%)	401
Padmanabhan [14]	177 (65%)	95 (34.9%)	0	0	272
Campos and Pellico [4]	94 (53.4%)	82 (46.5%)	0	0	176
Present study (2011)	201 (67%)	86 (28.6%)	9 (3%)	4 (1.3%)	300

probable reasons for the variations in the facets on the calcanei in the western and Indian series.

The distance between anterior and middle facet is important for evans' osteotomy. This technique is used for correction of pes plano valgus deformity and stage 2 posterior tibial tendon dysfunction, particularly when the apex of deformity is in the transverse plane. In lengthening the lateral column, talar head coverage by the navicular increases, forefoot abduction and hindfoot valgus decrease, and there is an increase in the height of the longitudinal arch. The osteotomy courses from lateral to medial in the calcaneal anterior process 1.5 cm proximal to the calcaneocuboid joint that crosses medially between the anterior and middle subtalar facets. A tricortical bone graft is used to lengthen the lateral column. So, we have divided the type 2 classifications in further subgroups to measure the distance between both of them [8].

An accessory anterolateral talar facet was found in 34% of the specimens in a pediatric osteologic group. The facet was associated with male sex, a reduced angle of Gissane, and dorsal talar beaking which we did not found in the present study [11].

Disposition of superior articular facets of the calcaneum is congenital and not a postnatal development with Type-1 more in females-sexual dimorphism [1]. Tarsal coalitions are inherited most probably as a unifactorial disorder of autosomal dominant inheritance with full penetrance [9]. They occur in association with carpal coalitions, phocomelia, hemimelia [12]. 83% are talocalcaneal leading to tarsal tunnel syndrome, osteophyte causing sensory disturbance in the region of medial plantar nerve and restriction of plantar flexion at the ankle joint [13]. Calcaneal fractures account for 33.3% of foot fractures. And it was seen that there was 100% involvement of posterior talocalcaneal facet in intra-articular calcaneal fractures [16].

In Indian populations where walking is mainly barefoot or in sandals so that the subtalar joint is more exposed to

the stresses that may be produced by walking unprotected by shoes the anatomy of these articular facets is important and may also have a role in planning foot surgery [10].

Conflict of interest We declare that we have no conflicts of interest. There is no financial help from the organizing research committee.

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