

## DEGREE OF SEPARATION BETWEEN ARTICULAR FACETS (ANTERIOR AND MIDDLE) ON ANTERIOR THIRD OF SUPERIOR SURFACE OF THE CALCANEUM IN H.K.E REGION

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### ABSTRACT

**Background:** Calcaneus is the largest and strongest of tarsal bones of the foot and presents six surfaces out of which, superior surface shows 3 facets for articulation with the talus namely anterior, middle and posterior talar facets. Anterior two thirds of the calcaneus's superior surface articulates with the talus. Alignment of these two bones i.e calcaneus and talus is responsible to maintain the arches of foot and also formation of subtalar joint takes place thus alignment is equally important to maintain joint stability.

**Objective:** Aim of the present work is to study different patterns of talar articular facets on the calcaneum in order to know degree of separation of facets on anterior third of the calcaneum i.e., between anterior and middle articular facet and to correlate findings of the present study with other authors study.

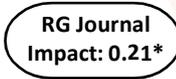
**Material and methods:** The pattern of talar articular facets with reference to their interfacet distance was studied in 150 dry adult human calcanei of unknown sex and age obtained from H.K.E region in the year 2017-2019. The data was statistically analysed.

**Results:** In Type I, IA was found with a higher percentage (40%) in comparison to IB. In type II, subtype II A was found with highest percentage (14%) and subtype II C was with least percentage (0.66%). Out of 110 calcanei in type I, subtype IA were 60 (54.5%) and subtype IB were 50 (45.4%). In type II out of 35 calcanei, subtype IIA was found with higher percentage of 60% (21), subtype IIB was found in 37.1% (13) and subtype IIC was found with least percentage of about 2.85% (1).

**Conclusion:** Calcaneal morphology is of clinical significance so as to maintain normal function of the hind foot, stress conduction for weight bearing and joint mobility. During calcaneal osteotomy, care is taken not to damage middle articular facet. So this facetal study is helpful for treatment and surgical point of view.

**KEYWORDS:** Calcaneus, Talus, Articular Facets, Surfaces, Degree, Separation.

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### INTRODUCTION

Calcaneum shares many unique characteristic features, like: It is the largest and strongest bone of the foot, only tarsal bone which rests on ground and forms prominence of heel. It is the first

tarsal bone to ossify, only tarsal bone that normally possess an epiphysis which is situated on its posterior part. It is highly vascular and several foramina can be seen on its surface. The superior surface is divisible into three parts:

Posterior third is rough and is covered with a pad of fibrofatty tissue, middle third carries a large oval posterior facet for talus. Anterior to this facet, a rough depression narrows into a groove on the medial side, the "sulcus calcanei", which completes the sinus tarsi with talus. In the anterior third, there are 2 facets (middle and anterior) for articulation with the head of talus [1].

The elongated articular area distal and medial to the sulcus calcanei covers the sustentaculum tali and extends from the distal aspect of the body. This facet is often, divided by a non-articular interval at the anterior border of the sustentaculum tali, to form the middle and anterior facets for the talus: these vary with sex and race [2].

Calcaneus form talocalcaneal joint with talus, this joint is called subtalar joint. Inversion and eversion takes place at this joint [1].

The articular facets are functionally important, as they give stability to subtalar joint. In talocalcaneal arthritis, intraarticular fractures, flat foot, valgus deformities, these following points are considered such as: the shape & size of the bones, relationships of the talus and calcaneus with each other and other bones of the foot so as to decide surgical procedures [3].

There are variations in number and arrangements of talar articular facets. Bunning and Barnett have observed that there are three types of variations:

**Type A:** three facets separated by variable intervals.

**Type B:** two facets i.e., anterior and middle, are continuous or presents notch between them

**Type C:** one facet i.e., three facets are continuous [4].

Jha et al, classified type B calcanei into four subtypes:

**Subtype 1:** anterior and middle articular facets are completely fused and form a single facet.

**Subtype 2:** anterior and middle articular facets are incompletely separated by a notch.

**Subtype 3:** anterior and middle articular facets are separated with no non-articular area in between.

**Subtype 4:** absence of anterior articular facet.

Middle and posterior articular facets were being present [5].

Gupta et al, classified talar articular facets as follows:

**Type 1:** one continuous facet on sustentaculum tali extending to distal part of calcaneus. The facet was either constricted or not constricted.

**Type 2:** two articular facets- one on sustentaculum tali and other on distal part of the calcaneus bone, with variable degree of separation between them:

Less than 2mm ( narrow interval )

Between 2 and 5mm ( moderate interval )

More than 5mm ( wide interval )

**Type 3:** a single well defined facet confined to sustentaculum tali.

**Type 4:** a single facet on sustentaculum tali extending to distal part of calcaneus and continuous with posterior talar facet of calcaneus [2].

According to some authors, in their previous study on calcaneal facet, anatomical variation is of no clinical significance. Bruckner said that calcanei with two separate facets in anterior 1/3<sup>rd</sup> of its superior surface showed subtalar joint with less chance to develop arthritis, trauma and biomechanical stress, thus concluding that this type of subtalar joint are more stable [6].

The study is carried out as it is important for science of anatomy, treatment and diagnostic procedures in orthopedic surgery.

#### **MATERIALS AND METHODS**

The study was undertaken on 150 dry adult human calcanei of unknown sex and age, obtained from ( H.K.E) Hyderabad Karnataka education region in the year 2017-2019. The materials used for the study were as follows: digital vernier calipers, Black marker pen, Tracing papers, Carbon sheets, White sheets. Calcaneal bones with pathological changes and damaged bones were excluded from the study. Bones were numbered and talar articular facets on the calcanei were outlined using a black marker pen. Boundaries of all the facets on the calcaneum were traced on a tracing paper and finally impressions on the tracing paper were copied onto a white paper using a carbon sheet.

Calcanei were classified according to below stated classification .; Number of facets were noted and interfacet distance in mm between the anterior and middle talar facet was measured by taking posterior most part of the anterior facet as anterior point and anterior most part of the middle facet as posterior point using digital vernier calipers. All the observations and the measurements were noted.

Accordingly, calcanei were classified into following five types by using classification of Bunning and Barnett [4], Jha et al [5] and Gupta et al [2]:

**Type I:** A single facet present on the anterior third of calcaneum resulting from the confluence of anterior and middle talar facets. It was further sub classified into two sub types depending on shape of the facet;

**Type IA:** Shape of the facet was constricted because of incomplete separation of anterior and middle talar facets.

**Type IB:** Shape of the facet was non constricted, as there was no separation between anterior and middle talar facets.

**Type II:** Three facets present on the superior surface of calcaneum (anterior, middle and posterior talar facets). Depending on the interfacet distance between anterior and middle talar facets, it was further sub classified into three subtypes;

**Type IIA:** Presented with narrow interfacet distance of less than 5mm.

**Type IIB:** Presented with moderate interfacet distance of 5-10mm.

**Type IIC:** Presented with wide interfacet distance of more than 10mm.

**Type III:** There was no anterior facet. A single well defined facet was present on the sustentaculum tali.

**Type IV:** A single facet was situated on the sustentaculum tali which was extending on to the anteromedial corner of distal part of calcaneum, proximally this facet was continuous with posterior talar facet.

**Type V:** In this type, middle and posterior facets were fused.

The results were tabulated and analyzed statistically. Descriptive statistical analysis was

carried out. Measurements have been taken in mm and results presented in Number (%). SAS 9.2, SPSS 15.0, Stata 10.1, MedCalc 9.0.1, Systat 12.0 and R environment ver. 2.11.1 were used for the data analysis.

## RESULTS

An observational study was undertaken on 150 dry adult calcanei of unknown sex, to study the degree of separation between anterior and middle facets in anterior third of superior surface of calcanei and to compare the results of present study with other authors study.

Depending on the pattern of talar articular facets with reference to their shape and number, calcanei were classified into 5 types. (Table 1).

In Type I, IA was found with a higher percentage (40%) in comparison to IB. In type II, subtype II A was found with highest percentage (14%) and subtype II C was with least percentage (0.66%).

Out of 110 calcanei in type I, subtype IA (constricted facet) were 60 (54.5%) and subtype IB (non-constricted facet) were 50 (45.4%). Out of 35 calcanei in type II, subtype IIA (<5mm interfacet distance) was found with higher percentage of 60% (21), subtype IIB (5-10mm interfacet distance) was found in 37.1% (13) and subtype IIC (>10mm Interfacet distance) was found with least percentage of about 2.85% (1). (Table 2).

**Table 1:** Incidence and percentage of various types and subtypes of calcanei.

Type & Subtype	No (n=150)	Percentage
Type IA	60	40
Type IB	50	33.3
Type IIA	21	14
Type IIB	13	8.6
Type IIC	1	0.6
Type III	2	1.33
Type IV	2	1.33
Type V	1	0.6

**Table 2:** Correlation of Types and Subtypes.

Column1	Column2	Column3	Column4	Column5
Type	No of bones	Sub types		
		A subtype	B subtype	C subtype
Type1	110	60(54.5%)	50(45.4%)	-
Type2	35	21(60%)	13(37.1%)	1(2.8%)
Type3	2	-	-	-
Type4	2	-	-	-
Type5	1	-	-	-

**Table 3:** Classification of calcanei as per Gupta SC.

Column1	Column2	Column3	Column4	Column5	Column6	Column7	Column8	Column9	Column10
Author	TYPE			TYPE			TYPE		TYPE
	I (%)	IA (%)	IB (%)	II (%)	IIA (%)	IIB (%)	IIC (%)	III (%)	IV (%)
Gupta S C et al [2]	67	28	39	26	9	4	13	5	2

**Table 4:** Comparison of inter facetal distance ( anterior& middle articular facets) between previous studies and present study.

Authors	A1 (<2mm) %	A2 (2-5mm) %	A3 (>5mm) %
Neshhan boyan et al [7] (n=57)	8.7	12.4	13.9
N.Bhanu Sudha Parimala et al [8] ( n=88)	13.63	9.09	13.9
K. Anjaneyulu et al [9] ( n=100)	10	10	11
Rohin Garg et al [10] ( n=310)	4.8	7.7	8.1
Nagar SK et al [11] (n=529)	32.2	48.3	19.49
S.C.Gupta et al [2] (n:401)	9	4	13
Present study (n=150)	60	37.1	2.85

## DISCUSSION

Calcaneum articulates with talus through three facets, whose pattern with regard to shape, size and number has shown considerable degree of variability. Various authors have used different classifications to categorize the talar articular facets on calcaneum into different groups.

Neshhanboyan et al, studied 57 calcanei from Anatolian adult population. They classified calcanei based on previous literature. In type A, based on degree of separation between anterior and middle articular facets it was classified into four subtypes: A1- <2mm, A2 2-5mm, A3->5mm. Type B was divided into subtype B1 as separation between anterior and middle facets was incomplete and subtype B2 as no separation. Out of 57 calcanei in type A, subtype A3 were left 5 (16.7%) and right 3 (11.1%) were most common and subtype A1 were left 3 (10%) and right 2 ( 7.4%) were least common. When compared with our study, it is not in congruence because in their study more interval between facet is most common and in our study moderate interval between facet is most common. Type B2 Left 9(30%) and right 11(40.8%) was most common then Type B1 left 9(30%) and right 6 ( 22.2%). When compared with our study, it is opposite of it because in their study non-constricted facet is most common were as in our study constricted facet is most common [7].

N.Bhanu Sudha Parimala et al, studied 88 dry calcanei right 47 and left 41. They classified

calcaneal facets into 5 types. Type 1, two facets on Calcaneum were middle and anterior facet are fused. Type 2, three facets on Calcaneum were anterior and middle facets are separate. Type3, two facets on calcaneum, anterior facet is absent. Type 4, one facet on calcaneum were anterior, middle and posterior facets are fused. Type 5, two facets on calcaneum were middle and posterior facets are fused. In Type 2, 27 out of 88 (30.7%) showed right 15 out of 47 (31.9%) and left 12 out of 41 (29.3%) .In Subtype 2A ( <5mm) 20 out of 27 (22.7%) showed right calcanei 13 out of 15 (27.6%) and left calcanei 7 out of 12 (17.1%) .Subtype 2B (5-10mm) 7 out of 27(8%) showed right calcanei 2 out of 15( 4.3%) and left calcanei 5 out of 12 (12.2%). Type 2A is more common then Type 2B which is similar to our study. In Type 1 ,53 out of 88 (60.2%) showed right 30 out of 47 (63.8%) and left 23 out of 41(56.1%). Type 1 with constricted facet was 26 out of 53(29.5%) and Type 1 with no constricted facet was 27 out of 53 ( 30.7%). In their study Type 1 with no constricted facet is more common which is not in congruence with our study were we found constricted facet calcanei more common [8].

K. Anjaneyulu et al, studied 100 adult dry human calcanei. They classified calcanei into four groups as Type A ( Subtype A1 - <2mm, A2- 2-5mm, A3- >5mm ), Type B, Type C (subtype C1- constricted facet, C2- unconstructed facet ) and Type D. Type A are 31%, Subtype A1- 10%, A2-10%, A3-11%. Type B- 5%, Type C-62%,

Type C1-43%, Type C2-19%, Type D-2%. In Type A, subtype A3 is more common than Subtype A1 and A2 which is not in congruence with our study. Similarly in Type C, subtype C1 (constricted facet) is more common than subtype C2 (unconstricted facet) which is similar to our study [9].

Rohin Garg et al, conducted study on 310 adult dry calcanei. They classified calcanei into five patterns as follows: pattern 1- two facets present were middle and anterior facets are fused. pattern 2- three facets present were anterior and middle facets are separate. Pattern 3- two facets present were anterior facet is absent. Pattern 4 –one facet present were anterior, middle and posterior facet are fused. Pattern 5- two facets present were middle and posterior facet are fused. Pattern 2(76 bones) was divided further as subtype A-<2mm seen in 15/76 bones (4.8%), subtype B-2-5mm was seen in 24/76 bones (7.7%), subtype C->5mm seen in 25/76 bones (8.1%). Thus subtype C is most common and subtype A is least common. This study is not in congruence with our study [10].

Nagar SK et al, studied 529 calcanei in Gujarat state. They classified calcanei into five types, Type A-three facets present, type B-Two facets present were anterior and middle facets are continuous as a single facet. Type C- one facet present (all facets fused). Type D- anterior facet is absent and middle and posterior facets are separate. Type E- anterior facet is absent and middle and posterior facets are continuous. Type A (118/529 -22.30%) was classified into subgroups based on interfacet distance between anterior and middle facets -small interval -<2mm (38/118- 32.20%), moderate interval- 2mm-5mm (57/118-48.30%), large interval->5mm (23/118-19.49%). Accordingly moderate interval is most common and large interval is least common which is similar to our study. In type B (404 bones/529-76.37%), subgroup 1 (unconstricted facet) were 237/404-58.66% and subgroup 2 (constricted facet) were 167/404- 41.33%. Subgroup 1 is more common than subgroup 2 which is not similar to our study [11].

S. C. Gupta et al, conducted study on 401 Indian calcanei. The facets for articulation with head of talus were classified into four types: type 1 - 268/401-67% one facet present, this was

further subdivided into two types – constricted facet (28%), not constricted facet (39%) thus not constricted facet is more common, which is not similar to our study. Type 2- 104/401-26% two facets present. Subdivided as: narrow interval <2mm -9%, moderate interval 2-5mm-4%, wide interval >5mm- 13%. Wide interval is more common and moderate interval is least common, which is not similar to our study. Type 3-single facet 21/401-5%. Type 4- single facet continuous with posterior facet 8/401-2%. (Table 3) [2].

## CONCLUSION

It is well known that the treatment choices of complex foot deformities are osteotomy, anatomic reduction and relaxation of the soft tissue to obtain a normal sized, painless and functional foot. It would be helpful to know the anatomy of foot so that some structurally based treatment plan could be formulated [12]. In many diseases of foot, such as talocalcaneal coalition or arthritis, intra articular fractures, congenital dysmorphism, flat foot, valgus deformities etc, the size and shape of bones, relationship of talus and calcaneus with each other and other bones of the foot must be considered for internal and external fixation and surgical procedures [13-17].

**Conflicts of Interests: None**

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