

A STUDY OF MORPHOLOGY AND TYPES OF TALAR ARTICULAR FACETS IN ADULT HUMAN CALCANEI OF ANDHRA REGION

N.Bhanu Sudha Parimala ^{*1}, D. Suma Devi ², S. Muralidhar Reddy ³.

^{*1} Associate Professor, Department of Anatomy, N.R.I Medical College, Chinakakani, Guntur Dist., Andhra Pradesh, India.

² Assistant Professor, Department of Anatomy, N.R.I Medical College, Chinakakani, Guntur Dist., Andhra Pradesh, India.

³ Professor & HOD, Department of Anatomy, N.R.I Medical College, Chinakakani, Guntur Dist., Andhra Pradesh, India.

ABSTRACT

Introduction: The calcaneum articulates with talus by three facets. They are anterior, middle or sustentacular and posterior facets. There is good number of studies conducted on these facets all over the world and in different regions of India but not in Andhra region. Owing to its morphological, functional and surgical importance in relation to maintenance of stability of sub talar joint the study was under taken.

Materials and Methods: 88 dry calcanei available in the Department of Anatomy, NRI Medical College were taken for the present study. The specimens included both right and left sided calcanei of both sexes. The study was conducted on type of arrangement, surface area(S) and distances (D) between the facets.

Observations: The present study followed recent classification of calcaneal facets into 5 types. TYPE 1 -53/88 (60.2%), TYPE 2-27/88(30.7%), TYPE 3-5/88(5.7%), TYPE 4 -2/88 (2.3%), TYPE 5 -1/88(1.1%). All 5 types were seen on left side whereas type 4 & 5 were not seen on right side. Subtypes of Type 2 were done based on distance between anterior & middle facets (DAM) and sub type A with, 2mm separation was the commonest.

Discussion: Incidence of facets was compared with other studies. In European studies the approximate ratio of Type I: Type 2 is 1:2 whereas in Indian studies it is 2:1. In Type2, Subtype A: with less than 2mm separation was commonest in the present study but Subtype B: with 2-5mm separation was reported to be common in previous studies. Morphological variability of the calcaneal facets could result from differences in gait or other habits influencing these articular areas post-natally or it could be indicative of genetically determined variations. Facet morphology influences the stability of sub talar joint, accordingly type 2 with osseous tripod was considered to be highly stable.

Conclusion: The management of intra articular calcaneal fractures remains controversial & treatment depends heavily on imaging findings. Radiographs have a limited role and thus MDCT becomes mandatory in clinical evaluation and management of injuries in this region.

KEY WORDS: Sub talar joint, Intra articular fractures, MDCT.

Address for Correspondence: Dr. N. B. S. Parimala, MBBS, M. D. (Anatomy), Associate Professor, Department of Anatomy, N.R.I Medical College, Chinakakani, Guntur District, Andhra Pradesh, INDIA. Mob: +919440791896 **E-Mail:** nbsparimala@gmail.com

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INTRODUCTION

The calcaneus, the largest of the tarsal bones, lies beneath the talus and supports it. It is major bone of hind foot the other being talus. All muscular attachments into the hind foot are into the calcaneus. The posterior talar articular surface is on the upper surface about the middle of the bone. Anterior to this is the sulcus calcanei, which receives the interosseus talo-calcaneal ligament and helps to form sinus tarsi; anterior to this, on the upper surface of medially projecting sustentaculum tali, is the middle talar articular surface and most anteriorly is the anterior talar articular surface, sometimes continuous with middle one[1]. There is good number of studies conducted on these facets all over the world and in different regions of India but not in Andhra region. Owing to its morphological, functional and surgical importance in relation to maintenance of stability of sub talar joint the study was under taken.

MATERIALS AND METHODS

88 (47 right and 41 left) dry calcanei available in the Department of Anatomy, NRI Medical College were taken for the present study. Right and left sided calcanei of both sexes were included in the present study. The study was conducted on talar facets of calcaneum and their morphology. The three facets posterior large, middle or sustentacular and anterior or small were studied with respect to type of arrangement of facets, their surface area(S) and distances (D) between the facets.

Calcaneal facets were grouped into 5 types based on classification done by recent authors [2, 3] in the present study.

I. Middle & Anterior facet fused- two facets on calcaneum

II. Middle & Anterior facet separate - three facets on calcaneum

III. Anterior facet absent - two facets on calcaneum

IV. Anterior, Middle & Posterior facets fused- only one facet on calcaneum

V. Middle & Posterior facets fused- two facets on calcaneum.

All the measurements were taken with digital vernier callipers after digital correction and the

values were recorded.

Surface area(S) was calculated in cm^2 after taking the maximum length and width measurements of each facet in cm.

Surface area of Anterior facet –SA; Surface area of Middle facet – SM; Surface area of Posterior facet –SP; Surface area of fused Anterior and Middle facet –SAM

Distance between any 2 facets was taken in mm.

Distance between anterior and middle facets- DAM (only in Type 2 can be recorded)

Distance between middle and posterior facets- DMP (recorded in Type 1 & Type 2)

Distance between posterior and anterior facets- DPA (recorded in Type 1, Type 2 & Type 4)

Distance between posterior and middle facets- DPM (recorded in Type 3 & 5)

Distance between Anterior & middle DAM, middle & posterior facets DMP cannot be recorded in type 4 where all 3 facets are fused.

Fig. 1: Types of calcaneal facets (right side).



Fig. 2: Types of calcaneal facets (left side).

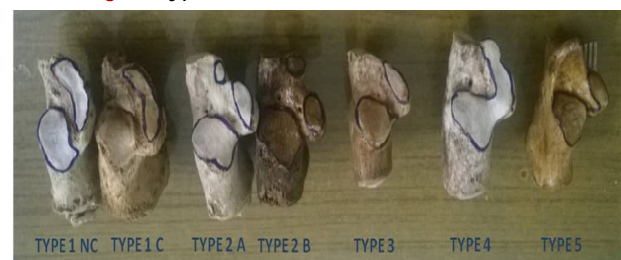


Fig. 3: Special Type1

Subscript: Anterior, middle facets fused and posterior facet separated by negligible distance- an intermediate Type between Type1 and Type 4.



OBSERVATIONS

Table 1: Incidence of various types of calcaneal facets.

TYPE	Right (%)	Left (%)	Total (%)
TYPE 1	30/47 (63.8%)	23/41 (56.1%)	53/88 (60.2%)
1C (with constriction)	15/30 (31.9%)	11/23 (26.8%)	26/53 (29.5%)
1NC (No constriction)	15/30 (31.9%)	12/23 (29.2%)	27/53 (30.7%)
TYPE 2	15/47 (31.9%)	12/41 (29.3%)	27/88 (30.7%)
A - (<5mm)	13/15 (27.6%)	7/12 (17.1%)	20/27 (22.7%)
B - (5-10mm)	2/15 (4.3%)	5/12 (12.2%)	7/27 (8%)
TYPE 3	2/47 (4.3%)	3/41 (7.3%)	5/88 (5.7%)
TYPE 4	0	2/41 (4.9%)	2/88 (2.3%)
TYPE 5	0	1/41 (2.4%)	1/88 (1.1%)

Table 2: Surface areas of different talar facets of calcaneum.

Surface area of facet (S) in cm ²	Type in which (S) measured	No of specimens	Mean \pm S.D (Standard Deviation)
Anterior facet (SA)	Type 2 only	27	0.86 \pm 0.32
Middle facet (SM)	Types - 2 & 3	32	1.97 \pm 0.60
Posterior facet (SP)	Types- 1,2 & 3	85	5.34 \pm 1.00
Fused Anterior & Middle facet (SAM)	Type 1 only	53	3.2 \pm 0.62

Table 3: Distance between different talar facets of calcaneum.

Distance between the facets (D) in mm	Type in which (S) measured	No of specimens	Mean \pm S.D (Standard Deviation)
Anterior & Middle facets (DAM)	Type 2 only	27	3.0 \pm 2.26
Middle & posterior facets (DMP)	Types - 1,2 & 3	85	5.47 \pm 1.78
Posterior facet & Anterior Facets (DPA)	Types- 1,2 & 4	82	20.02 \pm 2.82

When the distance DMP was studied, it was found that middle and posterior facets were separated by variable distance with max 9.1mm and min distance where no separation between articular surfaces except the articular margins.

This type of facets where no separation between articular surfaces (AM fused & P facet) except the articular margins appear to be intermediate between Type1 (AM & P facets separate) and Type 4 (A, M & P facets fused). Such intermediate types were not mentioned before. (Fig: 3)

Table 4: Subtypes of Type 2 based on Distance between Anterior & middle facets (DAM)

Type 2 : A- <2mm, B -2to 5mm, C -5 to 10mm, D ->10mm.

Type2	Right	Left	Total	% -total
Sub typeA	8	3	11	13.63
SubtypeB	5	4	9	9.09
SubtypeC	2	5	7	7.95
SubtypeD	-	-	-	-
Total	15	12	27/88	30.7

D ->10mm not found in the present Study

DISCUSSION

The subtalar joint is located in the foot between the talus and the calcaneus. Variations in joint geometry include having one, two, or three articular facets [4].

The calcaneus, the largest tarsal bone, is an irregular shaped bone with complex contour and articular facets. The integrity of calcaneal anatomic morphology is of important clinical value to maintain normal function of the hindfoot, supporting modality of the arch, and to ensure stress conduction for weight bearing.

Bunning et al [5] observed three types of variations in the arrangement of facets and classified these variations as follows:

Type-A: There are three 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. all three facets form a continuum.

Few Indian workers have also worked on this subject. Jha et al [6] reported that type-B calcanei 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 [7] 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).

The classification followed by recent authors [2, 3] was:

I. Middle & Anterior facet fused- two facets on calcaneum

II. Middle & Anterior facet separate- three facets on calcaneum

III. Anterior facet absent- two facets on calcaneum

IV. Anterior, Middle & Posterior facets fused-only one facet on calcaneum

V. Middle & Posterior facets fused- two facets on calcaneum.

Table 5: Comparison of incidences of various Types of Talar Facets of calcaneum with Studies from different countries.

Study	Country	n	I (%)	II (%)	III (%)	IV (%)	V (%)
Burning et al[8]	Britain	194	33	67	---	0	---
	Veddah	10	60	0	40	---	---
	Indian	78	78	22	---	0	---
	African	492	63	36	--	1	---
Campos et al[9]	Spain	176	53.41	39.77	6.82	0	---
Verhagen et al[10]	USA	191	54.45	26.7	18.85	---	---
Saadeh et al [11]	Egypt	300	63	30.3	4.7	2	---
Barbaix et al[12]	Belgium	134	25	64	11	0	---
Ragab et al[13]	American	--	46	25	12	0.2	---
Uygur et al[14]	Turkish race	221	58.37	34.39	4.98	2.2	---
Shahabpowr et al[15]	Belgium	49	44.9	44.9	10.2	0	---
Present study	South India	88	60.2	30.7	5.7	2.3	1.1

Table 6: Comparison of incidences of different talar Facets among different regions of India.

Study	Region	n	Type 1	Type 2	Type 3	Type 4	Type 5
Gupta et al, [7]	India	401	67	26	5	2	0
Mini Mol et al,[16]	Mumbai	50	74	26	0	0	0
Nagar SK et al,[2]	Gujarat	529	76.37	22.3	1.13	0	0.18
RohinGarg et al,[17]	Rajasthan	310	72.26	24.52	1.3	1.6	0.32
Jagdev singh et al,[18]	punjab	200	72.5	25.5	1.5	0.5	0
Gindha et al; [19]	H.Pradesh	325	69.5	29.8	0.31	0.6	0
K.Anjaneyulu et al:[20]	Sikkim	100	62	31	5	2	0
Priya et al, [21]	karnataka	71	67.6	25.35	7.04	0	0
Madhvi et al,[22]	South India	222	72.1	19.4	6.8	1.3	0.4
Muthukumaravel et al,[3]	Tamilnadu	237	65.82	33.33	0	0.42	0.42
Present study,	Andhra	88	60.2	30.7	5.7	2.3	1.1

Bunning et al [8] reported the incidence of type I calcanei somewhat higher (78%) when

compared to other studies. The incidence of Type1 was greater in Indian, African, Egyptian studies and less in American, Spanish and Turkish studies. In European studies the approximate ratio of Type I: Type 2 was 1:2 exactly opposite to that of Indian studies. Type 3 was highest in studies of Verhagen [10] followed by American; Belgium & El-Eishi studies and in other studies it was less than 10%. Bunning did not observe this type3 calcanei. Type 4 was reported in few whereas Type5 was not reported in any of the above studies.

In all the Indian regional studies incidence of Type 1 was about double that of type2 facets including the present study. Type 3 was not seen in one South Indian study [3], in only few studies incidence of type 5 was mentioned but the percentage is less in all studies including present study.

In the present study all 5 types were observed and the percentages were comparable to study done by Gupta et al [7].

In the present study the mean articular area of confluent middle and anterior facets (type I) was larger than the sum of the middle and the anterior facets (type II) in contrary to the previous observation [11].

Classification of Type 2 into sub types: Depending on the distance of separation between the anterior and the middle facets, pattern II was subtyped into three varieties as A (<5mm), B (5 to10mm) and C (>10mm), based on the Sadeeh et al study [11] where moderate separation of facets was the most frequent subtype. In El-Eishi's series [23] and in studies [8, 18, 21] done by South Indian authors, narrow separation was the commonest sub type. In the present study sub type c with > 10mm separation between anterior & middle facets was not found.

Depending upon distance of separation between middle & anterior facets, pattern II was divided into three subtypes taking different numerical value. [7, 16, 17]

Subtype A: less than 2mm. Subtype B:-2-5mm. Subtype C:-more than 5 mm.

Type C was more common according to Rohingarg et al [17] Gupta et al [7], Type B was common according to Nagar et al [2], Type A was common in Minipol [16] study and present study.

Table 7: Comparison of subtypes of Type 2 talar facets of calcaneum among different authors.

Study	country	n	A	B	C
Gupta et al;[7]	India	401	9	4	13
Campos et al;[9]	Spain	176	2.84	21.02	15.91
Saadeh et al; [11]	Egypt	300	-	6.7	23.7
Uygur M et al;[14]	Turkey	221	4.08	13.12	17.19
Muthukumaravel et al;[3]	South India	237	-	27	6.32
Mini Mol et al;[16]	Mumbai	50	22	2	2
Nagar et al;[2]	Gujarat	529	7.18	10.7	4.3
Rohin garg et al;[17]	Rajasthan	310	4.8	7.7	8.1
K.Anjaneyulu,etal;[20]	Sikkim	100	10	10	11
Present study	Mangalagiri	88	13.63	9.09	7.95

N-Total number of calcaneal bones studied, Sub Type A-Less than 2mm, B- 2-5mm, C-more than 5 mm.

Type 2 pattern can be reclassified into 4 Sub types depending on distance of separation between anterior and middle facets.

Type 2 – Sub type A- <2mm ; Sub type B - 2to 5mm; Sub type C -5 to 10mm; Sub type D->10mm.

Sub type A, includes Anterior and middle articular facets separated from each other but with no non-articular area intervening. In the present study sub type A was commonest with<2mm separation when compared with many studies where B & C subtypes tend to be more common.

Sub type D with >10mm separation was not found in present study.

Clinical Correlation: Disposition of superior articular facets of the calcaneum is congenital and not a postnatal development, with Type – C more in females-sexual dimorphism[5].

Calcaneal fractures account for 33.3% of foot fractures and about 60% of all major tarsal injuries. The majority of fractures are intra articular with sub talar joint involvement [24, 25]. 191 calcanei were analysed for correlations between sustentaculum tali facet morphology and osteoarthritis of the subtalar joint by Verhagen[10].Accordingly in pattern I facet configuration, the articular surface is continuous, flat and smooth giving less impediment to the medial rotation of the talar head eventually can result in laxity of the spring ligament, unstable subtalar joint and thus leading to its osteoarthritis.

Morphological variability of the calcaneal facets could result from differences in gait or other habits influencing these articular areas post-natally or it could be indicative of genetically determined variations [5].

A significant difference in joint mobility is expected between joints with different numbers of articular facets. Decreased mobility is expected in joints with greater numbers of facets [4].

Based on the above study it can be understood that Indians who have 2 facet configuration more commonly than the three facet, are prone for sub talar joint instability and its associated problems.

When performing an Evans calcaneal osteotomy, [26] placement of the cuts relative to the sustentaculum tali (ST) is critical in order to avoid damage to the middle facet of the subtalar joint.

Raines and Brage [27] performed a cadaveric study in twenty specimens in which simulated osteotomies were performed at 5, 10 and 15-mm proximal to the calcaneocuboid joint and in more proximal cut violation of the middle facet was found.

The management of intra articular calcaneal fractures remains controversial. Radiographs often have a limited role in the detection of these injuries. MDCT plays a vital role in establishing the presence of fractures and in the assessment of joint involvement [28].

CONCLUSION

Based on all studies it is appropriate to classify the calcaneal facets into 5 types.

Incidence of Type 1with fused anterior and middle facets is the commonest in the present study but varies in other races, where Type 2 predominates showing racial and environmental factors influencing the facet morphology.

In the present study all 5 types were observed and special type 1was reported that was not mentioned elsewhere before.

Radiographs appear to have a limited role and thus MDCT becomes mandatory in clinical evaluation and management of intra articular calcaneal fractures.

Conflicts of Interests: None

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