

ORIGINAL ARTICLE

Morphometric Analysis of Variations in Pattern of Talar Articular Facets on Calcaneum in North-West India

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Abstract:

Calcaneum, the largest tarsal bone forms joint with Talus (Talo-calcaneal joint). The superior surface of calcaneum shows three facets for talus. Patterns of facets are variable in different populations. Knowledge of the facets is important for orthopaedic surgeons in correction of foot deformities, as facet number is an important factor in subtalar joint stability and formation of osteophytes in osteoarthritis. The objective of the present study was to identify the patterns of talar facets on calcaneum in North-West India population and their comparison with other population of the world. For the present study; 100 calcanei of unknown age and sex were used. The calcanei were retrieved from the department of Anatomy, at a tertiary care hospital and medical college, in Haryana. The current study will focus on talar articular facets on calcanei. Patterns of talar articular facets on calcanei were observed as described by Bunning and Barnett et al. Present study revealed that pattern I and II were commonly present in the North West population, and accounted for 83% and 16% respectively. The North West population presented Pattern I as the most common pattern as compared to the European population where pattern II was reported as the most common pattern, so variation in the facet pattern between races demand a modification of surgical technique of calcaneal osteotomy to meet the needs of a particular population.

Keywords: Calcaneum; Talar facets; Arthritis.

Introduction:

The Calcaneum is a small, stout bone, and due to its anatomical position resists putrefaction better than other bones, can remain preserved for longer times under natural climatic conditions and is less likely to be fragmented further. Therefore possibility of finding this bone intact, in fragmented skeletal remains, is much higher as compared to other bones.¹ Calcaneum is also a useful tool in determination of sex and its length being considered useful in stature estimation.² The superior surface has three facets for talus. Earliest known study has been done by Bunning and Barnett³ in 1963. They classified the variations as follows:

Type A: Three facets -separated by variable space.

Type B: Two facets-anterior and middle which are either continuous or have a notch between them.

Type C: One facet- three facets form a continuity.

They studied and described articular facets with parameters of degree of separation, fusion and shape in various population groups like African, Indian, British, Egyptian and Spanish.

Morphological variations of articular facets of calcaneum may

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predispose people to joint instability, ligamentous laxity and development of arthritic changes in the subtalar joint. Knowledge of such variations is essential for treatment and diagnostic procedures in orthopaedic surgeries.⁴ In a study in India by Gupta et al. (1977) classified calcanei based on their articular facet.⁵

Materials and Methods:

For the study of pattern of talar facets on calcanei 100 complete human calcanei of either sex were procured. These bones were retrieved from Department of Anatomy, at a tertiary care Hospital in Haryana. Calcanei showing obvious pathological deformities were excluded from the study. The age of the calcanei was noted from the records and all the calcanei were around 40-50 years of age at the time of death. According to Bunning and Barnett⁶ pattern of talar facets on calcaneum were classified as given in table below:

Table 1.-

Pattern	Feature
I (Fig 1,2)	Anterior (A) and Middle (M) facets fused
II (Fig 3,4)	Three separate articular facets
a.	Anterior (A) and middle (M) facet separated by < 2mm
b.	A and M separated by > 2mm and < 5mm
c.	A and M separated by > 5mm.
III	Anterior facet absent. Only middle and posterior facets present
IV	All the three facets fused. Only one facet on calcaneum.

Observations and Results:

Calcaneum with obscuring pathologies such as cortical bone deterioration was excluded from the study. All the calcanei were

numbered for identification. Pattern of articular facets on calcaneum were observed and classified, and statistically analysed, and tabulated as below:

Table 2. Patterns of the talar articular facets of calcaneum on two sides:

Sr No	Pattern	Observed in	Percentage
1.	I Anterior and middle facets fused	Right 44 Left 39	83%
2.	II Anterior and Middle facets Separate	Right 6/50 Left 10/50	16%
3.	III Anterior facet absent	Right 0 Left 1	1%
4.	All three facets fused	Right 0 Left 0	0%

Study	Year	Country	N	I (%)	II (%)	III (%)	IV (%)
Bunning & Barnett ³	1965	Britain	194	33	67	-	00
	1965	Veddah	10	60	00	-	40
	1965	Indian	78	78	22	-	0
	1965	African	492	63	36	-	1
Gupta SC et al. ⁵	1977	India	401	67	26	5	2
Mini Mol et al. ⁷	2012	India (Mumbai)	50	74	26	00	00
Priya et al. ⁸	2006	South India	71	67.6	25.35	7.04	0
Madhvi C et al. ⁹	2008	South India	222	72.1	19.4	6.8	1.3
Muthukumar N et al. ¹⁰	2011	South India	237	65.82	33.33	-	0.42
Campos & pellicio ¹¹	1989	Spain	176	53.41	39.77	6.82	00
Verhagen FD ¹²	1993	USA	191	54.45	26.7	18.85	-
Saadaeh et al. ¹³	2000	Egypt	300	63	30.3	4.7	2
Shahabpowr et al. ¹⁵	2011	Belgium	49	44.9	44.9	10.2	0
Vucinic N ¹⁶	2020	Serbian	59	45.76	40.68	13.56	-
Barbaix et al. ¹⁷	2000	Belgium	134	25	64	11	00
Ragab et al. ¹⁸	2003	American	1056	37	46	12	5
Present study	2022	India (Haryana)	100	83	16	1	0



Figure 1. Calcanei of left side showing pattern I.



Fig.2: Calcanei of right side showing pattern I (Fused middle and anterior facets).

Discussion:

In the present study, the Dominent pattern of calcaneal facets for the talus in our population is pattern I (fig 1, 2) amounting to 83% followed by pattern II near about 16%.

On comparison with studies in India, this finding coincided with study by Mini Mol et al.,⁷ Gupta SC et al.,⁵ Priya et al.,¹¹ Madhvi et al.¹² and Muthukumar N et al.¹³ Outside India, similar results were observed in study conducted Spain,¹¹ Unites States of America¹² and Egypt,¹³ however the frequency of this type of pattern was quite less. Comparison of data with other population revealed that



Figure 3. Calcanei of left side with pattern II.



Figure 4. Calcanei of right side with Pattern II.

African, Indian, Egyptian, Spain, American, Serbian population had pattern I as the dominant pattern whereas the Britain and Belgium population reported type II as the dominant pattern. Bunning and Barnett compared adult African, Indian and European calcaneal bones and found a distinct racial difference. Since the racial differences observed in adult bones were also present in foetal calcanei; it indicated that different races exhibited variations in the facets and the differences were not due to any sequelae to physical activities.⁶ In the present study, percentage/frequency of pattern I is very high (83%). This can be explained on the basis of squatting position opted quite frequently by North West population. It can be proposed that in squatting position weight of the body is more frequently distributed in anterior part of talus and calcaneum thereby more chances of fusion of anterior and middle facets of calcaneum as was observed by study in Nepal.¹⁴

Shahabpour et al.¹⁵ in his study on Belgium population reported equal distribution of pattern I and Pattern II, somewhat similar frequency was observed in a study conducted in Serbian population in 2020,¹⁶ as compared to studies in year 2000 in Belgium¹⁷ and American¹⁸ where Type II pattern was more prevalent.

Information of the talar facets on the calcaneum is valuable for orthopaedicians who correct deformities of foot as pes planus, talocalcaneal arthritis, intra articular fracture and valgus deformities. In the pattern II, the three separated calcaneal facets form an "osseous tripod" for the talus, especially for the head of the bone, and, in this way, more effectively prevent movements that can lead to trauma and subsequent development of osteoarthritis.¹⁹

Medicolegally various parameters are used for identification of a person, the important ones are the determination of age, sex, stature and race etc. Identification of human skeleton requires thorough knowledge, especially in the field of comparative osteology, craniometry and racial morphology, by performing quantitative analysis of bones. Calcaneum, due to its characteristics, can thus help in determination of race as above and also further can be subjected to determination of sex of an individual.²¹

Conclusion:

In the present study, the data collected from 100 samples of calcaneal bones from the state of Haryana was analyzed.

1. Pattern I had been dominant followed by pattern II. Pattern I dominant in population of Africa, Spain, Egypt and American population as also in the Indian population of Mumbai, Rajasthan and South India but Britain population showed Pattern II as the dominant pattern.
2. Predominance of Pattern I in the North West population (83%) by a large proportion as compared to the rest of India can be accounted for by the squatting position of the residents of this region.
3. Variation in the facet pattern between races demand a modification of surgical technique of calcaneal osteotomy to meet the needs of a particular population.
4. It is also important to note that individuals with types 1 and 2 facets have been shown to have asymmetric wear patterns which might cause heavy pain, possibly leading to a habitually inclined position of the foot during walking that predisposes to osteophyte formation and subsequent osteoarthritis.

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