

A Study on Notches along the Lateral Border of Cuboidal Articular Surface of Calcaneus and its Correlation with the Direction of Grooves in Relation to Peroneal Trochlea

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ABSTRACT

Introduction: Calcaneus is the largest and most frequently fractured tarsal bone. The cuboidal articular surface is concavo-convex which fits on to the reciprocal surface of cuboid. The aim of study was to observe the relation between notches on the lateral border of cuboidal articular surface of calcaneus and the direction of grooves in relation to peroneal trochlea to guide the orthopedicians to avoid complications during surgery.

Material and methods: 120 dry human calcanei of unknown sex collected from the Anatomy department, Great Eastern Medical School, Srikakulam district, Andhra Pradesh were used for this study. The notches along the lateral border of cuboidal articular surface of calcaneus and the direction of grooves in relation to peroneal trochlea were observed, correlated and photographed.

Results: A single notch was found along the lateral margin of anterior articular surface in 46 calcanei, 2 notches in 2 calcanei and no notches in 72 calcanei. Different directions of grooves for the tendons of peroneus brevis and longus in relation to peroneal trochlea were observed.

Conclusion: The knowledge of notches on lateral margin of the cuboidal articular surface of the calcaneus is useful for radiologists and orthopaedic surgeons in performing arthroscopic peroneal tendon reefing for correcting chronic lateral ankle instability, repositioning the peroneal tendons after dislocation, and in triple arthrodesis for club foot.

Keywords: Calcaneus, Notches, Grooves, Peroneal Tubercle, Peroneus Brevis, Peroneus Longus.

aspect of the fibular / peroneal trochlea (peroneal tubercle) which is exceedingly variable in size and palpable 2cm distal to the lateral malleolus when well developed. There are two grooves directing downwards and forwards, one above and one below the peroneal trochlea. Therefore the direction of peroneal trochlea is also downwards and forwards. Upper groove lodges the tendon of peroneus brevis where as the lower groove lodges the tendon of peroneus longus. Middle 1/3rd of posterior surface receives the insertion of tendocalcaneus. Medial surface presents sustentaculum tali which gives support to the talus from below. It shows a groove below the sustentaculum tali for the lodgement of the tendon of flexor hallucis longus. It gives attachment with spring ligament, deltoid ligament and flexor retinaculum. Superior surface consists of 2 articular surfaces on the upper surface of sustentaculum tali to articulate with anterior 2 articular facets of inferior surface of talus to participate in talocalcaneonavicular joint separated from the posterior convex articular surface in the middle 1/3rd by sulcus tali to articulate with posterior concave articular surface on the inferior surface of talus to form subtalar joint. The inferior surface presents anterior tubercle and 2 posterior tubercles (medial and lateral) giving rise to the attachments of muscles of 1st layer and flexor digitorum accessorius of 2nd layer of sole of foot and short and long plantar ligaments.¹⁻⁴ The aim of study was to observe the relation between notches on the lateral border of cuboidal articular surface of calcaneus and the direction of grooves in relation to peroneal trochlea to guide the orthopedicians to avoid complications during surgery.

INTRODUCTION

Normally the calcaneus is the largest of the tarsal bones of foot and projects posterior to the tibia and fibula as a short lever for muscles of the calf attached to its posterior surface. It is irregularly cuboidal, its long axis being inclined distally upwards and laterally. It takes part in the transmission of body weight and helps in forming subtalar (talo-calcaneal) and midtarsal (calcaneo-cuboidal and talo-calcaneo-navicular) joints.¹⁻⁴ Primates have significantly elongated calcaneus in comparison to many non-primates.⁵

Calcaneus consists of six surfaces. The anterior cuboidal articular surface is smallest, concavo-convex from medial to lateral and is obliquely set to articulate with reciprocal proximal articular surface of cuboid to form calcaneocuboid joint. The complex shape of this joint surface allows the distinctive lateral swing of the human calcaneocuboid joint in to a close packed position during the stance phase of the bipedal locomotor cycle and allows the midtarsal region of the foot function as a rigid lever. The superior margin of this surface projects farther anteriorly than does the inferior margin. The lateral margin of this surface often presents no notches. The lateral surface is nearly flat. It is proximally deeper and palpable on the lateral

MATERIAL AND METHODS

120 dry human calcanei (60 right and 60 left) of unknown sex were collected from the bone bank of Anatomy department, Great Eastern Medical School, Srikakulam district, Andhra Pradesh. All the bones were studied for the following variables - presence of notches, number of notches, levels of situation of notches on the lateral margin of cuboidal articular surface, their correlation with grooves in relation to peroneal tubercle and

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photographed.

STATISTICAL ANALYSIS

Microsoft office 2007 was used for the statistical analysis. Descriptive statistics like mean and percentages were used to interpret the results obtained.

RESULTS

Out of 120 bones studied, no notches were found along the lateral margin of cuboidal articular surface of calcaneus in 72 bones (Figure 1A). 46 bones were found to have single notch (Figure 1B,1C and 1D) at 3 different levels and 2 bones showed the presence of two notches (Figure 1E).

3 levels (upper 1/3rd, middle 1/3rd and lower 1/3rd) of situation of notches along the lateral margin of anterior articular surface of calcaneus were also observed. Out of 46 bones, single notch was present in upper 1/3rd of lateral margin of anterior articular surface in 2 right bones (Figure 1B), middle 1/3rd in 32 right and 10 left bones (Figure 1C) and lower 1/3rd in 1 right and 1 left bones (Figure 1D) (Table 1). Two notches were noticed, one at the junction between upper 1/3rd and middle 1/3rd and another at the junction between middle 1/3rd and lower 1/3rd in 2 right bones (Figure.1E).

Along the lateral surface of calcanei, we found grooves running one above, and one below the peroneal trochlea in different directions in relation to peroneal trochlea. In 72 bones, faint grooves were seen without producing notches along the lateral margin of cuboidal articular surface (Figure 2A). In 46 bones, grooves were seen producing single notch at 3 different levels along the lateral margin of cuboidal articular surface (Figure 2B, 2C and 2D). But in 2 bones with two notches along the lateral margin of anterior articular surface, 2 grooves were seen running above the peroneal trochlea and one below the trochlea (Figure 2E).

In 2 right calcanei, the upper groove for the tendon of peroneus brevis was seen directing downwards, forwards and upwards producing single notch along the upper 1/3rd of lateral margin of cuboidal articular surface where as the lower groove for the tendon of peroneus longus is directed downwards and forwards without producing notch along the lateral margin of cuboidal

articular surface (Figure 2B). In 42 calcanei (32 right and 10 left), the upper groove for the tendon of peroneus brevis is directed downwards and forwards producing single notch along the middle 1/3rd of lateral margin of cuboidal articular surface where as the lower groove for the tendon of peroneus longus is directed downwards and forwards without producing notch along the lateral margin of cuboidal articular surface (Figure 2C). In 2 calcanei (1 right and 1 left), the upper groove for the tendon of peroneus brevis is directed downwards and forwards making single notch along the lower 1/3rd of lateral margin of cuboidal articular surface where as the lower groove for the tendon of peroneus longus is directed downwards and forwards without producing notch along the lateral margin of cuboidal articular surface (Figure 2D).

In 2 right calcanei, the upper groove above the peroneal trochlea for the tendon of peroneus brevis is directed downwards and forwards making two notches, one at the junction between upper 1/3rd and middle 1/3rd and another at the junction between middle 1/3rd and lower 1/3rd of lateral margin of cuboidal articular surface where as the lower groove for the tendon of peroneus longus is directed downwards and forwards without making any notch along the lateral margin of cuboidal articular surface (Figure 2E).

DISCUSSION

Several authors studied about calcaneus on various aspects. But the correlation between the presence of notches along the lateral margin of cuboidal articular surface of calcaneus and the grooves in relation to peroneal trochlea was not done till so far. This enlightened us to make a study to help radiologists and orthopedicians for diagnostic and therapeutic purposes.

In the present study, we found a single notch in the upper 1/3rd along the lateral margin of cuboidal articular surface of 2 right calcanei, continuous and correlating with the grooves above the peroneal trochlea (1.67%), in the middle 1/3rd in 42 bones (35%), in the lower 1/3rd in 2 bones (1.67%), two notches in

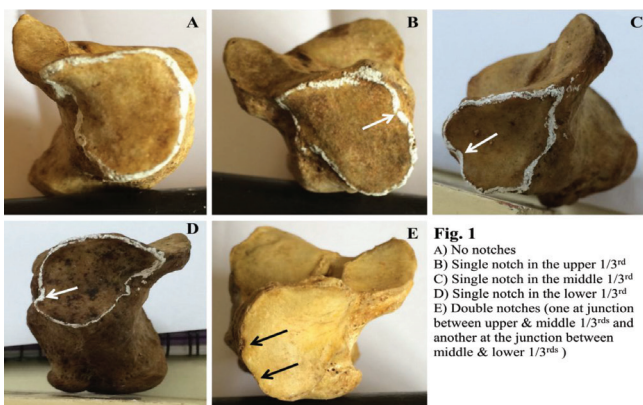


Fig. 1
 A) No notches
 B) Single notch in the upper 1/3rd
 C) Single notch in the middle 1/3rd
 D) Single notch in the lower 1/3rd
 E) Double notches (one at junction between upper & middle 1/3rd and another at the junction between middle & lower 1/3rd)

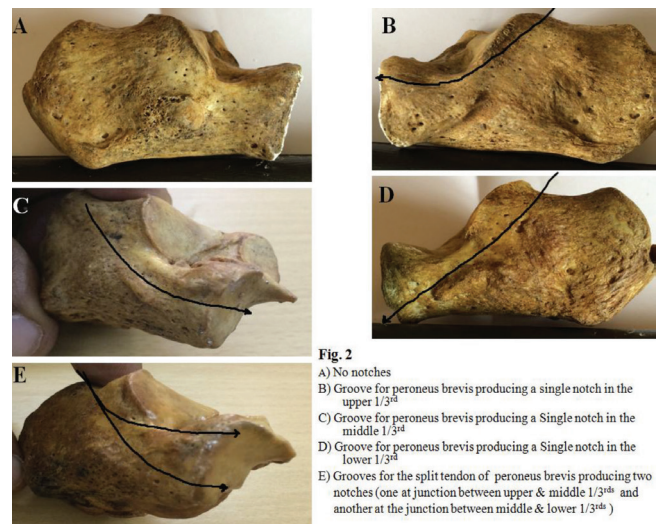


Fig. 2
 A) No notches
 B) Groove for peroneus brevis producing a single notch in the upper 1/3rd
 C) Groove for peroneus brevis producing a single notch in the middle 1/3rd
 D) Groove for peroneus brevis producing a single notch in the lower 1/3rd
 E) Grooves for the split tendon of peroneus brevis producing two notches (one at junction between upper & middle 1/3rd and another at the junction between middle & lower 1/3rd)

Right bones			Left bones		
Upper 1/3 rd	Middle 1/3 rd	Lower 1/3 rd	Upper 1/3 rd	Middle 1/3 rd	Lower 1/3 rd
2	32	1	Nil	10	1

Table-1: Situation of single notch along the lateral margin of anterior articular surface of calcaneus

2 right calcanei (1.67%) and no notches in 72 calcanei (60%). According to Sarrafian SK⁶, the groove of the peroneus longus tendon leaves a landmark on the lateral surface of the calcaneus in 85%. This groove may be present in the absence of a trochlear process, located then on the retrotrochlear eminence. A definitive groove for the fibular brevis tendon is present in 2.6%.

Brandes and Smith⁷ divided the areas of pathology into 3 zones for the tendons of peroneus longus and brevis. Zone A includes superior peroneal retinaculum and distal fibula. Zone B is the inferior peroneal retinaculum at the level of peroneal trochlea of calcaneus. Zone C is the cuboid notch where the peroneus longus turns and enters into osseous groove. Vincent James Sammarco⁸ and G. James Sammarco⁹ added an additional zone D to this classification that involves avulsion of tendons from their insertions at the respective bases of metatarsal bones. Attritional tears of the peroneus brevis tendon are most commonly affected in zone A. Attritional tears of the brevis typically are longitudinal and complete rupture is infrequent.

Several authors like Bardeen CR (1907)¹⁰, Anson BJ (1966)¹¹, Bhargava et al. (1961)¹², Johnson et al. (1993)¹³ and Bergman et al. (2004)¹⁴ found variations in the insertion of peroneus brevis in form of expansion to the tendons of 4th and 5th toes and on 4th metatarsal, slip to middle phalanx of 5th toe, distal phalanx of 5th toe, head of 5th metatarsal, on cuboid, on calcaneus. Variant insertion of Peroneus brevis can result in ankle pain radiating from the ankle to the base of the fifth metatarsal bone. The presence of notches along the lateral margin of cuboidal articular surface can be explained due to compression of the broad and thick tendon of peroneus brevis against lateral margin of cuboidal articular surface of calcaneus basing on the following reasons.

1. Congenital
2. Genetical
3. More lateral obliquity of the calcaneus
4. Presence of additional slips of peroneus brevis tendon
5. Occurrence of attritional longitudinal tears in the tendon of peroneus brevis
6. Talipes equinovarus
7. Pes planus, Pes cavus
8. Ankle inversion injuries

This study of relationship between the grooves for peroneus brevis and longus in relation to peroneal trochlea and notches along the lateral margin of the cuboidal articular surface of calcaneus was never attempted in the past. This data may help orthopedic surgeons in ankle arthroscopic procedures to be done in patients with lateral ankle pain and instability.

CONCLUSION

The knowledge of the relation between the grooves for peroneus brevis and longus in relation to peroneal trochlea and the notches along the lateral margin of the cuboidal articular surface of calcaneus is useful for radiologists and orthopedic surgeons in tenodesis of peroneus longus and peroneus brevis, in repositioning the dislocated peroneal tendons and also in treating the chronic lateral ankle instability by ankle arthroscopy, wedge tarsectomy and triple arthrodesis for club foot.^{15,16}

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