



Morphological and Morphometric Analysis of Talar Articular Facets in Human Calcanei in Maharashtrian Population – A Descriptive Study

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Abstract

Introduction: The calcaneum means heel, is the weight-bearing and largest tarsal bone. Morphology of articular facets on calcaneum for talus is important in stabilizing the subtalar joint. The study of configuration of articular facets as anatomical variations is having significance. Bruckner (1987) has mentioned that facet configurations directly influence the stability of subtalar joint and some types do lead to early arthritic changes.

Material and Methods: The present study was a descriptive study conducted by utilizing 300 dry adult human calcanei of unknown age and sex. Each calcaneum was examined carefully for the articular facets it bears for talus. Collected data was statistically evaluated. Microsoft Word and Excel were used to generate graphs, tables, etc. Results obtained were compared with the existing literature to study racial variations.

Results: Type I configuration showing convergence of anterior and posterior facets was predominant in the

present study with 76.67% calcanei. Type II configuration showing three facets - anterior, middle and posterior was 20.33%.

Discussion: In contrast to our findings, in the European race, type II with configuration showing three facets - anterior, middle and posterior was predominant. Considering these findings, the orthopedic surgeons in India need to change the techniques described in European literature for calcaneal osteotomy. The chances of subtalar arthritis in Maharashtrian population may be high prevalence of type I calcanei. Configuration of talar articular facets on calcaneum may be due to racial differences.

Keywords: Calcaneal osteotomy, Subtalar arthritis, Talar articular facet.

Introduction

Normal anatomical position of the foot is at right angle to the body. This permits sole to have a proper grip on the ground. The skeleton of the foot is composed proximodistally of tarsals, metatarsals and phalangeal bones. Out

of seven tarsal bones arranged in proximal and distal rows, talus and calcaneum form the proximal row.^[1]

Bipedal nature has led to many changes in the human foot. The arches of foot have evolved as an adaptation to the bipedal nature and erect posture. Calcaneum takes part as posterior pillar in the formation of medial and lateral longitudinal arches which along with the transverse arch plays an important role in standing, walking and running. Inversion and eversion occur at the talocalcaneal joint.^[2] Morphology of articular facets on calcaneum for talus is important in stabilizing the subtalar joint. Study regarding the configuration of articular facets as anatomical variations is having significance. Bruckner (1987) has mentioned that facet configurations directly influence the stability of subtalar joint and some types do lead to early arthritic changes.^[3]

Types of articular facets on calcaneum are described by various researchers using parameters like the number of articular facets, fusion of facets, shape of facets etc. These parameters may serve as indicators for racial variations. Morphometric analysis of calcaneum is important for treatment and diagnostic procedures for orthopedic surgeons for various foot diseases as in congenital club foot, valgus deformities, severe pronation cases, pes planus, unstable subtalar joint, calcaneal osteotomy.^[4]

Methodology

The present study examined 300 dry adult human calcanei from Government Medical Colleges of Maharashtra. The articular facets it bears for talus were examined carefully on each calcaneum.

Exclusion criteria

- Calcanei with pathological changes.
- Calcanei with anomalies.

The material used for the study were as follows: -

1. Black marker pen
2. Tracing papers
3. White sheets
4. HB Pencil

Detailed research plan

i- Calcanei obtained from the above mentioned colleges were collected.

ii- Black marker pen or pencil was used to outline the talar articular facets on the calcanei.

iii- All these facet-outlines were copied on to a tracing paper.

iv- Articular facets on calcaneum for talus were divided into five types considering the number of facets and their shape.^[5]

Type I – We observed the superior surface of calcaneum showed two articular facets. Convergence of anterior with the middle talar facets formed one facet on anterior one-third of calcaneum [A+M/P].

Type II- The superior surface of calcaneum showed three separate articular facets namely anterior, middle, posterior [A/M/P].

Type III- Anterior facet was absent. Middle and posterior facets were present as separate facets. [M/P, A-Ab].

Type IV- Convergence of anterior with middle and posterior facets resulting into a single facet on the superior surface of calcaneum was noted. [A+M+P].

Type V - There was no anterior facet. One articular facet was present due to fused middle and posterior facets [M+P, A-Ab].

Figure 1: Division of calcanei depending on the articular facets it bears for talus.



Observations & Results

We studied 150 right and 150 left sided calcanei (total= 300 calcanei). Out of these 300 calcanei studied, Type I showing convergence of anterior with middle facets was predominant [76.67%], followed by Type II calcanei showing separate three facets namely anterior, middle, posterior [20.33%]. Findings were statistically highly significant. [P <0.0001]

Types of calcaneum as per talar articular facets	Number of calcanei [N=300]	Percentage
Type I[A+M/P]	230	76.67
Type II[A/M/P]	61	20.33
Type III[M/P, A-Ab]	7	2.33
Type IV[A+M+P]	1	0.33
Type V [M+P, A-Ab]	1	0.33

$\chi^2=255.7$, $df=4$, $P<0.0001$ i.e highly significant

Table 1: Calcanei according to the articular facets they bear for talus and their incidence in the study population [N=300]

Discussion

Our present study consists of 300 dry calcanei with unknown age and sex where the talar articular facet configurations on calcaneum were observed. Data was compared with existing literature.

Morphology of articular facets on calcaneum for talus is important in stabilizing the subtalar joint. Studying the configuration of articular facets as anatomical variations is having significance. Bruckner (1987) has mentioned that facet configurations directly influence the stability of subtalar joint and some types do lead to early arthritic changes.^[3] Types of articular facets on calcaneum are described by various researchers using parameters like the number of articular facets, fusion of facets, shape of facets etc. These parameters may serve as indicators for

racial variations. Morphometric analysis of calcaneum is important for treatment and diagnostic procedures for orthopedic surgeons for various foot diseases as in congenital club foot, valgus deformities, severe pronation cases, pes planus, unstable subtalar joint, calcaneal osteotomy.^[4] Clinically, cavus feet are rigid and flat feet are more mobile. During walking in erect posture, the human foot flexibly adapts to the uneven surfaces first and then acting as a lever propulses our body ahead.

Lateral process of talus maintain the structural stability on the lateral side along with the anterolateral process of calcaneum whereas the sustentaculum tali maintain the stability on the medial side of the foot along with the medial tubercle of the talus.^[6] Bruckner stated that joint mobility is significantly affected by the talar facet configurations on the calcanei. As the articular factes on calcanei increase in number, the articular surface area goes on decreasing and the angular measurements start increasing, smaller is the articular surface area and higher are the angular measurements. Subtalar axis angles might be less and more of the joint mobility may be observed with subtalar joints involving two articular facets. Vice versa is the case with subtalar joints involving three articular facets.

Patients with two facets subtalar configuration respond more to exercise and soft tissue maneuvers as compared to those with three facets configuration. Appropriate shoe modification is the need in case of patients with rigid foot having any difficulties. Knowledge of different talar configurations in athletes will help in apt and timely interventions for prevention of any injuries and help in getting the best possible outcome.^[3]

Bunning and Barnett compared the African, Indian & European calcanei. They found that in British population type II with three articular facets was predominant

followed by type I with two articular facets on calcaneum. In Nigerian, Veddah and Indian population, type I with two articular facets was predominant followed by type II with three articular facets on calcaneum.^[7] Similar findings were found in present study. Type I [The superior surface of calcaneum showed two articular facets. Convergence of anterior with the middle talar facets forming one facet on anterior one-third of calcaneum] was predominant followed by type II [The superior surface of calcaneum showed three separate articular facets namely anterior, middle, posterior].

On comparing our findings with the findings of other authors, similar result stating that the configuration with anterior and middle facets fused is predominant was obtained.^[5,7-15] In British population, the incidence of superior surface of calcanei showing three separate articular facets namely anterior, middle, posterior was a lot more as compared to the Indian studies.^[7]

Considering the percentage of calcanei with different talar facet configurations, there was difference in findings in the present study and study by Turkish, Pakistani, American, British, Nigerian, Egyptian and Isan

Thais populations^[7,11-15] whereas similar findings were with most of the studies done in Indian population.^[5,7-10]

In fetal calcanei, Bunning and Barnett found same racial differences and sexual dimorphism as in adult calcanei indicating genetic influence rather than the influence of physical activities.^[7]

Francine Drayer Verhagen states that talar facets have a major role in maintaining the stability of subtalar joints. Bruckner has also stated that subtalar joint involving three separate facets increased the stability of these joints. Subtalar joints involving such calcanei are less prone to arthritis.^[3,11] They also noted that the talar head was more mobile when the subtalar joint is formed by the calcanei with anterior and middle facets fused configuration. Here, the articular surface being flat and continuous, the talar head can rotate more which will further exert continuous pressure on spring ligament and the supporting muscles. This in turn causes the ligaments and the muscles to become lax leading to unstable subtalar joints and osteoarthritis.^[11]

Table 2. Comparison of incidence of talar articular facet configurations on calcanei with other researches.

Study	Year	Country	n*	I [A+M/P] [%]	II [A/M/P] [%]	III [M/P, A-Ab] [%]	IV [A+M+P] [%]	V [M+P, A-Ab] [%]
Bunning and Barnett ^[7]	1965	India	78	78	22	-	00	-
Gupta SC et al ^[8]	1977	India	401	67	26	5	2	-
Muthukumara val N et al ^[9]	2011	South India	237	65.82	33.33	-	0.42	0.42
Mini M et al ^[10]	2012	India [Mumbai]	50	74	26	00	00	-

Garg R et al ^[5]	2013	India [Rajasthan]	310	72.26	24.52	1.3	1.6	0.32
Verhagen FD ^[11]	1993	USA	191	54.45	26.7	18.85	-	-
Saadeh FA et al ^[12]	2000	Egypt	300	63	30.3	4.7	2	-
Uygun M et al ^[13]	2009	Turkish	221	58.37	34.39	4.98	2.2	-
Wajid Hussain Bakri et al ^[14]	2000	Pakistan	350	62.90	28.60	-	8.6	-
Iamsaard S et al ^[15]	2015	Isan Thais	396	60.86	38.64	-	0.51	-
Present study		India [Maharashtra]	300	76.67	20.33	2.33	0.33	0.33

These studies suggest that people having type I showing convergence of anterior with the middle talar facets [A+M/P] configuration are prone for developing subtalar arthritis. Orthopedic surgeons performing procedures for correction of deformities of foot need to keep these facts of talar facets in mind. In such procedures, the relationship between the talar facets is important for best desired outcome.^[4,16,17]

The technique of calcaneal osteotomy is best suited for the European population predominately having calcanei with type II showing three separate facets for tali. Since type I [converged anterior and middle facets] are more in study population in Indians, such surgical techniques need to be modified to best suit the Indian population. Hence, anatomical knowledge of calcanei with regards to the articular facets it bears for talus is very important from surgical point of view.^[9]

In complex foot deformities, surgical intervention is the employed method of treatment for achieving painless functional foot. Knowledge of anatomy for

implementing any treatment for structural deformity is a must.^[5,13] In the triple arthrodesis done in cases of flat foot, the subtalar joints are denuded of the articular cartilages it bears. While performing this type of procedure, one should always keep in mind the various configurations of calcanei depending on the talar facets.^[4]

The relationship of talus & calcanei and other bones with each other is very important for understanding the various diseases affecting the foot. Due consideration should be given to these facts during surgical procedures.^[16,18-21]

The advanced technology is immensely helping for developing better implants and prosthesis. The detailed knowledge of this regional anatomy will be of great help for the same.^[5]

The use of 3-dimensional imaging techniques can identify the calcanei with various configurations of the talar facets leading to diagnosis and treatment of many foot deformities.^[17-19]

Conclusion

- A. In present study type I configuration showing convergence of anterior with the middle talar facets was predominant with 76.67% calcanei which was statistically highly significant.
- B. Second commonest configuration found was type II calcanei bearing three separate talar facets [20.33%].
- C. These findings differ from the European race, in whom type II with separate anterior, middle and posterior facet configuration was predominant.
- D. Considering these findings, the orthopedic surgeons catering to the Indian population need to change the techniques described in European literature for calcaneal osteotomy.
- E. There are more chances of subtalar arthritis in people with type I calcanei.
- F. Configuration of talar articular facets on calcaneum may be due to racial differences suggesting some genetic influence on the same.
- G. The effect of different races on talar facet configuration of calcanei indicate towards a change in the surgical approach to best suit the Indian Population.

References

1. Datta AK. Essentials of Human Anatomy [superior and inferior extremities]. 4th ed. Kolkatta: Current Books International;2013.p.151-52.
2. Susan Standring.Gray,s Anatomy,The Anatomical Basis of clinical Practice. 40th ed. London: Churchill Livingstone,Elsevier; 2008.p.1436-63.
3. Bruckner JAN. Variations in the Human Subtalar Joint.JOSPT.1987;8(10):489-94.
4. Greer Richardson E.Pes Planus.In:S Terry Canale ST-Editor. Campbell's operative orthopaedics. 9th ed. St.Louis :Mosby -year Book;1998.p.1720-25.
5. Garg R, Dagal N, Kumar S, Shekhawat S. Study of patterns of talar articular facets of human calcanei and their clinical implications in population of Rajasthan. Indian Journal of Basic and Applied Medical Research.2013;(7):643-50.
6. Jahss MH. The subtalar complex. 1982;1:727-36.
7. Bunning PSC, Barnett CH. A comparison of adult and foetal talocalcaneal articulations.J.Anat.1965;99(1):71-76.
8. Gupta SC, Gupta CD, Arora AK. Patterns of talar articular facets in Indian calcanei.Journal of Anatomy.1977;124(3):651-55.
9. Muthukumaravel N, Ravichandran D,Melani R S. Human Calcaneal Facets for the Talus : Patterns and Clinical Implications. Journal of Clinical and Diagnostic Research.2011;5(4):791-94.
10. Mini M P, Nazmeen S,Haritha K N. Morphological study on patterns of talar articular facets of human calcanei.International Journal of Medical and clinical Research. 2012;3(3):136-39.
11. Drayer-verhagen F A. Arthritis of the subtalar joint associated with sustentaculum tali facet configuration.Journal of Anatomy.1993;183:631-34.
12. Saadeh FA FA et al. Patterns Of Talar Articular facets of Egyptian Calcanei. J AnatSocIndia. 2000;49(1):6-8.
13. Uygur M AF et al. The types of talar articular facets and morphometric measurements of the human Calcaneus bone on Turkish Race. Arch orthop Trauma Surg. 2009;129:909-14.

14. Wajid HB, Sarah K. The Racial Polymorphism in Talar articular facets of Calcaneum. *Nishtar Med J.* 2010;2(1):10–13.
15. Iamsaard S, Uabundit N, Boonruangsri P, Sawatpanich T, Hipkaeo W. Types of Facets on the Superior Articular Surface of Isan-Thai Dried Calcanei. 2015;33(4):1549–52.
16. Dagan A, Albayrak K et al. The results of calcaneal lengthening osteotomy for the treatment of flexible pes planovalgus and evaluation of alignment of the foot. *Acta Ortop Traumatol Turc.* 2006;40(5):356–66.
17. Kwak Y H, Park K B PHW. Use of allograft in skeletally immature patients for calcaneal neck lengthening osteotomy. *Yonsei Med J.* 2008;79–84.
18. Anathakrishnan D, Ching R, Tencer A, Hansen ST SB. Subluxation of the talocalcaneal joint in adults who have symptomatic flat foot. *J Bone Jt Surg.* 1999;81(8):1147–54.
19. Smith SD, Millar E A. Arthrosis by means of a subtalar polyethylene peg implant for correction of hindfoot pronation in children. *Clin Orthop Relat Res.* 1983;181:15–23.
20. Wilde P H, Torode I P et al. Resection for symptomatic talocalcaneal coalition. *J Bone Jt Surg Br.* 1994;76(5):797–801.
21. Giannini S, Ceccarelli F et al. Operative treatment of flat foot with talocalcaneal coalition. *Clin Orthop Relat Res.* 2003;411:178–87.