International Journal of Anatomy and Research,
Int J Anat Res 2018, Vol 6(1.1):4794-97. ISSN 2321-4287
DOI: https://dx.doi.org/10.16965/ijar.2017.466

Original Research Article

INTERNAL ARCHITECTURE OF HUMAN TALI

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ABSTRACT

Introduction: The talus is one of the seven tarsal bones. It is responsible for receiving the body weight and transmitting it to the plantar arch below. The architecture of cancellous bone is based on its mechanical demands. The trabecular patterns of a bone are formed by the stress trajectories that are placed on that bone. The preferred directional orientation of the trabeculae thus provides a history of the stresses to which the bone has been subjected.

Aim: To study the internal architecture and pressure lines of human tali.

Materials and Methods: 30 tali were dissected out from the formalin fixed lower limbs available at the Department of Anatomy of KVG Medical College, Sullia and they were dried and serial longitudinal (parasagittal), transverse (coronal) and horizontal sections of the bone were made in 10 each. The coronal sections were made at 3 levels i.e at the body, neck and head. A good quality digital photograph of the cut surfaces were taken using a digital camera for analysis of the trabeculae of cancellous bone. Radiographs of the slices were also taken to study the pressure and the tension lines.

Results: The sections showed an outer thin layer of compact bone, but it was much thicker at the neck of the talus. In the head, the cancellous bone was made of thick, parallel running semi-arched plates which consisted of two limbs i.e vertical and horizontal which were continuous with each other

Conclusion: It can be concluded that the part of compressive force, acting vertically downward on the body of the talus during standing, was converted to tensile force in the neck, and its direction was made perpendicular, to enable this force to go toward the head of the talus. These findings may help in better understanding of fracture lines in the talus, which could improve internal fixation techniques, and help in designing of talar prosthesis.

KEY WORDS: Architecture, Tali, Compact Bone, Neck Of The Talus, Compressive Force.

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Access this Article online	Journal Information
Quick Response code	International Journal of Anatomy and Research ICV for 2016 90.30 ISSN (E) 2321-4287 | ISSN (P) 2321-8967 https://www.ijmhr.org/ijar.htm DOI-Prefix: https://dx.doi.org/10.16965/ijar BY-NC-SA
	Article Information
DOI: 10.16965/ijar.2017.466	Received: 04 Oct 2017 Peer Review: 05 Oct 2017 Revised: None Accepted: 18 Nov 2017 Published (O): 05 Jan 2018 Published (P): 05 Jan 2018

INTRODUCTION

The talus is one of the seven tarsal bones. It is responsible for receiving the body weight and transmitting it to the plantar arch below. The architecture of cancellous bone is based on its mechanical demands. The trabecular patterns of a bone are formed by the stress trajectories that are placed on that bone. The preferred directional orientation of the trabeculae thus provides a history of the stresses to which the bone has been subjected. The trochlea of the human talus receives compressive forces from the tibia and fibula when standing, walking, and running, and transmits the force to the calcaneus through the talar body, and anteriorly to the navicular via the talar head. As a result, the body of the talus has predominantly vertical trabeculae, running superiorly to inferiorly [1]. These findings may help in better understanding of fracture lines in the talus, which could improve internal fixation techniques, and the design of talar prosthesis [2].

MATERIALS AND METHODS

Source of data: 30 tali were dissected out from the formalin fixed lower limbs available at the Department of Anatomy of KVG Medical College, Sullia and they were dried.

Method of collection of data: Of the 30 tali, serial longitudinal (parasagittal), transverse (coronal) and horizontal sections of the bone were made in 10 each. The coronal sections were made at 3 levels i.e at the body, neck and head. A good quality digital photograph of the cut surfaces were taken using a digital camera for analysis of the trabeculae of cancellous bone. Radiographs of the slices were also taken to study the pressure and the tension lines.

Inclusion criteria: Human talus which is apparently normal, free from any congenital or acquired deformity were included in the study.

Exclusion criteria: Deformed and unossified tali were excluded from the study.

RESULTS

We found that talus showed an outer thin layer of compact bone, but it was much thicker at the neck of the talus. The cancellous bone in the body consisted of thick plates that were arranged parallel to each other. The plates extended in an anteroposterior direction. In transverse section, the plates extended vertically from trochlear surface to posterior calcaneal facet. In the neck, we found that the cancellous bone was present in the form of a meshwork without any definite direction. In the head, the cancellous bone was made of thick, parallel running semi-arched plates which consisted of two limbs i.e vertical and horizontal.

Fig. 1: Sagittal sections of tali.

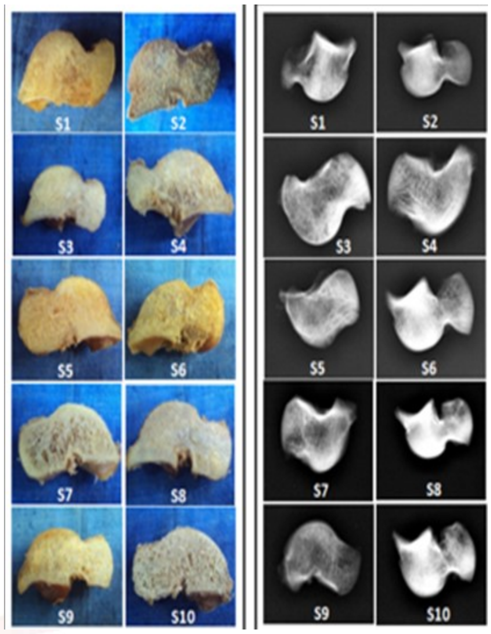


Fig. 2: Horizontal sections of tali.

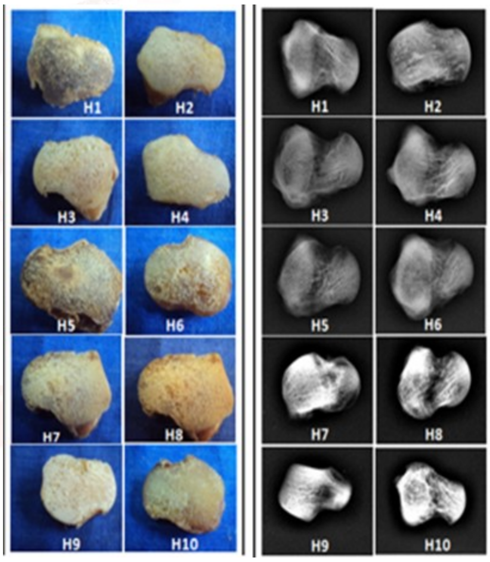


Fig. 3: Coronal section at the level of body.

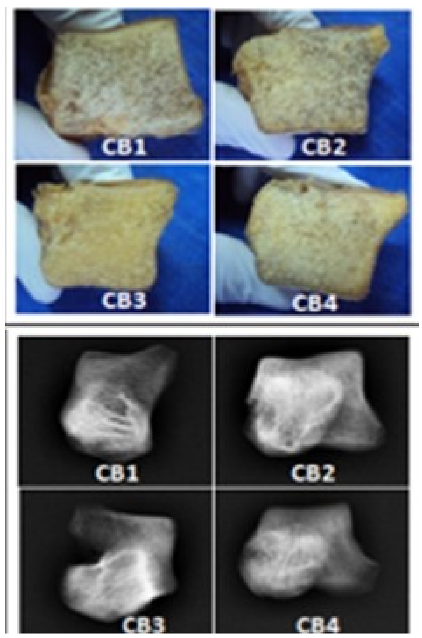


Fig. 4: Coronal section at the level of neck.

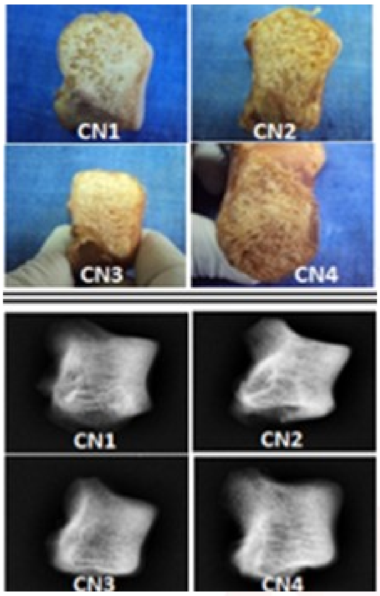
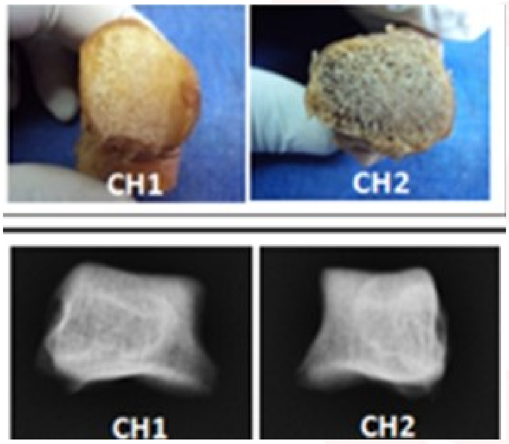


Fig. 5: Coronal section at the level of head.



DISCUSSION

Since the weight of the entire body is transmitted from the inferior articular surface of the tibia and fibula across the ankle joint to the upper trochlear surface of the talus with gravity, the talus, has a strong trabecular architecture. The direction and density of these trabeculae correspond to the magnitude of the stress subjected to definite areas of the talus [3].

In the present study sections of tali were taken at different levels and the trabecular architecture of the cancellous bone was studied. Radiograms of the sections were then taken to compare it with the gross observations and also to study the pressure and tension lines.

In our study, we found that the body of the talus consisted of thick plates that were arranged parallel to each other. The direction of plates was anteroposterior. In transverse section, these plates extended vertically from trochlear surface to posterior calcaneal facet. In the neck, the cancellous bone was present in the form of an irregularly arranged meshwork. There was no definite direction. It consisted of a coarse network of trabeculae. The finding by D N Sinha[4] that the neck consisted of “coarse network of trabeculae” is also similar to the present study. In the head, the cancellous bone was made of thick, parallel running semi-arched plates which consisted of two limbs i.e vertical and horizontal which were continuous with each other. These findings are in accordance with the findings N reported by G P Pal and Rohini Routal [6].

According to Wood Jones[5], two sets of arched lamellae (one set running from the trochlear surface to the posterior calcaneal facet and other from the trochlear surface to the neck) were present, but the present study did not correspond to his finding. According to Athavale[2], two sets of lamellae were observed in the body of the talus. One set was descending from the posterior two-thirds of the lateral part of trochlear surface onto the posterior calcaneal facet of the talus. The second set of trabeculae originated from medial and anterior third of the lateral part of the trochlear surface. The present study did not find any such lamellae.

This observation indicates that the cancellous bone of the talus is responsible for the change in direction of force within the bone, i.e., downward to the calcaneus and forward to the navicular bone. Due to the very unique disposition of the articular surfaces of the talus, the bone and its constituent components (body and the head) are oriented in specialized spatial orientation. Thus, the force subjected to the talus in load bearing not only dictates the resultant shapes and dimensions of the articular surfaces acquired by the bone, stress on the talus also probably decides the outcome of the angular orientation of the bone in conjunction with configuring the overall architecture of the bone [3].

CONCLUSION

We studied the internal architecture of the talus to understand the mechanism of transmission of force within the bone. Different parts of talus showed difference in the arrangement of trabeculae. It can be concluded that the part of compressive force, acting vertically downward on the body of the talus during standing, was converted to tensile force in the neck, and its direction was made perpendicular, to enable this force to go toward the head of the talus. In a similar manner, the semi-arched pattern of plates in the head facilitated the change in the direction of the force, at the end of the stance phase, from the downward (toward calcaneus) to the forward (toward navicular) direction. Studying the properties of trabecular bone and the changes in its structure may help in the musculoskeletal research. The present study is done to understand these changes further, so as to help in surgical interventions and treatments of congenital abnormalities and trauma to the talus. These findings may help in better understanding of fracture lines in the talus, which could improve internal fixation techniques, and help in designing of talar prosthesis.

Conflicts of Interests: None

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How to cite this article:

Gautham K, Muhammed Asif, Sheela N, Vidyashambhava P, Ramakrishna A. INTERNAL ARCHITECTURE OF HUMAN TALI. Int J Anat Res 2018;6(1.1):4794-4797. **DOI:** 10.16965/ijar.2017.466