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Study of Anatomical Variations of Human Tali Based on Their Calcaneal Articular Facets.

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ABSTRACT

Talus is the important tarsal bone which participates in the formation of talocrural, subtarsal and talocalcaneo-navicular joints. Anatomical variations of calcaneal articular facets on tali can be of help to Orthopaedic surgeons in pathologies of foot for reconstruction and rehabilitation procedures in many diseases of the foot such as Talocalcaneal arthritis, tarsal coalition, fracture neck of talus, congenital dysmorphology like flat foot, valgus deformity etc. So this study was aimed to observe the anatomical variations in tali. 200 adult human tali were studied from department of Anatomy, Mahathma Gandhi Medical College and Research Institute, Puducherry and other medical colleges in and around Puducherry. Each talus was examined for the presence of various patterns of articular facets. Later they were classified into five groups. Type I tali was found in 42 %. Type II in 30%, type III in 4% and type IV in 3% of cases. Type V had three subtypes, subtype A was present in 10%, B was in 9% and C was in 2%. In the present study, type I had highest incidence and type IV had lowest incidence.

Keywords: talus, calcaneal articular facets, subtalar joint, stability

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INTRODUCTION

The word talus is derived from the latin word taxillus, which refers to the ankle bone of a horse [1]. Talus is the second largest of the seven tarsal bones, and forms the major bone of the ankle joint. It is the key bone of the longitudinal arch and participates in the formation of talocrural, subtarsal and talocalcaneo-navicular joints. It is squat in a dorso-plantar direction, and elongated in a postero-anterior direction. It receives the body weight and transmits it to the plantar arch below [2]. Approximately 60% surface of the talus is covered by articular cartilage and it is the only bone which has no muscular and tendinous attachment [3]. Inversion and eversion takes place at subtalar joint [4]. The inferior surface of the talus has three articulating facets separated by indistinct ridges, they are 1) Large oval facet on its most posterior aspect, articulating with sustentaculum tali of calcaneum, 2) a flat facet on its anterolateral surface articulating with upper surface of calcaneum 3) on its anteromedial surface and medial to the above two facets, is the third facet articulating with spring ligament which is covered by articular cartilage [5].

The configuration of the facets between talus and calcaneum is very important because patients with chronic subtalar instability typically complain of giving away symptoms and history of recurrent sprains. Subtalar instability can be defined as chronic functional instability with increased values of talar tilt and talocalcaneal displacement. It can be treated either with a tendon transfer or tenodesis procedure [6]. Bruckner [7] had hypothesized that sustentaculum tali facet variations are functionally important.

The talus forms a considerable more flexible joint in mammals than it does in reptiles. Since the fracture of the talus is quite common, prior knowledge of anatomy of talus is significant for anatomists and orthopaedicians. Those patients with displaced fractures of the neck run a considerable risk of developing osteoarthrosis especially in subtalar joint [8]. 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 results in development of arthritic changes in subtalar joint [9]. Talectomy has been described as a limb-saving procedure for the treatment of neglected talipes equino varus deformity [10]. Pesplanus or flat foot is a deformity in which there is loss of the medial longitudinal arch of foot. It may be associated with mild subluxation of subtalar joint [11]. Snowboarding can result in fracture of the lateral process of talus [12]. The term Aviators astragalus was used to describe the fractures that happened as old war planes made crash landings. But now talus fractures are seen in high speed car accidents and severe falls [13]. Donoghue and Sell [14] quoted that talo-navicular synostosis in reality was a congenital absence of the navicular bone, accompanied by compensatory hypertrophy of the talus. Tarsal coalition is a condition in which two or more bones in the midfoot or hind foot are joined. The most common types are those between talus and calcaneum [15]. Variations in intraosseous anastomosis and lack of collateral circulation predispose the talus to Osteonecrosis when its vascular supply is disturbed [16].

Various authors classified the different patterns of articular facets of calcaneum in human tali and explained that the differences in incidence of different types of articular facets could be due to differences in gait, built, structure of population or racial differences. Thus the present study was carried out to determine the incidence and percentage of different types of articular facets of calcaneum and to compare it with the existing literature.

MATERIALS AND METHODS

This study included 200 dry human tali (100 right, 100 left) of unknown age and sex, collected from the department of Anatomy, Mahathma Gandhi Medical College and Research Institute, Puducherry and other medical colleges in and around Puducherry. The talus was evaluated one by one. In all the tali, the calcaneal articular facets on the plantar surface were examined. The margin of all the three calcaneal facets were outlined with a dark black pencil, numbered and photographed. The number of tali with a particular type of facets was noted, classified, and their percentages were calculated. Then the incidence was compared with the available literature.

RESULTS

In the present study incidence of various types of calcaneal articular facets were classified in to five types according to classification given by Arora et al [17], Kaur et al [18] and Garg et al [19]. In the previous

studies the facets were classified into 5 types and type V has two subtypes VA, & VB. In the present study we noted another subtype under type V as VC which is not observed in the available literature.

Type I: Single calcaneal facet on plantar surface of head of talus was found in 42 % (Fig 1).
Type II: Single calcaneal facet on plantar surface of head of talus separated by a ridge in 30% (Fig 2).
Type III: Two calcaneal facets on the head of talus separated partly by a ridge and partly by a groove were found in 4% (Fig 3).
Type IV: Two calcaneal facets on the head of talus separated by a groove were found in 3% (Fig 4).
Type V: has three subtypes:
VA- single calcaneal facet continuous with posterior calcaneal facet. It was found in 10% cases (Fig 5).
VB- Two calcaneal facets, in which one of them continuing with posterior calcaneal facet. It was found in 9% cases (Fig 6).
VC -Two calcaneal facets, one of the single facet is divided by a ridge into two and the other one is continuous with posterior calcaneal facet. It was found in 2% of cases (Fig 7).
In the present study, Type I tali had the highest incidence and Type IV had lowest incidence (Table 1). Results were compared with earlier studies (Table 2).

Figure 1: showing single calcaneal facet present on plantar surface of head of talus (Type I)

Figure 2: showing single calcaneal facet on plantar surface of head of talus separated by a ridge (Type II)

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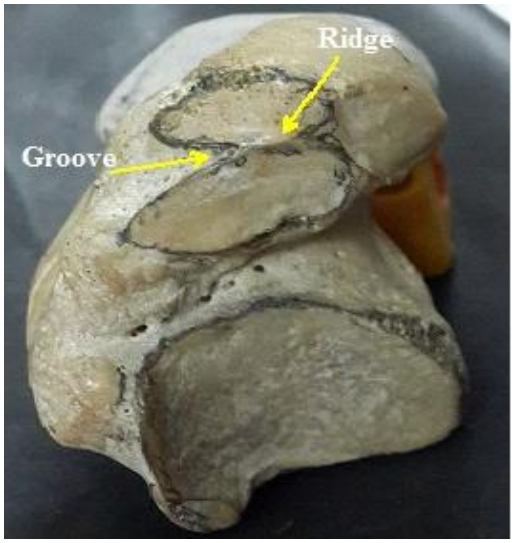

Figure 3: showing two calcaneal facets on plantar surface of head of talus separated partly by a groove and partly by a ridge (Type III)

Figure 4: showing two calcaneal facets on plantar surface of head of talus separated by a groove (Type IV)

Figure 5: showing single calcaneal facet continuous with posterior calcaneal facet (Type VA)

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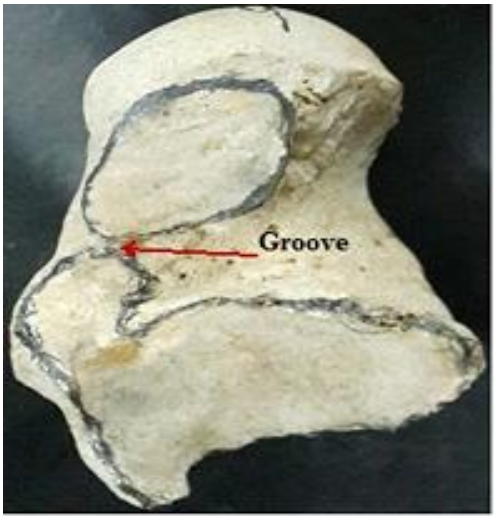

Figure 6: showing two calcaneal facets, one of them is with the posterior calcaneal facet (Type VB)

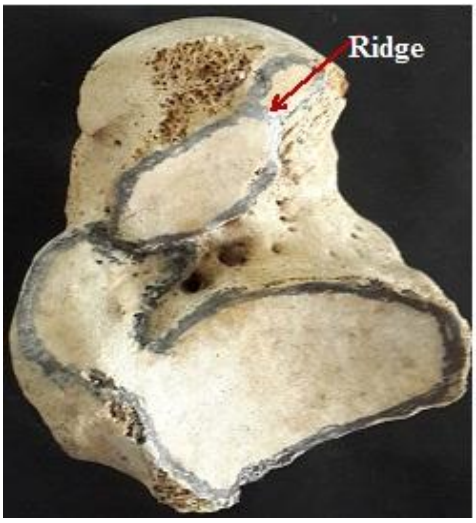

Figure 7: showing two calcaneal facets, one of the single facets is divided by a ridge into two and the other one is continuous with posterior calcaneal facet (Type VC)

Table 1: Number and percentage of different types of calcaneal articular facets of talus

Types of calcaneal articular facets	Right		Left		Total	
	n (100)	%	n (100)	%	n (200)	%
Type I	48	58	36	42	84	42
Type II	22	36	38	64	60	30
Type III	4	50	4	50	8	4
Type IV	2	33	4	66	6	3
Type V	28	66	14	34	42	21
Subtypes						
Type VA	14	70	6	30	20	10
Type VB	12	56	6	44	18	9
Type VC	2	50	2	50	4	2

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Table 2: Comparison of percentage of various types of tali by different workers

Study, Year	Population n= sample size	Percentage of Types of articular facets in tali							
		I	II	III	IV	V	VA	VB	VC
Arora[17] et al,1979	Indians/ 500	16%	78%	1%	3%	2%	-	-	-
Barbaix[24] et al, 2000	Belgium/ 122	21%	22%	6%	39%	-	-	-	-
Bilodi& Agarwal,[22] 2003	Nepal/ 50	10%	14%	20%	-	56%	-	-	-
Bilodi et al[23], 2006	South Indians/240	10%	50%	16.6%	5%	18.4%	-	-	-
Kaur et al[18] 2011	North Indians/ 100	45%	24%	9%	5%	17%	8%	9%	-
Lee et al[25] 2012	Koreans/ 76	30%	31.6%	28.9%	9.2%	-	-	-	-
Garg et al[19]2013	Rajasthan/ 300	39%	43.7%	6%	5.3%	6%	5%	1%	-
Present study 2014	South Indians/ 200	42%	30%	4%	3%	21%	10%	9%	2%

DISCUSSION

The present study was done to determine the incidence of different types of calcaneal articular facets of talus. In this study, Type I showed the highest incidence of 42%. On right side it was higher (58%) compare to the left which was 42 %. This study was compared with kaur et al [18] who studied in 100 north Indian dry tali (50 right and 50 left) of unknown age and sex and classified it into 5 types. In addition they further classified the type V into 2 sub-types i.e. type A and B. The incidence of type I was highest i.e. 45% and type IV was lowest i.e. 5%. They compared their results with the previous studies and found that the type V (A) was present in 8% of cases and type V (B) was found to be present in 9% of cases. Arora et al [17] conducted a detailed study on 500 Indian human tali and found out that there are considerable variations in articular facets on the plantar surface of the head and body of talus. He classified the talus into 5 types depending on the variations. The incidence was found to be 16%, 78%, 1%, 3% and 2% respectively.

Jones [20] has studied the talus and described different patterns of articular facets of calcaneum in human tali. Breathnach [21] concluded that the talus exhibits variations in the calcaneal articular facets. Bilodi & Agrawal [22] did a similar study on 50 dry human tali. Their study showed four types of calcaneal articular facets on the plantar surfaces of head of talus. Bilodi [23] conducted a study on 240 dry human tali and classified it into 5 types. Garg et al [19] studied 300 adult tali and classified into 5 types and further classified type 5 into A and B. The highest incidence of type II tali was 43.7 % and type IV had lowest incidence of 5.3%. Barbaix et al [24] and Lee et al [25] did not find type V in their studies.

Kaur et al [18] concluded that these variations may be due to different type of population, type of gait and built of an individual or the place of living which could be plain or hilly area. Some of these variants probably have an impact on the position of the axis of movements between talus and calcaneum resulting in different positions relative to load and ground reaction forces, and hence, in more or less inversion momentum.

Bruckner [7] stated that a significant difference in joint mobility is expected between joints with different numbers of articular facets. In the three-facet arrangement, the talus sits on an architecturally stable articular tripod and contacts the calcaneum at three distinct points. Both joint motion and facet surface areas are restricted. A two facet configuration would be more mobile. The two anterior facets combine to form one larger facet and enable more gliding of joint surfaces. The one facet configuration should be the most mobile since all the facets have blended into one. Verhagen [9] supported Bruckner's hypothesis and found that arthritic limping was significantly less common in 3 separate facets configuration than in others and stated that people with long continuous facet or only medial facet may be at a greater risk for subtalar joint instability than individuals with the 3 facet configuration.

Richardson [12] explained that the configuration of articular facets is important in order to safely denude the surfaces of the subtalar joints of all the articular cartilages in the 'triple arthrodesis' procedure to correct the deformities of flat foot. Results of the present study showed wide range of variations in incidence of various patterns of articular facets of tali as compared to earlier workers. The subtalar joint is a complex articulation both in its structure and function. The Orthopaedicians and sports physiothearapists must be familiar with these areas to better understand the rationale for examination and treatment procedure [26]. These variations in the present study and their incidences can be used as an anthropological marker for differentiation of unidentified bones in different races.

CONCLUSION

These anatomical variants of calcaneal articular facet of tali and its various articulations have significance not only in knowing the underlying pathology but also help in the treatment. Variations in talar anatomy can be of help for reconstruction and rehabilitation of foot and in identifying the joint instability and arthritic changes in the talus.

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