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Variations in the Articular Facets on Superior Surface of Calcaneus in North Indian Population: A Dry Bone Study

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ABSTRACT: *This study was conducted in the department of anatomy of Gian Sagar Medical College, Ramnagar, Rajpura, District Patiala. 325 dry calcanei were studied. Out of which 167 were of right side and 158 were of left side and are of both sexes. The facet for talus were observed in all the calcanei. The grouping was done on the basis of number of facets present on the superior surface of calcanei. Group-I was having single facet on the two bones only (0.615 %). Group-II was having two facets and this group was further divided into three subgrpoups i.e Group-II (A,B,C), Group-II A (15.69 %) of right side and (12.00 %) left side. Group-II C (0.31 %) of right side only. Group-III was having three facets i.e (20.62%). it was further divided into two subgroups i.e Group-III (A,B.) Group-III A (8.62 %) of right side and (12.00 %) of left side and Group-III B (4.92 %) right side and (4.3 %) left side . It was concluded that the variations in differences between various types of facets on calcanei can result from differences in gait, habit of shoe wearing, sitting posture, clinical changes and embryological abnormalities of foot. Some of the types of facets can produce the problems in gait and can also cause pain in foot.*

Keywords*:- Calcaneus talus, Sustantaculum tali, Facets, Confluence, Sulcus calcanei, High arched foot, Flat foot, Pess vulgaris, Spring ligament, Calcaneo navicular ligament .*

INTRODUCTION :

Calcaneus is the largest tarsal bone, having dorsal or superior, anterior, posterior, medial, lateral and planter surfaces. On the planter surface there is no articular facet but there

are medial and lateral tuberosities. Anterior surface is having articular facet which articulates with the cuboid bone. Posterior surface is partly subcutaneous and partly it gives the attachment to tendo calcaneus ligament. Above the attachment of tendocalcaneous ligament there is a bursa which prevents the friction between the tendon and bone. On the lateral surface there are peronei tubercles on which the peroneal retineculum attaches, to give passage to the peroneus longus muscle. The medial surface is somewhat concave. There is shelf like structure projecting medially. This projecting part is known as sustantaculum tali. On the superior surface of sustantaculum tali most of part of head of the talus sustains on it .The superior surface of calcaneus is divided into three parts i.e posterior 1/3 rd non articular, middle 1/3 rd articular which articulates with the inferior articular surface of talus, anterior 1/3 rd again articular surface for inferior articular surface of head of talus and also having the groove which is known as sulcus calcanei , which completes the sinus tarsi with talus. Distal and medial to the groove an elongated articular area covers the sustentaculum tali , extending distolaterally on the bone's body. This facet is often divided by a non-articular interval at the anterior limit of the sustantaculum tali , forming middle and anterior talar facets , the incidence of which varies with sex and race(Williams et al. 1965).

Superior surface of calcaneus is marked by a large, oval posterior articular facet for the talus, which is convex antero posteriorly. The medial part of the area has the anterior articular surface for the head of the talus anteriorly and forms the floor of the sinus tarsi posteriorly.Medial to the main surface for the talus, the sustantaculum tali projects with rough medial border. The upper surface of the sustantaculum tali carries a middle articular surface for the talus. This may be fused with the smaller anterior articular surface for the head of the talus just lateral to the planter calcaneonavicular ligament. The groove between the posterior and middle articular surface is the sulcus calcanei which forms the floor of the sinus tarsi. It recieves fibres of the inferior extensor retinaculum (Harrison,1995).

The patterns of distinct facets identified by **Bunning and Barnett (1965)** studied 78 Indian calcanei and gave their classification as following:-

Type-A This type was having three facets on the superior surface of the calcanei posterior, middle and anterior facets on the body ,sustantaculum tali and superior surface of distal part of calcanei and was reported in 16.67% in cases.

Type-B The posterior facet on the body and the middle facets present on the sustantaculum tali but the anterior facet fused with the middle facet of calcanei to form the one facet and they found this type in 83.33% cases of calcanei .

Type -C This type was having single facet which was formed by confluence of all the three facets present on superior surface of calcanei. This type is very rare.

Jha and Singh (1972) studied 1600 (800 right and 800 left) grossly normal human calcanei. They observed the facets on superior surface of calcanei and noted and divided the facets into three types i.e type A, B and C. Type-B was having two facets on the superior surface of calcanei and reported that 998 calcanei out of 1600 calcanei belong to this type i.e largest number of calcanei belong to this type i.e 62.375 % and divided it into further four sub groups.

Sub group-1 Anterior and middle articular facets completely fused and form a simple facet and large number of calcanei belong to this group i.e 33.75% in cases.

Sub group-2 Anterior and middle articular facets incompletely separated from each other by means of a notch and reported 190 calcanei having such like facets out of 1600 calcanei i.e 11.875 % in cases.

Sub group-3 Anterior and middle articular facets separated from each other but with no non-articular area intervening and just like sub group-2 and reported 222 calcanei out of 1600 i.e 13.875% in cases.

Sub group-4 Anterior articular facet absent and the middle and posterior articular facet were present in this sub group. They reported 46 calcanei out of which 16 of right side and 30 of left side out of 1600 calcanei i.e 2.875 % in cases.

Type-A calcanei having 3 articular facets were 600 out of 1600 i.e 37.5 % of cases. In these calcanei articular facets were compeletely separated from each other. The anterior and middle facets were separated by a non-articular area interveining and the groove of calcaneus (Sulcus calcanei) separated the middle facet from the posterior one.

El-Eishi (1974) studied 200 calcanei and classified facets into three types i.e type-1,type-2 ,type-3. No calcaneus was found with one facet which is found by the joining of all the three facets i.e anterior, middle and posterior facets. He reported following three main patterns of facets:-

Type-1 in 49 % cases which were having one continuous , elongated , concave facet situated on the sustantaculum tali and anterior facet on the medial corner of the distal part of the body of the calcaneus.

Type-2 in 40 % of cases in which there were two articular facets i.e one situated on the sustantaculum tali and other on the distal part of the calcaneus. However degree of separation between these two facets was variable.

Type-3 in 11 % cases there was one well circumscribed oval facet confined to the sustantaculum tali. No calcaneus was found with single facet which may confluence with the posterior facet on the superior surface of calcaneus.

Gupta et al (1977) studied 401 Indian calcanei and classified the facets present into four types. Type-I (67%) showed one continous facet on the sustentaculum tali extending to the distomedial calcaneum corner ; Type-II (26%) presented two facets , one sustentacular , one distal calcaneum ; Type-III (5%) possessed only a single sustantacular facet; and Type-IV (2%) showed all anterior, middle and posterior facets confluent.

Saadeh et al. (2000) : studied 300 dry calcanei irrespective of their sex and of adult subjects. They described the facets on the superior surface of calcanei into four distinct facet patterns.

Type-I reported as highest frequency and prescribed a single facet resulting from the confluence of middle and anterior facets. They found 189 calcanei having this type of facet out 300 calcanei i.e 63.0 % of cases.

Type-II was having middle facet on the sustantaculum tali along with posterior facet, and anterior facets were distinct with a variable degree of separation. They found 91 calcanei having this type of facet out of 300 i.e 30.3 % in cases.

Type-III a single facet was present which was limited to the sustantaculum tali. They found 14 calcanei having this type of facet out of 300 i.e 4.7 % in cases.

Type-IV reported as least frequent with a single extended facet representing the confluence of the posterior, middle and anterior facets and reported 6 calcanei out of 300 i.e 2.0 % in cases.

MATERIAL & METHOD

The present study of dry calcanei was conducted in the Department of Anatomy of Gian Sagar Medical college, Ramnagar , Rajpura , District Patiala. 325 (167 of right and 158 of left side) dry calcanei were the study material. All the bones belonged to adult and were of both sexes. This study is based on morphological study. The facets were observed with naked eye, where ever it was difficult to observe the magnifying glass of 5 X was used. The facets present on the superior surface of calcanei were studied with care and were outlined with black marker. The shapes, positions and numbers of facets were recorded and photographed. The data was compiled and calcanei were grouped according to the number of facets for the talus. The present study was compared with the previous studies done by other workers.

OBSERVATIONS

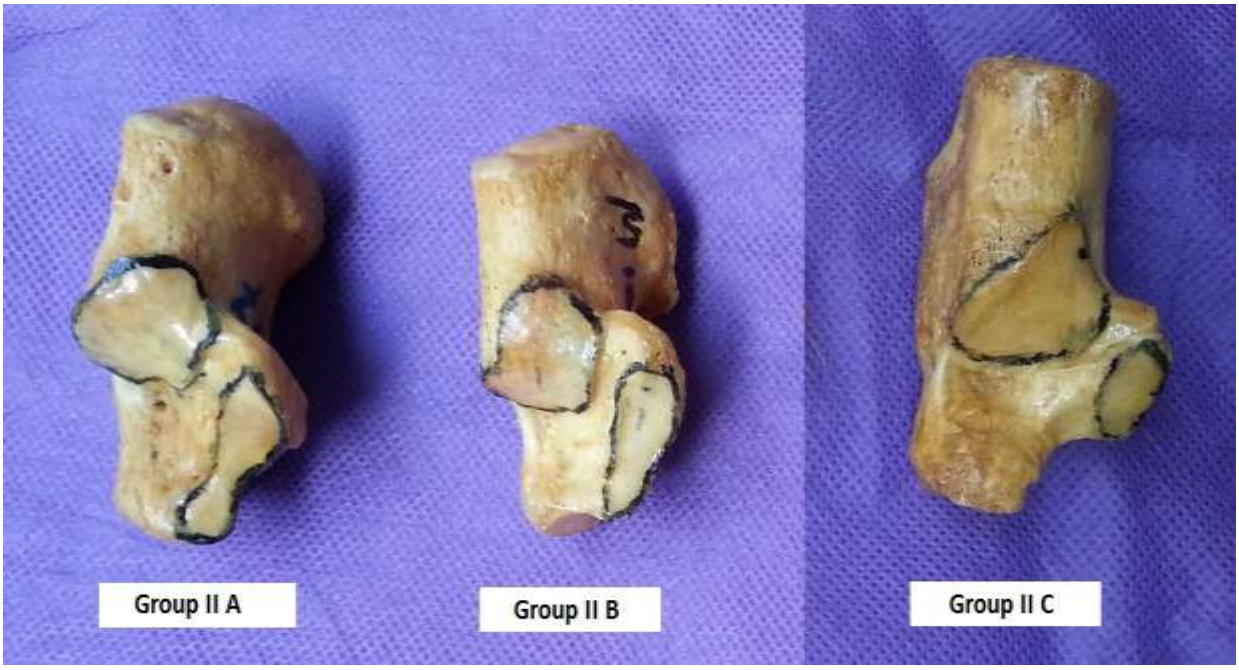
The present study was conducted in the department of Anatomy of Gian Sagar Medical college, Ram Nagar, Rajpura, District Patiala. 325 dry calcanei were studied. Out of 325 calcanei 167 calcanei were of right side and 158 were of left side. All the calcanei were of adult age and of both sexes.

Grouping of calcanei was done according to the presence of number of facets on superior surface of calcanei as under:-

Group-I (Photograph-1) In this group all the three facets posterior, middle and anterior were united to form a single facet. Out of 325 dry calcanei studied only 2 calcanei (0.615%) both of right sides were having single articular facet on their superior surface. These facets were having irregular shapes and margins. In these 2 calcanei all the three (anterior, middle and posterior) facets were united to form the single facet (Type-C of Bunning and Barnett-1965).

Photograph-1

Group-II (Photograph-2) This type was having two facets on the superior surface of the calcanei, one posterior facet and one middle facet. 226 calcanei out of 325 calcanei belonged to this group i.e 69.53 % of cases (Type-B of Bunning and Barnett-1965). The calcanei having two facets were further grouped into three subgroups i.e group-IIA, group-IIB, group-II C the most common type/group**.**



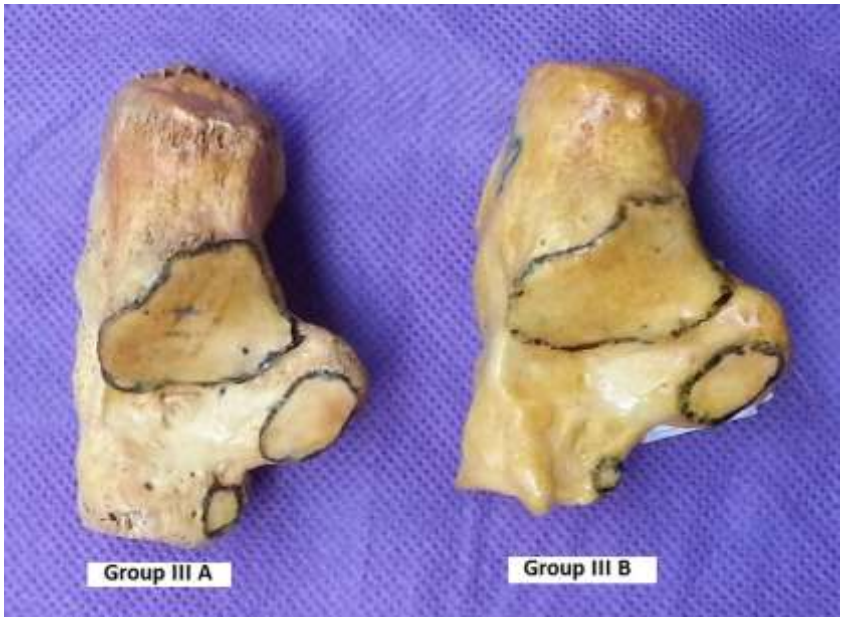
Photograph-2

Group-II A (Photograph-2) The calcanei were having two facets i.e one posterior facet and the other elongated facet showing fusion of middle and anterior facets with a middle contriction. Total number of calcanei having this type of facets were 90 out of which 51 i.e 15.69% were of right side and 39 i.e 12.00 % were of left side.

Group-II B (Photograph-2) The calcanei having the two facets , one posterior and the other elongated facet with no constriction and anterior end taperinge facets. Out of 135 calcanei of this type 69 calcanei i.e 21.23 % were of right side and 66 calcanei i.e 20.30 % were of left side.

Group-II C (Photograph-2) In this group there was only one calcaneous out of 325 calcanei in which two facets were present i.e one posterior facet and one middle facet and anterior facet being absent, the middle facet was rounded circumscribed and limited to the proximal part of sustantaculum tali and smaller as compared to group –IIB. It was present only in 0.31% of cases.It was of right side.

Group-III (Photograph-3) In this group of calcanei there were three facets on the superior surface of calcanei i.e posterior, middle and anterior facets. Posterior facet for the body of talus, middle and anterior facets for the head of talus. One facet on the sustantaculum tali and another facet on the superior surface of distal part of the calcanei. 97 calcanei out of 325 calcanei were having this type of facets i.e 29.85 % of cases.This group further sub divided into two sub groups i.e Group-III A and Group-III B**.**



Photograph - 3.

Group-III A (Photograph-3) This group was having three facets, one posterior facet on the body of calcanei , one middle facet on sustantanculum tali and another facet on the distal part of the superior surface of calcanei. In this group anterior facet was larger in size as compared to Group-III B. 67 calcanei out of 325 i.e 20.62 % were having this type of facets out of which 28 i.e 8.62 % of right side and 39 i.e 12 % of left side**.**

Group-III B (Photograph-3) The anterior facet was very small as compared to Group-III A. 30 calcanei were having this type of facets i.e 9.23 % out of total 325 calcanei. Out of which 16 calcanei i.e 4.92 % of right side and 14 calcanei i.e 4.3 % were of left side**.**

DISCUSSION

The calcaneus is designated in such a way that it gives support to the talus to rest on it. The head and body of the talus rests on the superior surface of calcaneus and as this the articular facet forms on the superior surface of calcaneus. Most commonly there are three facets on the superior surface of calcaneus, posterior facet for the body of the talus, middle facet for the head of the talus, anterior facet for the anterior part of head of the talus. Various studies have been performed on the facets on calcaneus for talus. These are being compared with the present study.

In the present study we observed the facets on the superior surface of the dry calcanei which belonged to adults and were of both the sexes. The grouping the pattern of facets was done according to the presence of facets on the superior surface of the calcanei as under:-

Group-I A single facet was present which was formed by the fusion of posterior, middle and anterior facet and was irregular in shape.2 calcanei out of 325 calcanei i.e in 0.615 % of cases (Photograph-1).

Group-II In this group two well defined facets were present, one posterior and one middle facet and middle was formed by fusion of anterior facet .226 calcanei were found to belong to this group i.e 69.53 % of cases. It was further divided into three subgroups i.e group-II A, B, C (Photograph-2).

Group-III In this group three well defined and distinct facets were present. 97calcanei belonged to this group i.e 29.85 % of cases and Group-III was further subdivided into two subgroups i.e Group-III A and B (Photograph-3).

Group-III A In our study is found to be minimum and it is in concordance with the reported literature. In present study it is 0.15 % and it matches with type c of Bunning and Barnett (in El-Eishi 0 %).Type- 4 In Saadah 2 % and gupta-et al 2 %.

Group-III B of present study contributes the maximum occurrence in the studies i.e 69.153 % in present study Bunning and Barnet (1965) Type-B 83 %, Gupta et al 1977 67 % , Saadah et al Type-I 63 %.

Group-III forms the 2nd largest occurrence in all the studies. In present study it is 24.85 %. Bunning and Barnett (Type-A) 22.0 %, Gupta et al (Type-2) 26 % and Saadah (Type-II) 30.03 %.

There is no much variation as far as in the occurrence of facets on calcanei for talus, Group-II are maximum in all previously reported studies followed by Group-III and rarest is Group-I which has not been reported in certain studies. It shows that occurrences of facets are independent of environmental, geographical and ethnic distribution. Single facet on the sustanteculum tali and anterior small facet may have some relation to foot wear which has not yet been proved.

Table-1. Comparison of present study with that of other authors

Author & Year	Number of Calcanei Studied (Country)	Pattern of Articular facets on the calcanei (According to number of facets)			
		One Facet	Two Facets	Three Facets	Any Other
Bunning and Barnett (1963)	78 (Egyptian)	-----	83.33%	16.67%	-----
Jha and Singh (1972)	1600 (Indian)	0.125%	62.375%	37.5%	------
El-Eisri (1974)	200 (Egyptian)	-----	49.0 %	40.0%	11.0 %
Gupta et al. (1977)	401 (Indian)	2.0 %	67.0 %	26.0 %	5.0 %
Saadeh et at, (2000)	300 (Egyptian)	2.0 %	63.0 %	30.0 %	4.7 %
Present study (2014)	325 (Indian)	0.62 %	69.53 %	29.85%	-----

Bunning and Barnett (1965) reported that type B is more common in Indians than type A , however the ratio of type B to type A in Indian's was 24:4. As this they concluded that type B was 83.33% and type A 16.67%.This result could perhaps be ascribed to special posture or gate (Table-1).

Campos FF, Pellics L G (1989) studied 176 calcanei and classified into three types : Type A- Calcanei with two articular facets for the talar head , with four subtypes ; Type B- Calcanei with one articular facet for the talar head and devided into two subtypes and Type C- Unique articular facets in the superior surface of the calcaneus for the talus. They found 53 % (94 cases) Type- B calcanei and 46 % (82 cases) Type- A calcanei. No calcaneus of Type- C was seen. They wrote that in type C all the three facets i.e posterior, middle and anterior facets were united with each other and reported 2 calcanei out of 1600 calcanei i.e only 0.125 % and both were of right side (Table-1) .

Gupta et al. (1977) studied facets of 401 calcanei and divided the facets into four types i.e type-1 type-2 type-3 and type-4 and reported that type I as 67 % , type II as 26 % and type III as 5 % and type IV only 2 % of cases (Table-1).

In literature the posterior facet was present in all the calcanei. The variations found was in other two facets i.e middle and anterior. It was either a fused continuous facet which

was observed in maximum calcanei including the present study i.e 69.53%. It was the commonest pattern. The second was having one posterior (constant) facet and two facets (middle and anterior) but not fused. It uniformily made the 2nd type of calcaneus in all the previous and present study. However the distance between two and size of the facets was variable and this type has been divided into subtypes by various authors based on the distance and shape of these two facets. The minimum occurrence was of third type having confluence of all the three (posterior, middle and anterior facets. In some of the studies it was not found even in a single case. Bunning and Barnett 1963, El-Eishi 1974 found no calcanei of this type (Table-1). A separate group explained by some authors is of Group-II C observed in present study. Bunning and Barnett 1963, Jha and Singh 1972 and in present study no such type of group was found (Table-1).

Clinical implication of different types of the facets of calcanei :-Variations of facets of calcanei depend on the shape of foot, foot wears and clinical deformity of foot. The facet which was irregular and formed by the fusion of posterior, middle and anterior facets of calcanei can be due to the continous squatting and in telepus aquanus condition of foot. The calcanei in which there are two facets (posterior and middle) on the superior surface of the calcaneus, these facets can be present in the normal shape , simple wearing of the foot and without any deformity.

The calcanei in which there are three facets (posterior, middle and anterior) present on the superior surface of calcaneus, can be due to high heeled foot wearing. The high heeled wearing will give rise the anterior facets on the superior surface of distal part of the calcaneus because high heel transmits the weight of body anteriorly and gives rise to the anterior facet on the superior surface of distal part of the calcaneus .The anterior facet can appear in flat foot also, due to loose calcaneo-navicalar ligaments and spring ligament and the anterior part of head of talus will rest on the superior surface of the distal part of the calcaneus. The calcanei in which there is one well circumscribed facets along with the posterior facet on the proximal part of the sustantaculum tali is present, can be due to high arched foot in which head of talus partially articulates with the sustantaculum tali and give rise the impression on the proximal part of sustanticulum tali to form this facet. (Bunning and Barnett 1963; 1965)

These clinical implications can be confirmed by the physical examination, clinical correlations, radiological examination and MRI, etc. examination of the subjects. The radiological examination, MRI examination is not done in this study.

Conclusion

The variations in differences between various types of facets on calcanei can result from differences in gait, habit of shoe wearing, sitting posture, clinical changes and embryological abnormalities of foot. Some of the types of facets can produce the problems in gait and can also cause pain in foot.

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