ORIGINAL ARTICLE

TYPES OF TALAR ARTICULAR FACETS AND MORPHOMETRIC MEASUREMENTS OF THE HUMAN CALCANEUS BONE

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ABSTRACT

Introduction: The calcaneum is the largest tarsal bone. On its dorsal or superior surface, there are three articular facets for the talus.
Objective: The main purpose of the present study has been to find the incidences of variations in types of the talar facets and their association with racial factors, if any. The other objective of the study has been is to find the relation between the total length of the calcanei and the types of calcanei.
Method: In the present study of 529 calcanei of unknown sex in Gujarat State, were studied.
Result: We found that in 73.67 % of calcanei, the anterior and the middle facets are continuous with each other and in 22.3 % calcanei these two facets are separate from each other. In 1.13 % calcanei, the anterior facet is absent.
Conclusion: The study shows racial similarities and differences. The study will serve as a prelude for biomechanics of foot.

Key-words: Calcaneal length, Articular Facets, Inter Facet distances

INTRODUCTION

The calcaneus is a weight bearing tarsal bone of the proximal row. It also forms the posterior pillar of the two longitudinal arches of the foot. The superior surface has articular facets on the body and the sustentaculum tali by which it articulates with the talus.

Normally there are three facets for synovial joints between calcaneus and talus, Anterior, Middle and Posterior. The anterior and the posterior facets are situated on the body and the middle is situated on the sustentaculum tali. There is considerable variation in the number and arrangement of these facets..

Bunning and Barnett (1963) have observed that there are three types of variations in the arrangement of facets. They have classified these variations as follows:

Type-A: There are there facets separated by variable intervals.
Type-B: There are two facets anterior and middle which are either continuous or have a notch between them.
Type-C: There is only one facet i.e. the three form a continuum.

Few Indian workers have also worked on this subject. Jha et al (1972) have reported that type-B clacnei are common amongst the population in Uttar Pradesh and also have classified type-B calcanei into four subgroups :

Subgroup-1: Anterior and middle articular facets completely fused and form a single facet.
Subgroup-2: Anterior and middle articular facets incompletely separated from each other by means of a notch.
Subgroup-3: Anterior and middle articular facets separated from each other but with no non-articular area intervening.
Subgroup-4: Absence of anterior articular facet. Only middle and posterior articular facets were being present.

Gupta et al (1977) have classified the calcanei in numerical types as follows:
Type-I(1): Corresponds to type-B of the Bunning and Barnett classification (1963).
Type-II(2): Corresponds to type-A of the Bunning and Barnett classification (1963).

Type-III(3): Has only two facets, not corresponding to any type of Bunning and Barnett. The anterior facet is absent. Only the middle and the posterior facets are present.
Type-IV (4): Corresponds to type-C of the Bunning and Barnett classification (1963).

However, this subject is interesting but comparing the larger population of the Indian subcontinent and the amount of study carried on the variation of facets is much less. Similar study in population of Gujarat State has not yet been undertaken so far.

It was therefore, considered necessary to carry out the study of calcaneal facets in Gujarat State.

MATERIAL AND METHOD

Five hundred twenty nine grossly normal adult human calcanei were procured from the departments of Anatomy, Medical College, Baroda; B.J. Medical College, Ahmedabad; Government Medical College, Surat and Dental College, Ahmedabad.

Sexual dimorphism was not considered. A good properly aligned sliding calliper was selected for the measurement of the total lengths of the calcanei. The total length of the calcaneum was taken in the horizontal position. The anterior point was the upper part of the cuboidal articular facet situated on the anterior surface of the calcaneum. The posterior point was the rough bony part for the attachment of the tendo clacaneus. The measurements were taken in decimal system.

Where the anterior and the posterior facets were separated from each other, the distance between the two was measured with the help of the blunt pointers of the sliding calliper. The posterior most part of the anterior facet was taken as the anterior point and the anterior most part of the posterior facet was taken as the posterior point.

All the observations and the measurements were put into tabular form.

OBSERVATION

The total numbers of calcanei examined were 529, out of these 260 were of the right side and 269 were of the left side.

These calcanei were classified into type A, B, C, D and type E according to the configuration of the superior talar articluar facets. The criteria to group them into various types are as follows :

Type-A: Presence of three separate articular facets anterior, middle and posterior on superior surface.
Type-B: Presence of two articular facets where anterior and middle are continuous with each other. The posterior facet is separate.
Type-C: Here all the three facets i.e. anterior, middle and posterior are continuous with each other.

Type-D: In this group, the anterior facet is absent and only the middle and posterior articular facets are present. (Fig 1)
Type-E: Here the anterior articular facet is absent and the middle and the posterior articular facets are continuous with each other. (Fig :2)

Fig 1

Fig 2

Fig 1 Type-D Calcaneum (Left Side) Absent Anterior Facet

Fig:2: Type-E Calcaneum (Left Side) Continuous middle and posterior facet

Table 1: Percentage incidence of the types of calcanei

Type of Calcaneum	Right side Bones (%) (n=260)	Left side bones (%)(n=269)	Total bones (%) (n=529)
Type-A	54 (20.76)	64 (23.79)	118 (22.30)
Type-B	204 (78.46)	200 (74.34)	404 (76.37)
Type-C	0 (0	0 (0)	0 (0)
Type-D	01 (0.38)	05 (1.85)	06 (1.13)
Type-E	01 (0.38)	00 (0)	01 (0.18)

From the Table -I, it is clear that the pattern of facets of type-B is commonest. The percentage of incidence on the right side is 78.46 and that on the left side, it is 74.34. The difference is 4.The next common type is the type-A group. On the right side the percentage incidence is 20.76 and that on the left side is 23.79 %. The incidence of type-A facet is higher by 3 % on the left side than the right side. There are no calcanei belonging to type-C. The incidence of type-D and type-E is very less. The type-D has an incidence of 1.138, while the type-E is only 0.18 %. The type-B calcanei were further classified into two subgroups on the following criteria :

Subgroup-I In this subgroup, the anterior and middle articular facets were completely fused and formed a single continuous facet.

Subgroup-II In this subgroup, the anterior and middle articular facets were incompletely separated from each other by means of a notch Constriction.

Table 2: Percentage of Incidence of the Two Subgroups of Type-B Calcanei (n=404)

Subgroup	Type B Calcanei		
	Right side (%) (n=204)	Left side (%) (n=200)	Total (%) (n=404)
I	126 (61.76)	111 (55.5)	237 (58.66)
II	078 (38.23)	089 (44.5)	167 (41.33)

The total length of the calcanei was measured and the range was found between 5 cms and 9 cms. They were further grouped into smaller units, each unit having a difference of 0.5 cm. These units were designated as a, b, c, to h.

Table 3: Incidences of the Various Types of the Calcanei in Relation to the Total Length (Right Side - Total Bones 259)

Type of calcanei	Total length range measured in cm. RT.							
	a	b	c	d	e	f	g	h
Type-A	0	0	01	04	25	14	09	1
Type-B	1	1	15	15	95	44	29	4
Type-C	0	0	00	00	00	00	00	0
Type-D	0	0	00	00	00	01	00	0
Type-E	0	0	00	00	00	00	00	0

The above table shows that the type-A calcanei falls in the range between 'e' and 'g' i.e. between 7 cm to 8.5 cm.The type-B calcanei falls in the range of 'c' to 'g' i.e. between 6 cm to 8.5 cm. Those smaller units or ranges were omitted where the number of calcanei where less than 5. The type-A calcanei falls in the range of 'd ' to 'g' i.e. their total length is between 6.6 cm to 8.5 cms. The type-B calcanei fall in the range of 'c' to 'g' i.e. between 6.0 cm to 8.5 cms. The number of calcanei in the other types was too small to record any significant finding.

Table 4: Incidences of the Various Types of the Calcanei in Relation to the Total Length (Left Side - Total Bones 270)

Type of calcanei	Total length range measured in cm.LT.							
	a	b	c	d	e	f	g	h
Type-A	00	00	01	08	27	18	10	00
Type-B		01	11	25	70	59	31	03
Type-C	00	00	00	00	00	00	00	00
Type-D	01	00	01	00	01	02	00	00
Type-E	00	00	00	00	00	01	00	00

From the Table -3 and Table -4, It is evident that the total length of type-A calcanei (where the three facets are separate) falls in the range of 6.6 cm. to 8.5 cms. The percentage which falls below 6.6 cm is 1.69 %.

The total length of type-B calcanei falls in the range of 6 cm to 8.5 cm. The percentage of the type-B calcanei which falls in the range of 6 cm to 6.5 cm is 6.43 %.

The type-A clacanei where all the three articular facets are separate (anterior, middle and posterior) ,the distance between the anterior and the middle was measured. The measurement was in millimeters. The detailed analysis is shown in the following table 5

One hundred eighteen type -A calcanei of right and left side classified according to the distance between the anterior and the middle articular facet measured in millimeters.

Table -5: Distance between Anterior and Middle Facet in Type A Calcanei

Type A calcaneum	Right side (%) (n=54)	Left side (%) (n=64)	Total (%) (n=118)
Small interval (<2mm)	19 (35.18)	19 (29.68)	38 (32.20)
Moderate interval (2 mm to 5 mm)	24 (44.44)	33 (51.56)	57 (48.30)
Large interval (>5mm)	11 (20.37)	12 (18.75)	23 (19.49)

Table 6: Total Length of Calcanei of the Right Side Classified as per Interfacet Distance

Total Length of calcanei in cm	Interfacet distance in mm		
	Small interval less than 2 mm	Moderate interval 2 mm to 5 mm	Large interval more than 5 mm
5.0 to 5.5	0	0	0
5.6 to 5.9	0	0	0
6.0 to 6.5	1	0	0
6.6 to 6.9	2	2	0
7.0 to 7.5	9	13	3
7.6 to 7.9	4	6	4
8.0 to 8.5	2	3	4
8.6 to 8.9	1	0	0
Total (n=54)	19 (35.18)	24 (44.44)	11 (20.37)

The range of total length of the calcanie of type-A of the right side falls between 7 cm to7.5 (vide Table -3), correlating this length with the interfacet distance from the above table, it indicates that the number of calcanei with the moderate interval is more (44.44 %) . The next common range is the small interval with the percentage of 35.18 % and the least common range is the large interval having a percentage of 20.37 %.

From the table, it is inconclusive that with the increase of the total length of calcanei there is increase in interfacet distance. The reverse is also not true that

with decrease in the interfacet distance, there is also decrease in the total length of the calcanei.

Table-7: Length of Calcanei of Type-A of the Left Side Classified as per Interfacet Distances

Total Length of calcanei in cm	Interfacet distance in mm		
	Small interval less than 2 mm	Moderate interval 2 mm to 5 mm	Large interval more than 5 mm
5.0 to 5.5	0	0	0
5.6 to 5.9	0	0	0
6.0 to 6.5	0	1	0
6.6 to 6.9	4	3	1
7.0 to 7.5	7	13	7
7.6 to 7.9	5	11	2
8.0 to 8.5	3	5	2
8.6 to 8.9	0	0	0
Total (n=54)	19 (29.68)	33 (51.56)	12 (18.75)

The range of the total length of the calcanei of type-A of the left side falls between 6.6 cm. to 8.5 cm (Vide Table-5) correlating this with interfacet distance from the Table-7, it is evident that interfacet distance of moderate interval is more common with the percentage of 51.66 %. The next common range is the small interval percentage being 29.68 %. And the least common in the large interval with 18.75%

There is no correlation that with increase in the total length of the calcanei, with the increase of the interfacet distance. The reverse is also inconclusive that with decrease in the total length of the calcanei, there is decrease in the interfacet distance.

DISCUSSION

The main purpose of the present study has been to find the incidences of variations in types of the talar facets and their association with racial factors, if any.

Table 8: Comparison with various studies

Author	Types of calcanei				
	Type A	Type B	Type C	Type D	Type E
A. Barnett (1964)					
a) British calcanei (194)	67.0	33.0	-	-	-
b) Veddah calcanei (10)		60.0	40.0	-	-
c) Indian calcanei (78)		78.0	-	-	-
B. Present study (529)	22.3	76.4	--	1.1	0.2

(All figures in percentage)

The incidence of type-A in British calcanei (67 %) was much higher than in the present study which is 22.3 %, showing a difference of 45 %. While in the British type-B calcanei the incidence was 33 % which in the pesent study it is 76.37 %, which gives a difference of 43 %. In the British calcanei there were no type-C calcanei. In the present study also no type-C calcanei were found. In the British calcanei there were no type-D and type-E calcanei as reported in the present study.

In the Veddah, 6 calcanei were of type-B and 4 were of type-C, out of 10 bones reported by them. This small number was not considered in the present study for comparison to arrive at any positive conclusion.

In their study of 78 Indian calcanei the type-A was 22 %, type-B was 78 % and there was no type-C calcaneum. Comparing these findings with the present study, it is observed that the incidence of various types of clacanei is very much close to findings in the present study. It also confirms that the type-B calcanei have higher incidence of occurrence than type- Jha and Singh (1972) studied 1600 calcanei of which 800 were of right side and 800 were of left side. They had sutdied the calcanei belonging to U.P. State. They found that the type-B calcanei were the commonest. Less common were the type-A and the least were the type-C. the incidence of type-B was 62.37 %, of which the right side was 63 % and the left side was 61.75 %. The incidence of type-A calcanei was 37.25 % of which the right side was 36.75 % and the left side was 38.25 %. In the present study, the incidence of the type-B calcanei is 76.37 % of which the right side is 78.46 % and the left side is 74.34 %. Although in the present study the type-B calcanei is commonest type, it shows a difference of 16 %. on the right side, the incidence in their findings was 63 % and on left side it was 61.75 %. In the present study on the right side it is 78.46 % and on the left, it is 74.34 %. Their study shows the preponderance of type-B calcanei on right side over the left side. On right side it is more by 1.25 %. In the present study also the type-B has preponderance over the left side. It is 4 % showing a difference of 2.75 %.

Hamdy El-Eishi (1974) studied 200 adult Egyptians calcanei for the variation of talar articula facets on its superior surface. Sex and sides of the calcanei were not considered by him. According to his classification, 49 % of calcanei were of type-1, which corresponded to type-B of the present study, 40 % calcanei were of type-2 which corresponded to type-A of the present study and 11 % calcanei were of type-3 which corresponded to type-D of the present study.Comparing these findings with the present study, we find that the type-B calcanei has higher rates of occurrence compared to type-A. The incidence of type-B calcanei in Egyptian population was 49 %, while in the present study, it is 76.37 % which gives a difference of 27 %.

In his study the type-A calcanei were 40 % while in the present study, it si 22.30 % the difference being 18 %. Thus, it could be inferred that the type-A calcanei has higher incidence in the Egyptian than the Indian calcanei. Forriol campor and Gomez (1989) studied 176 calcanei of the Sapnish people irrespective of sex and side. They reported that 46 % of calcanei belonged to type-A and 53 % of them belonged to type-5. They

found no type-C, D and E calcanei. Their study shows the preponderance of type-B calcanei.

In the present study, the incidence of type-A calcanei is 22.30 %, while in their study it was 46 %. This gives a difference of 24 %, which shows that in the Spanish people the occurrence of type -A calcanei is higher than in the Indians

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