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Full Length Research Paper

Patterns of talar articular facets on calcaneum and its clinical implication

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Calcanei with certain talar facet patterns predispose to subtalar arthritis. Knowledge about variations in the talar facets of the calcanei is essential for orthopedic surgeons while correcting foot deformities like pes planus. This study was undertaken after finding a scarcity of such data in the Gujarat population. The objective was to identify the patterns of the talar facets of calcanei and their clinical implications. Calcanei (n=205) from the Gujarat was utilized. Only four patterns were described as follows: Pattern (I): Fusion of the middle and the anterior facets, Pattern (2): The middle and the anterior facets separate, Pattern (3): Absent anterior facet, Pattern (4): Fusion of all the three facets. And surface area was also measured. Pattern (I) was predominant (65.82%), followed by Pattern (2) in (33.33%) of cases. In the Pattern (2), the subtype b with (3-5) mm separation was the commonest. Pattern (3) found in 4.39% cases. Rare cases of pattern (4) was found in (1.39%) of cases. There is a dominance of pattern (I) calcanei in Indians as compared to the Europeans whose present pattern (2) are common. This fact necessitates the orthopedic surgeons in India to modify the surgical techniques when they perform calcaneal osteotomy. Indians may be at a greater risk of developing subtalar arthritis due to the dominance of Pattern (1) calcanei according to different studies performed. In our study we measured surface area of facets which shows more available surface area for articulation in pattern (I) which provides better stability. So chances of subtalar arthritis are less. We have to correlate it with clinical data.

Key words: Calcaneum, facets for the talus, pattern, variation, arthritis.

INTRODUCTION

Calcaneum is the longest and largest of the tarsal bones, it possesses the shape of somewhat irregular cuboids' bone with its long axis inclined upwards and laterally. It articulates with overlying talus to form talocalcanean joint which together with the talaocalcaneonavicular joint is referred to as (clinically sub- talar joint), MooreKL (1992).where inversion and eversion of foot occurred. In the middle one/third of the superior surface of the calcaneum, there is an oval shaped posterior facet for articulation with the body of the talus. In the anterior one/third of the calcaneum, there are middle and anterior facets for articulation with the head of the talus Ranganathan TS (2002). The variations in the anterior and the middle calcaneal facets for the talus are correlated with race Williams PL (1995). Studies in different population groups also confirm it (Bunning PSC 1963, Bunning PSC 1965, Gupta SC 1977). Certain morphological variations of calcaneal facets for the tali may predispose to the development of arthritic changes

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Table 1. Incidence of individual types and sub types of calcaneum**.**

Type	No of calcanei/total	(%)	Subtype	No of calcanei/total	Percentage (%)
I	133/205	64.88	Ia	52/133	39.1
			Ib	81/133	60.9
II	59/205	28.78	IIa	08/59	3.9
			IIb	30/59	14.63
			IIc	21/59	10.24
III	09/205	4.39	-	-	-
IV	04/205	1.95	-	-	-

Figure 1. Type Ia and type Ib showing fused anterior & middle **facets** Constricted & non constricted respectively.

Figure 2. Type II a, b and c. Separate anterior & middle facets with <3mm, 3-5mm & >5mm distance respectively.

in the subtalar joint (Francine D-V 1993). Bruckner (1987) hypothesized that variations in the talar facets of calcanel are important because they influence subtalar joint stability. Knowledge about the variations in the talar facets of calcanei is essential for orthopaedic surgeons while correcting foot deformities like pes planus .Therefore, this study was carried out after finding a scarcity of data on the variations of the calcaneal facets for the tali in the Gujarat population. Calcaneum indexing is an effective method of surveying osteoporosis to predict the population at risk of sustaining fractures (Jhamaria NL, 1983). Calcaneum is also a useful tool in determination of sex (Steele DG 1976, Bidmos MA 2004, Bidmos MA 2003) and is long being considered useful in stature estimation (Bidmos MA, 2004). The objective of the present study was to identify the patterns of the talar facets of calcanei and their clinical implications in the population of Gujarat part of the western states of India. And data has been compared with other studies in other parts of India.

MATERIALS AND METHODS

This study was conducted by utilizing 205 dry calcaneal bones which belonged to the bone banks of different medical colleges of Gujarat states of India. Adult bones, irrespective of the sex were included for this study. Calcaneal bones with pathological changes or with anomalies were excluded. The patterns of the talar articular facets of calcanei were observed with the naked eye and by using a hand lens. A sliding vernier calliper was used to measure the separation between the facets. Surface area of facets was measured three times and then

Figure 3. Type III absent anterior facet.

Figure 4. Type IV fused anterior, middle & posterior facets**.**

Table 2. Comparison of results of different calcaneal studies including the present study.

Study, year	Country, sample size	Pattern i (%)	Pattern ii (%)	Pattern iii (%)	Pattern iv(%)
Bunning & Barnett, 1965	Britain / n=194	33	67	-	-
Gupta SC et al, 1977	India / n=401	67	26	5	-
Francine Drayer-Verhagen, 1993	U.S.A / n=191	54.65	26.7	18.85	-
Saadeh FA et al, 2000	Egypt / n=300	63	30.3	4.7	-
Priya Ranganath et al, 2006	South India / n=71	67.6	25.35	7.04	-
Muthukumaravel N.et al,2011	South India / n=237	65.82	33.33	-	0.42
Present study,2011	Western india/n=205	64.88	28.78	4.39	1.95

average of three was taken as final measurement. Literature analysis revealed that five patterns of talar facets were found in the calcanei. In this present study, only four patterns were described as follows: Pattern (I) showed the fusion of the middle and the anterior facets; Pattern (2), the middle and the anterior facets were separate; pattern (3) absence of anterior articular facet; Pattern (4), there was fusion of the anterior, middle and the posterior facets. Depending on the constriction of facets type (I) is sub typed into (a) if the facet was constricted and (b) if the facet was not constricted. Depending on the degree of separation between the anterior and the middle facets, pattern (2) was sub typed into three varieties as (a) 3mm, (b) 3 to 5mm and (c) 5mm.

OBSERVATION

In the present study, in pattern (I) the sub type (b) non constricted was the commonest one (figure 1). This finding coincided with the finding of the south Indian study by Priya Ranganath (2006)**.** Our findings confirmed the observations of other Indian studies (Priya R. 2006,

Table 3. Comparison of surface area among the type I, type II, type III.

Pattern type	Mean range(cm^2)	Surface area(cm^2)
Type I (AAF & MAF confluent)	2.27 ± 0.51	1.0−3.1
Type II (AAF & MAF distinct)	1.94 ± 0.56	0.75−3.37
Type III (AAF absent)	1.18 ± 0.48	0.25−2.10

Gupta SC 1977). In African studies (Saadeh FA 2000, Bunning PSC 1963) also, Pattern (I) was common. But pattern (2) Table 2 and Figure 2 was predominant in Europeans (Bunning PSC 1965, Forriol C F,1989) whereas in Americans, pattern (I) with fused anterior and middle facets was common than pattern (2) Francine D-V,1993. A comparison of the adult African, Indian and European calcaneal bones by (Bunning and Barnett 1965). Revealed a distinct racial difference for which no functional explanation can readily be offered. These findings were compared with those which were derived from the study of the corresponding foetal calcaneal bones of African, Indian and European populations. The racial differences which were observed in adult bones were also present in foetal calcanei, thus indicating that they were probably genetically determined and did not develop responses to physical activities. Thus, the association of genetic factors with variations of the calcaneal facets were indirectly established. References are not readily available to establish a specific association of the calcaneal variations with genetic or functional factors like squatting habits. The findings of Francine Drayer- Verhagen (Francine D-V, 1993) suggest that the talar facet morphology of the calcaneum is an important factor in subtalar joint stability. This finding was consistent with the hypothesis of (Bruckner 1987) which stated that the subtalar joint formed by calcanei which had the pattern (2) facet configuration were comparatively more stable and had less chances for developing arthritis. There are two separate facets, anterior and middle, in the anterior one third of the calcaneum with the pattern (2) facet configuration. These two facets along with the posterior facet provide an ‘osseous tripod’ for the talus to sit on and to prevent excess motion of the talar head. Thus, the subtalar joint with this tripod support is less likely to suffer trauma or biomechanical stress and the incidence of osteoarthritis becomes less in such cases. Indians may be at a greater risk of developing subtalar arthritis, since they predominantly have pattern (1) calcanei. The same study by Francine Drayer-Verhagen (1993) supported another theory which explained the increased mobility of the talar head in the subtalar joints formed by the calcanei with the pattern (I) facet configuration. In calcanei with the pattern (I) facet configuration, the articular surface is continuous, flat and smooth giving less impediment to the medial rotation of the talar head. Eventually, this configuration (pattern I) can cause laxity of the spring ligament and other supporting muscles due to the continuous and excessive pressure which is exerted by the talar head. This laxity of the ligaments and the muscles is thought to be responsible for the unstable subtalar joints, thus leading to osteoarthritis. The two theories which have been explained above imply that Indians may be at a greater risk of developing subtalar arthritis, since they predominantly have pattern (I) calcanei. An elaborate calcaneal study to evaluate this risk factor in India can be planned in future. The above table compare the surface area available for articulation with corresponding part of talus. With various configurations of the anterior and middle facets, the surface area varies. Available surface area with type (I) configuration is greater than that of type (2) configurations. It can be considered as one of the factors responsible for the stability of subtalar joints that is type (I) with larger surface area may give better stability as compared to the rest of the type. It is obvious that type (3) figure 3 which has absence of anterior facet provides the least surface area for articulation resulting in least stable joint. The pattern (4) figure 4 calcaneum which was noted in the present study was unique and has been scarcely reported in the literature.

CONCLUSION

In the present study, the data which was collected from 205 normal dry calcaneal bones from Gujarat states in the western part of India were analyzed and compared with the data of other part of India. According to that, there was a dominance of the pattern (I) calcanei in Indians as compared to the Europeans who presented pattern (2) calcanei commonly. These racial differences

in the calcanei were probably genetically determined. This knowledge on the racial differences is vital for orthopaedic surgeons in India when they perform calcaneal osteotomy. In spite of blindly following the surgical techniques described in European literature, modifications to suit the Indian scenario are mandatory. In pattern (2), the subtype (b) is more common in Indian as compared to Egypt where the subtype (a) is more common. The pattern (2) calcanei form more stable subtalar joints, with less chance for developing arthritis. Pattern (3) calcanei (with absent anterior facet) were found in 4.39% cases compare to the south Indians which is conspicuously absent. The pattern (4) confluent all facets were noted in 1.95% cases which is scarcely seen.

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