The Types Of Talar Articular Facets And Morphometric Measurements Of The Human Calcaneum Bone of Gujarat Region

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Abstracts: Introduction: There are three facets over superior surface of calcaneum which forms Sub talar or talocalcaneal joint: Anterior, middle, and posterior talar facet. Three types of calcaneum that have distinct talar facets Were defined as types A, B and C. Materials and methods A total of 250 calcaneum (130 right, 120 left), with unknown gender, were dried and evaluated. Results In our study type B calcaneum (68.8%) was defined as the most common type, and type A calcaneum (30.8%) was second. By using joint facet differences and bone measurement, we tried to define calcaneum bone. Discussion In many diseases of foot, such as the talocalcaneal arthritis and coalition, intra articular fractures and congenital dysmorphology, flatfoot, valgus deformities, the size and shape of the bones, the relationships of the talus and calcaneum with each other and other bones of the foot must be considered for the internal and external fixation and surgical procedures. Type B calcaneum was defined as the most common Type in Gujarat region and these results correlate with the ones which were performed on bones of American, Indian and African, Turkish race and it was uncorrelated with the results of the Researches performed in Europe. [Sarvaiya B et al NJIRM 2012; 3(3) : 34-38]

Key words: Calcaneum, Facet, Anatomy, Talus

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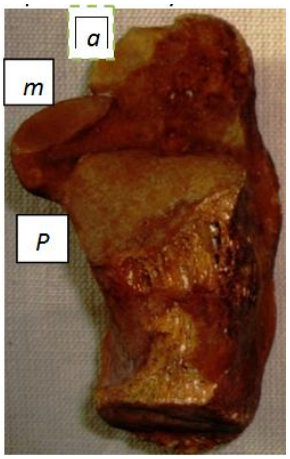
Introduction The Calcaneum is the largest tarsal bones among the all tarsal bones. It forms talocalcaneal / subtalar joint with talus. This joint maintains eversion and inversion of foot. There are three facets over superior surface of calcaneum, anterior, middle, and posterior talar facet. (Fig.1). Using parameters such as degree of separation, fusion and shape, some researchers have described types and preponderance of articular facets. Morphometric values of calcaneum are important for the science of anatomy, treatment and diagnosis procedures on orthopaedic surgery, kinesiology, physical treatment and rehabilitation sections. The racial and individual differences of the anatomic construction of the calcaneum play a key role on static and kinetic dynamic on the foot. During the treatment period of the congenital club foot, talocalcaneal coalition, severe pronation cases, valgus deformities, subtalar instability and development of subtalar implants talus–calcaneum relation should be well defined[1,2,3,4,] Boehler's angle according to Boehler the angle normally ranges from 25^{o}-40^{o} [16]. Especially in calcaneum fractures, in diagnosis and treatment, radiographics of Boehler's angle are used in orthopaedic surgery. Preoperatively decreased Boehler's angle is in favour of fracture[5, 6,7,8, 9, 10].By using joint facet differences and bone measurement we tried to define calcaneum bone of Gujarat region.

Material and Methods: A total of 250 calcaneum (130 right, 120 left), without prominent pathology, with unknown gender, were dried and evaluated one by one In the anatomy department of Medical college Baroda & Govt, medical college Bhavnagar. Three types of calcaneum that have distinct talar facets as types A, B and C were defined by using Campos and Pellicio's parameters according to the report of Koshy et al.[4,10].

Fig. 1 The talar articular facet of calcaneum. *a* - Anterior, *m*- middle, and *P* -posterior talar facet.



Type A: On calcaneum, anterior and middle talar facet was observed, forming a joint with the head of talus. Since the degree of separation of these two joint facets was different,

Type A was divided into following **four subtypes** (Fig. 2).

A1: the distance between anterior and middle talar facets was less than 2 mm.

A2: the distance between anterior and middle talar facets was 2–5 mm.

A3: the distance between anterior and middle talar facets was more than 5 mm.

A4: there was only one joint facet, named as anterior talar facet.

The A1, A2 and A3 types have three joint facets while A4 has two joint facets.

Fig. 2 Types A1, A2, A3, A4 Calcaneum.

Type B: There is no separation between anterior and middle facets. There was a common joint facet for talus head. Calcaneum has two joint facets (Fig.3).

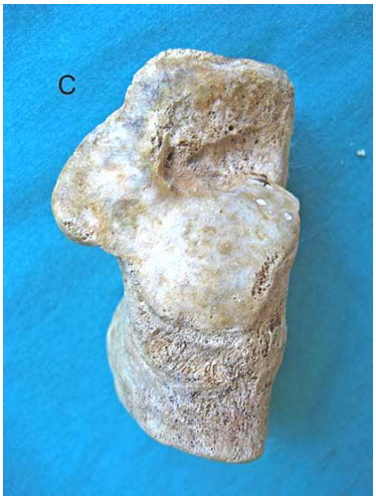
Type B1: the separation between these two joint facets was not completed. The shape of facet joint was constricted (anteromiddle joint facets were constricted).

Type B2: there was no separation between these two joint facets. There was only one wide smooth facet (unconstricted).

Fig. 3 Types B1, B2 calcaneum.

Type C: there was no separation between these three joint facets.There was one joint facet (Fig.4).

Fig. 4 Type C Calcaneum.



We used following values during calcaneum measurements: Maximum anterior–posterior length, Maximum transverse diameter (Width), vertical length of calcaneum. Width, depth, length of the groove over the sustentaculum tali, width, depth, length of the calcaneal sulcus. Calcaneum was fixed on transverse axis, like calcaneum of a man standing. Boehler's angles were measured with a universal goniometer at frontal axis. Boehler's angle stands between two lines, and it is directed towards anterior or posterior (Fig. 5)[6,9].

These lines are:

1: superior margin of posterior facet to superior margin on anterior process.

2: superior margin of posterior facet to superior margin of tuberosity. (Fig. 5)

Fig.5 Calcaneum was fixed on transverse axis and Boehler's angle was measured by Goniometer.

Vertical lengths of calcaneum were measured from the superior margin of posterior facet to floor.Measurements were carried out with a Baker's electronic digital calliper.

The correlation analysis was performed by using Pearson rank correlation coefficients. SPSS for Windows software was used for data management and statistical analysis. All the results were expressed as mean ± SD (standard deviation).

Result: Based on our morphometric study of articular facets on the Superior surface of the 250 calcaneum, three distinct calcaneum Types could be identified (Table 1).

Type A calcaneum was observed on 77 samples (30.8%).40 (16%) on the left, 37(14.8%) on the right. Type A1, 14 samples (5.6%) 7 on the left, 7 on the right. Type A2, 27 samples (10.8%), 14 on the left, 13 on the right. Type A3, 24 samples (9.6%), 13 on the left, 11 on the right. and Type A4, 12 samples (4.8%), 6 on the left, 6 on the right.

Type B calcaneum was observed on 172 samples (68.8%), 79(31.6%) on the left, 93(37.2%) on the right with the highest frequency. Type B1, 107 samples (42.8%) 54 on the left, 53 on the right. Type B2, 65 samples (26%), 25 on the left, 40 on the right.

Type C calcaneum was observed only on 01-samples (0.4%, 1 on the left, 0 on the right). The morphometric measurements were carried out using Koshy's parameters and findings were demonstrated with Koshy's findings and finding of M.Yugur's et al on Turkish race on Table 2, [10, 19]. In the present study, right and left calcaneum, the Boehler's angles were found as mean 29.39°±4.56°with a range of 17.5°–39°, and 29.6°±4.17°with a range of 18.5°–40°, respectively. In the present study the vertical length of the calcaneum was found as mean 41.33±3.24 mm in right (min–max: 32–49 mm) and 40.75±3.1in left (min–max: 32–50 mm).The change of vertical length is important in the decompression fractures of the calcaneum[5,6,9].

In the present study Pearson correlation analysis, Boehler's angle was not correlated with the vertical length of the calcaneum on right side (r = 0.17) and on left side(r=0.04) and A-P length of the calcaneum on right side (r = -0.05) and on left side (r = -0.12).in our study we find a pair of calcaneum with maximum A-P length on right side

Table 1 In our study type B calcaneum (68.8%) was defined as the most common type.

Types	Total Number	Percentage %	Right	Left
A1	14	5.6	07	07
A2	27	10.8	13	14
A3	24	9.6	11	13
A4	12	4.8	06	06
B1	107	42.8	53	54
B2	65	26	40	25
C	01	0.4	00	01
Total	250	100%	130	120

Discussion: In our study the type B Calcaneum (68.8%) was the most common type; type A (30.8%) as the Second and type C (0.4%) least common type in Gujarat region. This result was correlated (Table-3) with the ones which were performed by **Camposs and Pellicio** examined 176 calcaneum in their study, in Spain. They observed type A (46.59%), type B (53.41%) and Type C was not found[4]. **Gupta and colleagues** have examined 401 normal Indian calcaneum. They have observed type B most commonly (67%), type A (31%) and type C (2%) least commonly[7].**Padmanabhan** examined 272 calcaneum in Indian race and he observed type B most commonly (65%), type A (35%) (Table 3)[12,15]. **Bunning and Barnett** examined adult and fetal calcaneum in British, Nigerian and Indian subjects. Their research pointed out a higher percentage of type A (67%) among the Europeans and a higher ratio of type B among the Africans (63%) and Indians (78%). (Table 3)[3] **Saadeh and colleagues** have examined 300 calcaneum in Egypt. They have observed type B as the most common type and type C as the least common type[14] **Ragab et al.'s** research results, for American: type A 37%, type B 46%, type C 0.2%. For White people: type A 47%, and type B 33% calcaneum, while for black people: type A 23% and type B calcaneum 60% [13]. M.Yugur's, F.Atamaz et al In their study on Turkish race type B calcaneum (58.37%), and type A calcaneum (39.37%) as the second[19]. Based on the measurements performed on calcaneum, Koshy

Table 2 The mormophmetric measurements of the calcaneum. The comparison of our findings with those of the Koshy's finding & Turkish race.

Calcaneum (mm)	Koshy's Total	Present Total	Turkish Right	Present Right	Turkish Left	Present Left
AP-Length	73.6±5.7	74.36±6.6	77.5±5.7	74.05±6.47	77.9±5.6	74.68±6.74
Transverse DM	40.8±4.6	38.57±3.12	48.2±4	38.73±3.27	46.9±4.4	38.4±2.94
Vertical length	--	41.05±3.18	48.2 ± 3.2	41.33±3.24	48.3 ± 3.7	40.75±3.1
Boehler's angle	--	29.49°±4.37°	30.09°±5°	29.39°±4.56°	30.8°±4.9°	29.6°±4.17°
Groove over sustentaculum tali						
Length	20.7±3.2	18.91±2.55	21.5±2.2	18.82±2.62	21.2±2.37	19.01±2.47
Width	10.8±1.5	6.79±1.56	6.6±1.0	6.82±1.51	7.0±1.3	6.76±1.62
Depth	02.9±0.6	2.43±0.75	2±0.5	2.45±0.84	1.8±0.5	2.41±0.65
calcaneal Sulcus						
Length	31.9±3	10.44±1.66	30±3	10.32±1.66	30.8±3.2	10.57±1.67
Width	21±2.4	15.28±1.94	5.8±1.7	15.04±1.99	6.5±3.7	15.54±1.85
Depth	03.4±0.9	4.36±1.0	2.5±0.7	4.22±1.05	2.6±0.7	4.5±0.94

Table 3 The comparison of our results with those of the other researchers. For in white race type A calcaneum and in black type B calcaneum has a high ratio. Type in Percentage (%).

	A	A1	A2	A3	A4	B	B1	B2	C
Camposs&pellicio	46.59	2.84	21.02	15.91	6.82	53.41	28.98	24.43	00
Gupta	31	09	04	13	05	67	28	39	02
Padmanabhan	35					65			
Bunning & Barnett.									
White/ European	67					33			
Black/ African	36					63			
Indian	22					78			
Ragab									
American	37				12	46			0.2
White	47					33			
Black	23					60			
Turkish race.	39.37	4.08	13.12	17.19	4.98	58.37	25.34	33.03	2.2
Present Study.	30.8	5.6	10.8	9.6	4.8	68.8	42.8	26	0.4

and his team created a morphological map of the bone. Their findings may be seen in Table 2 (Table 3),[10]. In our study the mean Boehler's angle on right (29.39˚±4.56˚) & on left (29.6˚±4.17˚).this result is correlated with, M Yugur et al study over Turkish race, the angle on right (30.09˚±5˚) & on left (30.8˚±4.9˚)[19], Chen MY, Bohrer SP, et al study on 120 patient with normal radiograph having mean Boehler's angle is (30˚±6˚)[17],Boehler suggested that the normal Boehler angle 25˚-40˚[16], Khoshhal's research suggest that the mean Boehler's angle in the Saudi population was 31.21° and is not related to age, gender, or side of body[8], T. Scheper's: A.Z.Ginai et al study over radiographic evaluation of calcaneal fracture suggested that average angle measured 16 ˚ ($p<0.001$) on injured side compared with an average of 32 ˚ (25 ˚ -40 ˚)on uninjured side[18].

In present study vertical length of calcaneum is 38.73±3.27 on right and 38.4±2.94 on left is not correlated with M Yugur et al study over Turkish race they found mean vertical length 48.2±3.2 on right & 48.3±3.7 on left (table-2). In present study length of calcaneal sulcus 10.32±1.66 on right and 10.57±1.67 on left is not correlated with M Yugur et al study over Turkish race they found 30±3 on right & 30.8±3.2 on left (table-2).For correlation of other finding see (table-2).

Conclusion: Type B calcaneum (68.8%) was defined as the most common type in Gujarat region. The mean Boehler's angle on right (29.39˚±4.56˚) & on left (29.6˚±4.17˚) in Gujarat region.

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