



Original Research Article

Morphometry of talus - for an anatomically compatible prosthesis

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ABSTRACT

Introduction: The talus is the tallest bone in the foot and also one of the bones that makes up the ankle joint. The treatment options available for Talar pathology are limited with unsatisfactory results affecting the quality of life. However, very little is reported in the literature about the morphology of the talus. A better understanding of ankle anatomy is essential for better design of ankle prosthesis, especially when aiming to restore the Normal Anatomy of the Ankle joint.

Aim: This study was aimed at measuring various dimensions of Talus on Radiographs and its measurements can act as baseline data and help in designing better anatomically and functionally effective prosthesis.

Materials and Methods: The present study was conducted on patients between the age group of 25 years to 50 years who were scheduled for anteroposterior and lateral plain ankle radiographs because of clinical hindfoot symptoms. All patients without radiological pathologies, fully able to load the foot were included in the study. In a sample size of 96 measurements such as length, breadth, height and intermalleolar distance were noted down for 2 years in the Department of Radiology, K.M.C. Mangalore.

Results: As observed in the study the right Tali exhibited greater measurements than the Left.

Conclusions: An anatomical compatible prosthesis can be developed due to the baseline data available and keeping in mind that right Talus exhibited higher measurements than left, hence prosthetic design would vary for each side.

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1. Introduction

The talus is the tarsal homolog of the carpal lunate. The talus (astragalus) sits at the top of the tarsal skeleton.¹ Talar neck fracture is infrequent and is associated with high complication rates.² Patients younger than 50 years can be treated by microfractures, retrograde drilling, mosaicplasty and those older than 50 years by microfractures or, in the case of large defects, by ankle joint replacement or fusion.³

The treatment options available presently have not been successful enough to improve the quality of life. Modern designs are now contributing to a remarkable renewed interest in total ankle arthroplasty (TAA), but TAA is still not as successful as total hip and total knee arthroplasty have chronic pain as the most common complication. Among the remaining issues, there is the design of the prosthesis

components, which are often claimed to be 'anatomical' or compatible with the bony and ligament structures. However, very little is reported in the literature about the morphology of the talus. A better understanding of ankle anatomy is essential for better design of ankle prosthesis, especially when aiming to restore the natural joint kinetics.

2. Aim

Ankle arthroplasty is a relative newcomer to the gamut of joint replacement. Because of this anatomical importance and clinical implications, the present study was aimed at measuring various dimensions and its distribution which can act as baseline data of the various parameters and help design better anatomically and functionally effective prosthesis.

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3. Materials and Materials

3.1. Measurements of dimensions on the radiograph

The present study was also based on patients between the age of 25 years to 50 years who were scheduled for anteroposterior and lateral plain ankle radiographs because of clinical hindfoot symptoms. All patients without radiological pathologies, fully able to load the foot will be included in the study.

3.2. On an anterior-posterior radiograph

1. The breadth of the body of talus- the distance between the medial and the lateral surface.
2. Intermalleolar distance- the distance between the medial and lateral malleolus.

3.3. On lateral radiograph

1. Length of talus- the distance between the foremost part of the rounded articular surface of the head to the apex of the lateral tubercle.
2. Height of talus- the distance between the superior and inferior surface.



Fig. 1: On anteroposterior x-ray

4. Results

4.1. Length of talus on radiograph

The average length of right talus is 5.7359 ± 0.6075 cms. The average length of the left is 5.6306 ± 0.5331 cms. It



Fig. 2: On lateral x-ray

has been observed that the right talus was longer than the left by 0.1053 cms.

4.2. Breadth of body of talus on radiograph

The average breadth of the body of the right talus is 3.0833 ± 0.4081 cms. The average breadth of the body of the left talus is 3.0990 ± 0.4238 cms. It has been observed that the body of the left talus was broader than the right by 0.0157 cms.

4.3. Intermalleolar distance on radiograph

Average intermalleolar distance of right talus is 4.4959 ± 0.5571 cms. The average intermalleolar distance of the left talus is 4.3572 ± 0.6470 cms. It has been observed that the right talus was thicker than the left by 0.1387 cms.

4.4. Height of talus on radiograph

The average height of the right talus is 3.2280 ± 0.6179 cms. The average height of the left talus is 3.2248 ± 0.6078 cms. It has been observed that the right talus was taller than the left by 0.0032 cms.

5. Discussion

It is important to analyze the anatomical features of talus that predispose it to complex injury. The geometrical model is a necessary preliminary step to the study of ankle joint stability in response to applied loads and can be used to

predict the effects of changes to the original geometry of the intact joint.⁴

Restoration of normal anatomy is very important to prevent the development of secondary complications. The success of an ankle prosthesis design depends largely on the morphological data from the ankle joints of its targeted population. The ankle joint is unique and has the smallest surface area compared to all the other major weight-bearing joints. This factor makes total ankle replacement difficult with low success rates. When non-operative methods fail, ankle replacements remain gold standard.⁵ Cases of instability, excessive polyethylene wear, and malunion between the bone and implant in first-generation models raised questions to the viability of TARs. As a result, arthrodesis or fusion is considered the golden standard for treating ankle joint disorders. It wasn't until the early 1990's that a newfound interest for TARs caused researchers to again look toward ways of improving the devices.⁵ Dimensions of talus on radiology are important for the fabrication of ankle prostheses. Many studies have brought out the data as follows:

In the present study average length of the right talus on a radiograph is 5.7359 cms and the left talus is 5.6306 cms. It has been observed that the right talus was longer than the left. According to Gautham K⁶ the length varied from 5.23 on right and 5.29 on the left side. According to Ilkur ali and Mustafa K,⁷ the mean values were 5.72 for the right side and 5.64 for the left side, which was slightly higher as compared to the present study. According to Niladri KM⁸ the length varied from 5.57 cms on the right side and 5.58 cms on the left side.

The average breadth of right talus on a radiograph is 3.0833 cms and the left talus is 3.0990 cms respectively. It has been observed that the right talus was broader than the left for X-ray tali. According to Gautham K⁶ the breath varied from 3.79 cms on right and 3.68 on the left side. According to Ilknur A, Ilkar MK,⁷ the mean values were 4.91 for the right side and 4.69 for the left side, which was higher as compared to the present study. According to Niladri KM⁸ the breath varied from 2.99 cms on the right side and 3.03 cms on the left side.

The average height of the right talus on radiographs is 3.2280 cms and the left talus is 3.2248 cms respectively. It has been observed that the right talus is taller than the left. In another study by Lihan O and Mehmet C⁹ observed that the height of the right tali measured 3.149 cms and left tali measured 3.215 cms.

In the present study, the average intermallelor distance of the right talus on a radiograph is 4.4959 cms and the left talus is 4.3572 cms. In a study by kuo CC et al¹⁰ the intermallelor distance varied from 5.82 cms to 6.08 cms with the average being 6.15 cms.

Vallier HA, Nork SE, Barei DP, Benirschke SK, Sangeorzan BJ² in 2004 conducted a retrospective study analyzing

the results and outcome of talar neck fracture in 100 patients with a total of 102 talar neck fracture. They observed that all talar neck fractures had been treated with open reduction and internal fixation. Radiographic evidence of osteonecrosis was seen in 19 patients (49%), 7 (37%) of these 19 patients demonstrated revascularization of the talar dome without collapse. Overall, osteonecrosis with the collapse of the dome occurred in twelve (31%) of 39 patients. Osteonecrosis was seen in association with 9 (39%) of 23 Hawkins group-II fractures and 9 (64%) of 14 Hawkins group-III fractures. Fractures of the talar neck are associated with high rates of morbidity and complications.¹¹

The fracturing of the talus bone is a common occurrence in younger members of the population that can result in the death of the bone with subsequent collapse and development of severe osteoarthritis.¹²

Arthrodesis or talectomy for the treatment of avascular necrosis of the talus or a severe crush fracture of the body of the talus often produces disability of the ankle and the foot. Therefore, prosthesis designed to replace the body of the talus and to preserve the function of the ankle and the foot was developed. The prosthesis has a superior curved surface, and the medial and lateral surface are inclined to articulation with the tibia and the fibula. The inferior aspect has a concave curved surface at the posterior aspects of the prosthesis to serve as a posterior facet for articulation with the posterior facet of the calcaneus. The neck and head of the talus are preserved to allow the insertion of the prosthetic stem into the bone. All except 1 of the 9 patients, who were evaluated 11 to 15 years postoperative had a satisfactory result. The authors concluded that the Talar body prosthesis could be used to replace the body of the talus with avascular necrosis or severe crush fracture, thus maintaining the function of the ankle and foot for a prolonged period.¹³ Given these realities, talus bone replacement through the use of an implant has become a possible option in orthopedic surgery to promote proper functioning of the ankle joint.¹⁴ The restoration of proper ankle joint function through surgery is an unresolved challenge due to the lack of refinement of implant design for whole Talar replacements. Proper joint kinematics not only depends on the load-carrying capacities of implants but also on restoring the proper three-dimensional shapes i.e., complex articulating surfaces. Therefore, better understandings of ankle anatomy and morphology are integral to successful talus bone replacement using an implant.¹⁵

6. Conclusion

Talar prosthesis is relative newcomer to the gamut of prosthesis, and the data available regarding the measurements of talus is limited and in the era of modernized surgical technique where joint replacement surgeries are gaining their popularity, ankle joint replacement is relatively new

and not widely accepted because of poor patient compliance due to non-compatible prosthesis, hence the data collected would be useful to develop a better anatomically compatible Talar prosthesis keeping in mind the morphometric variation exhibited based on side.

7. Source of funding

None.

8. Conflict of interest

None.

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