ORIGINAL RESEARCH ARTICLE

INTERNATIONAL JOURNAL OF ANATOMY PHYSIOLOGY AND BIOCHEMISTRY

http://www.eternalpublication.com

IJAPB: Volume: 2; Issue: 7; July 2015 *ISSN(Online):2394-3440*

Variations in talar facets on calcaneum and their clinical implications

Published online on 7 th July 2015©www.eternalpublication.com

DR. NISHA YADAV[1]
DR. DIPTI NIMJE[2]
DR. KALPANA PATIL[3]
1,2 Assistant Professor, Dept. of Anatomy, Shri Bhausaheb Hire Government Medical College, Dhule
3 Assistant Professor, Dept. of Anatomy, Government Medical College, Aurangabad

Corresponding Author:

Dr. Nisha Yadav
Assistant Professor
Dept. of Anatomy
Shri Bhausaheb Hire Government Medical College
Dhule (Maharashtra, India)
+91-
dr.nishayadav@gmail.com

Received: 14th June 2015; Accepted: 3rd July 2015

How to cite this article: Yadav N, Nimje D, Patil K. Variations in talar facets on calcaneum and their clinical implications. International Journal of Anatomy Physiology and Biochemistry 2015; 2(7):1- 5.

Abstract:

Calcaneum is the longest, largest tarsal bone. The dorsal surface of calcaneum is having three facets i.e. anterior, middle and posterior. Facet variations are functionally important because they influence subtalar joint stability and suggest that the 2-facet configuration is more stable than the others. 70 calcaneal facets were studied. In that pattern I was predominant and found in 68.5%, pattern II in 21.4%, pattern III in 7.1%, pattern IV in 2.8% and none were of pattern V. Knowledge about variation is important for orthopaedicians while correcting foot deformities like pes planus. Therefore, this study is carried to identify patterns of talar facets on calcaneum and their clinical implications.

KEYWORDS: calcaneum, facets for the talus, arthritis, subtalar joint

Introduction:

Calcaneum is the longest, largest and weight bearing, somewhat irregular cuboid tarsal bone of the proximal row and forms the posterior pillar of the two longitudinal arches of the foot. Calcaneum articulates with overlying talus to form the talocalcaneal joint which together with the talaocalcaneonavicular joint form the sub-talar joint. The dorsal or the superior surface of calcaneum is divided into three parts, posterior third which is rough concavo-convex, middle third carries the posterior talar articular facet and anterior third which is partially articular.[1]

The literature describes five patterns of calcaneal facets for the talus.

Pattern I: Fusion of the middle and the anterior facets.

Pattern II: Middle and the anterior facets separate

Pattern III: Absent anterior facet

Pattern IV: Fusion of all the three facets

Pattern V: Fusion of the middle and the posterior facets.

Facet variations are functionally important because they influence sub-talar joint stability and suggest that the 2-facet configuration is more stable than the others.[2] Unstable joints are more likely to suffer trauma, accidents or other biomechanical stress as a result of uneven weight distribution and excessive incremental motion which cause osteoarthritis.[3] It is claimed by research workers that certain pattern of talar facets predispose to sub-talar arthritis. Knowledge about variation is important for orthopaedicians while correcting foot deformities. Therefore, this study is carried to identify patterns of talar facets on calcaneum and their clinical implication.

Material and Methods:

70 adult ossified calcaneum bone (n= 70) irrespective of sex and side without any pathological changes or anomalies were included in the study. Calcaneum for the study was taken from Department of Anatomy of various Government Medical Colleges from Maharashtra. Pattern of talar articular facets on calcaneum were observed with naked eye. Sliding Vernier Caliper was used to measure inter-facet distance. All the observations and the measurements were put into tabular form.

Result:

Out of 70 calcanei studied, 48 were of pattern I (68.5%), 15 were of pattern II (21.4), 5 were of pattern III (7.1%), 2 were of pattern IV (2.8%), none were of pattern V. Three subtypes in Pattern II were noted; in Subtype A with middle and anterior facet separation of less than 5mm was seen in 64 bones. Subtype B with middle and anterior facet separation of 5-10mm was seen in 12 bones. Subtype C with middle and anterior facet separation of more than 10 mm was seen in 3 bones.

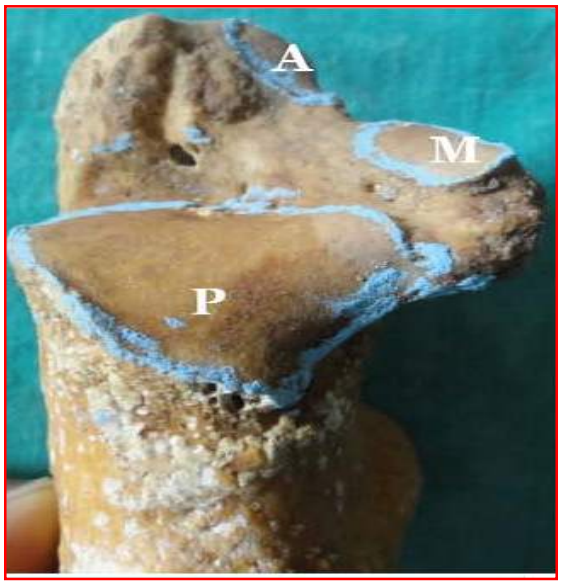
Table-1: Showing patterns of calcaneal facets for talus

Patterns of calcaneal facets	Number of bones	Percentage
Pattern I: M & A fused	48	68.5
Pattern II: M & A separate	15	21.4
Pattern III: A absent	5	7.1
Pattern IV: A, M & P fused	2	2.8
Pattern V: M & P fused	0	0

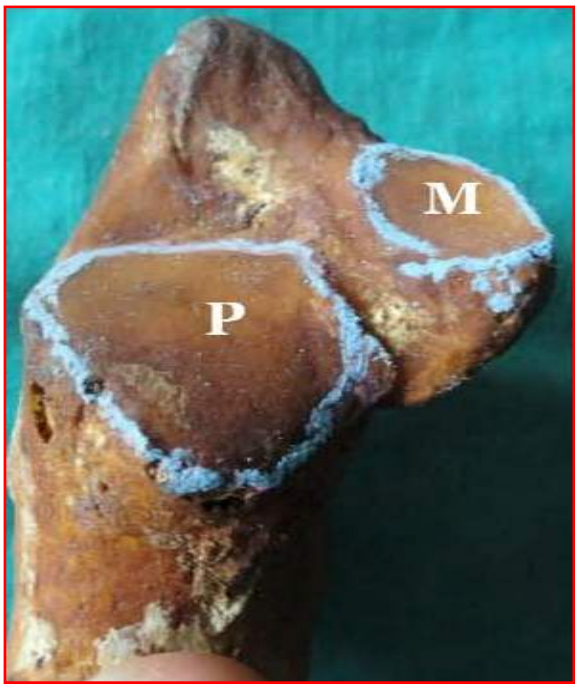
A-Anterior facet, **M**-Middle facet, **P**-Posterior facet

Photograph 1: Pattern I - Fusion of the Middle (M) and the Anterior (A) facet.

Photograph 2: Pattern II- Middle (M) and Anterior (A) is facet separate.



Photograph 3: Pattern III- Absent Anterior (A) facet



Photograph 4: Pattern IV- Fusion of Posterior, Middle and Anterior facets

Discussion:

Analysis of provided data showed that Pattern I was most commonly found in this study was also predominant pattern found by previous workers.[4,5] Pattern II was found to be dominant in Europeans. These findings suggest that there is correlation between pattern and race. Since these racial differences were also observed in fetal series, these are thought to be genetically determined with notable functional explanation.[6] Pattern III with absent anterior facet found in this study (7.1%) also found in the study done by other researchers.[4,7,8] The rare Pattern IV also found in this study (2.8%) was also found in Egyptian and Indian studies.[4,5,8] The rarest Pattern V was found only in study done by Muthukumaravel N et al.[5]

Table-2: Showing comparison of present study results with other studies

STUDY, YEAR	PATTERN					
	Country	I (%)	II (%)	III (%)	IV (%)	V (%)
Bunning and Barnett[6] (1965)	Britain	33	67	_	_	_
Gupta SC et al[4] (1977)	India	67	26	5	2	_
Francine Drayer-Verhagen[7] (1993)	U.S.A	54.45	26.7	18.85	_	_
Saadeh FA et al[8] (2000)	Egypt	63	30.3	4.7	2	_
Muthukumaravel N. et al[5] (2011)	India	65.82	33.33	_	0.42	0.42
Present study (2015)	India	68.5	21.4	7.1	2.8	-

The findings of Francine Drayer-Verhagen[7] (1993) suggest that the talar facet morphology of the calcaneum is an important factor in sub-talar joint stability. This finding was consistent with the hypothesis of Bruckner[2] (1987) which stated that the subtalar joint formed by calcanei which had the pattern II 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 in pattern II. 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 sub-talar 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 sub-talar arthritis, since they predominantly have pattern I calcanei. The same study by Francine Drayer-Verhagen[7] (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.[7] Stability of the subtalar joint also depends on the height of the longitudinal arch, which is determined by the inclination of the subtalar joint axis.[5] Greer quoted that calcaneum with absent anterior facet have inadequate talar head support which allows excessive anterior and inferior rotation of the talus during weight bearing. This results in a valgus position of the calcaneum and a downward tilt of the talar head. The planus foot (hyper mobile or flat foot) has absent anterior sustentaculum tali facet on CT scans.[9] For correcting deformities of pes planus the orthopaedic surgeons should have knowledge about variation of talar facets on calcaneum while performing 'Lengthening-distraction wedge calcaneal osteotomy and interposition bone graft'. In this procedure, the identification of the interval between the anterior and the middle facets is important for the exact placement of the retractor, since the line of osteotomy usually passes through the same interval.[3] Since pattern I calcanei (with fused middle and anterior facets) are found to be dominant in Indians, the surgeons here have to be careful while applying this technique. In the 'triple arthrodesis' procedure to correct the deformities of flatfoot, the articular facet configurations of the calcaneum should be clearly kept in mind in order to safely denude the surfaces of the sub-talar joints of all the articular cartilages.

Conclusion:

The study conducted shows that;

1. People with Pattern I may be at a greater risk for sub-talar joint instability than individuals with Pattern II and predispose people to joint instability, ligamentous laxity and the development of arthritic changes in the sub-talar joint.

2. The knowledge of the racial differences is important for orthopedic surgeons in India while performing calcaneal osteotomy. In spite of blindly following the surgical techniques described in European literature, modifications to suit the Indian scenario are mandatory.

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