

A STUDY ON MORPHOMETRY OF ARTICULAR CARTILAGE OF TALOCRURAL JOINT

Santhini Arulselvi Kaliyaperumal¹, Udaya Sankari Tamilarasan², Kalaivannan J³, Indhu Priyadharshini Rajaraman⁴

¹Associate Professor, Department of Anatomy, Vinayaka Missions Medical College, Karaikal.

²Tutor, Department of Anatomy, Vinayaka Missions Medical College, Karaikal.

³Assistant Professor, Department of Anatomy, Vinayaka Missions Medical College, Karaikal.

⁴Tutor, Department of Anatomy, Vinayaka Missions Medical College, Karaikal.

ABSTRACT

BACKGROUND

Very few attempts have been put sincerely to study the morphometry of the cartilages of the talocrural joint. The sheer strain put on it by the weight of the adult is tremendous and so the structure to be studied is very interesting.

This weight bearing quality of the cartilage makes it susceptible to wear and tear and so the measurements that we might get in study may actually help the orthopaedic surgeon in reconstruction. Study in India on this topic is very limited and we use a lot of morphometric values from the western world. What we should understand is the fact that Indians are anthropologically different and it is time to study our own morphometric values, so that the values can be used by the orthopaedic surgeons and ultimately the patients get benefitted by this.

METHOD

One hundred specimens were studied in the Department of Anatomy, Vinayaka Missions Medical College, Karaikal, Puducherry.

RESULTS

Morphometry of the articular surface in wet talus: The lateral length measurement is higher than the other length measurements. Articular surface is wider in front and narrows posterior. The measurements are similar on both sides. In males, the measurements are similar to that of females except females had significantly ($p=0.043$) longer anterior radius when compared to males in articulating surface of wet talus.

Morphometry of articulating surface of wet tibia: The lateral side measurement is higher than the other length measurements. The articular surface is wider in front and narrows posterior. The measurements are similar on both sides. The measurements are similar in both sexes.

Morphometry of articular surface in wet fibula: The measurements are similar on both sides. Measurements are similar in both sexes.

CONCLUSION

The morphometry of the cartilage has been successfully done and this may be of immense value to the surgeon in reconstruction works.

KEYWORDS

Morphometry, articular cartilage, talocrural, synovial joint.

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INTRODUCTION: Very few attempts have been put sincerely to study the morphometry of the cartilages of the talocrural joint. The sheer strain put on it by the weight of the adult is tremendous and so the structure to be studied is very interesting.

This weight bearing quality of the cartilage makes it susceptible to wear and tear and so the measurements that we might get in study may actually help the orthopaedic surgeon in reconstruction. Study in India on this topic is very limited and we use a lot of morphometric values from the western world. What we should understand is the fact that

Indians are anthropologically different and it is time to study our own morphometric values, so that the values can be used by the orthopaedic surgeons and ultimately the patients get benefitted by this.

One sixth of the static load of the human body is carried by the fibula at the tibiofibular joint.¹ These require a high degree of stability which is determined by the passive and dynamic factors.² The passive stability depends on the contour of the articular surfaces of the participating bones of the joints. Talocrural joint is an approximately uniaxial joint.³ Although, it is considered to be a simple hinge, its axis of rotation slightly changes, during dorsiflexion and plantar flexion. Starting from the plantigrade position, the normal range of dorsiflexion is 10° when the knee is straight and 30° with the knee flexed. The range of normal plantar flexion is 30°. Dorsiflexion results in the joint adopting the 'close-packed' position,⁴ with maximal congruence and

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Corresponding Author:

Dr. Santhini Arulselvi Kaliyaperumal,

K1 Staff Quarters, V MMC Campus, Karaikal-609609, Puducherry.

E-mail: drksanthiniarulselvi@gmail.com

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ligamentous tension; from this position. All major thrusting movements are exerted, in walking, running and jumping. The malleoli grip the talus, and even in relaxation no appreciable lateral movement can occur without stretch of the inferior tibiofibular syndesmosis and slight bending of the fibula. The superior talar surface is broader in front, and in dorsiflexion the malleolar gap is increased by slight lateral rotation of the fibula, by 'give' at the inferior tibiofibular syndesmosis and gliding at the superior tibiofibular joint.

The lower end of tibia along with its medial malleolus and the lateral malleolus of the fibula form a deep recess to accommodate the body of talus. The mortise formed by the lower end of tibia and the fibula is usually considered syndesmosis. The tibiofibular joints permit only slight movement. Due to the varying slope of the talar lateral malleolar surface, the fibula rotates laterally a little bit during dorsiflexion at the ankle, the bones being also slightly separated. Slight bending or torsion of the fibular shaft may permit movements at the distal tibiofibular joint. The proximal tibiofibular joint also helps.

The empirical axis of ankle joint passes distal to tips of malleoli at $5\text{ mm} \pm 3\text{ mm}$ range, (0 to 11 mm) distal to the tip of medial malleolus and $3\text{ mm} \pm 2\text{ mm}$ range (0 to 12 mm) distal to and $8\text{ mm} \pm 5\text{ mm}$ anterior to the tip of lateral malleolus.³ The axis is inclined downwards and laterally in the frontal plane and is rotated posterolaterally in the horizontal or transverse plane. In the frontal plane, the angle between empirical axis of the ankle and midline of the tibia is $82.7\text{ degrees} \pm 3.7\text{ degrees}$, with a range of 74 to 94 degrees in the transverse plane, the angle of ankle axis with the transverse axis of the knee is 20 to 30 degrees. Some workers recognised two axis to the ankle joint.^{5,6,7,8} A dorsiflexion axis inclined downwards and laterally and a plantar flexion axis included downward and medially. The changeover occurs within a few degrees of the neutral position of the talus.

So a sincere effort has been made in this study to study the morphometry of articular cartilage that participate in the formation of talocrural joint.

AIMS AND OBJECTIVES: To study the morphometry of articular cartilage that participate in the formation of talocrural joint.

MATERIALS AND METHODS: One hundred specimen were studied in the Department of Anatomy, Vinayaka Missions Medical College, Karaikal, Puducherry.

RESULT: Fifty were from the males and fifty were from females' specimens.

This study was done from 2010 to 2015.

The measurements that were taken on the superior articulating surface are, medial side length, lateral side length, central length, anterior width, central width, posterior width, lateral side: central radius, lateral side: posterior radius, medial side: anterior height.



Image 1: Length measurements of superior articulating surface of talus taken at different levels



Image 2: Width measurements of superior articulating surface of talus taken at different levels

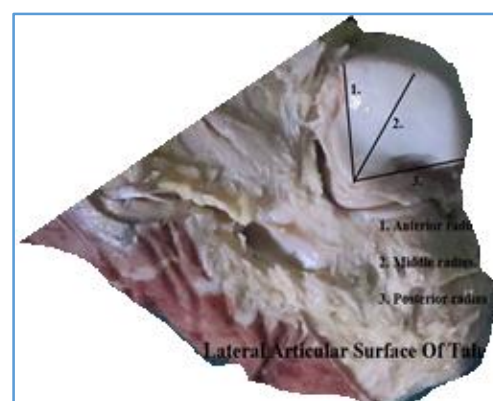


Image 3: Measurements of lateral articulating surface of talus taken at different levels



Image 4: Measurements of medial articulating surface of talus

The measurement that were taken on the articulating surface of tibia and fibula are, medial side length, central length, lateral length, anterior width, central width, posterior width, medial malleolus (wide width), medial malleolus (narrow width), medial malleolus (height), lateral malleolus (width), lateral malleolus (height).



Image 5: Length measurements of inferior articulating surface of tibia taken at different levels



Image 6: Width measurements of inferior articulating surface of tibia taken at different levels



Image 7: Measurements of lateral malleolus



Image 8: Measurements of medial malleolus

RESULTS:

Morphometry of articular cartilage of the talus:

Irrespective of the side and sex to which the bone belongs, the mean values of the length of superior trochlear surface of talus on the medial, lateral and central part are 35.63 mm, 35.72 mm and 38.09 mm. The mean values of the width of superior trochlear surface of talus on the anterior, central and posterior part are 30.45 mm, 27 mm and 21.45 mm. The mean values of the anterior, middle and the posterior radius on the lateral articulating surface are 21.27 mm, 22.63 mm and 21.45 mm. The mean value of the anterior height on the medial side is 14 mm.

On the right side, the mean length measurements are 34.6 mm, 36.2 mm and 38 mm. The mean width measurements are 30.2 mm, 26.8 mm and 21.2 mm. The mean radius measurements are 21.2 mm, 22 mm and 21.4 mm. The mean height measurement is 14 mm.

On the left side, the mean length measurements are 36.5 mm, 35.33 mm and 38.16 mm. The mean width measurements are 30.66 mm, 27.16 mm and 21.66 mm. The mean radius measurements are 21.33 mm, 23.16 mm and 21.5 mm. The mean height measurement is 14 mm.

In males, the mean length measurements are 35 mm, 35.8 mm and 38.2 mm. The mean width measurements are 30.8 mm, 26.8 mm and 21.6 mm. The mean radius measurements are 19.8 mm, 21.8 mm and 20.6 mm. The mean height measurement is 14.4 mm.

In females, the mean length measurements are 36.16 mm, 35.66 mm and 38 mm. The mean width measurements are 30.16 mm, 27.16 mm and 21.33 mm. The mean radius measurements are 22.5 mm, 23.33 mm and 22.16 mm. The mean height measurement is 13.66 mm.

Females had significantly ($p=0.043$) longer anterior radius when compared to males in morphometry of articulating surface wet talus.

Morphometry of Articulating Cartilage of Tibia:

Irrespective of the side and sex, the mean values of the length of the tibial plafond on the medial, central and lateral part are 23 mm, 26.54 mm and 26.18 mm. The mean values of the width of tibial plafond on the anterior, central and posterior part are 28.81 mm, 26.27 mm, and 21.74 mm. The mean measurements of wide width, narrow width and the height of the medial malleolus are 22.54 mm, 11.72 mm and 17 mm.

On the right side, the mean length measurements are 23 mm, 26.4 mm, and 26 mm with a standard deviation of 1.41 mm, 1.14 mm, and 1 mm. The mean width measurements are 29 mm, 26.4 mm and 21.4 mm. The mean measurements of the medial malleolus are 22 mm, 11.6 mm and 17.6 mm.

On the left side, the mean width measurements are 23 mm, 26.66 mm, and 26.33 mm. The mean width measurements are 28.66 mm, 26.16 mm and 21.66 mm. The mean measurements of medial malleolus are 23 mm, 11.83 mm and 16.5 mm.

In males, the articular mean length measurements are 22.8 mm, 27 mm, and 26.4 mm. The articular mean width

measurements are 29.2 mm, 26.4 mm, and 21.2 mm. The articular mean measurements of medial malleolus are 22.8 mm, 12 mm, and 16.8 mm.

In females, the articular mean length measurements are 23.16 mm, 26.16 mm and 26 mm. The mean width measurements are 28.5 mm, 26.16 mm and 21.83 mm. The articular mean measurements of the medial malleolus are 22.33 mm, 11.5 mm and 17.16 mm.

Morphometry of articular cartilage in fibula:

Irrespective of the side and sex to which the bone belongs, the mean value of the height of the articulating surface of the fibula is 19.81 mm. The mean value of the breadth of the articulating surface of fibula is 18.90 mm.

On the right side, the mean height measurement is 19.4 mm. The mean width measurement is 19 mm.

On the left side, the mean height measurement is 20.16 mm. The mean width measurement is 18.83 mm.

In males, the mean height measurement is 20 mm. The mean width measurement is 19 mm.

In females, the mean height measurement is 19.66 mm. The mean width measurement is 18.83 mm.

DISCUSSION:

Morphometry of the articular cartilage in talus: The measurements are similar on both sides.

In males, the measurements are similar to that of females except in the anterior radius of lateral articulating surface there is a statistically significant difference. The female measurement is higher than the males. ($p=0.043$). This may be an indication of the fact that females in our society work more in their household work by stressing on their talocrural joint.

This may be because of the difference in gait that is present in females when compared to males and also according to S.G. McLean et al.⁹ the effect of gender on lower extremity kinematics during rapid direction changes: an integrated analysis of three sports movements, females had increased initial knee valgus and peak knee valgus, when compared to males, in three sports movements linked to non-contact ACL injury.

According to Andrew R. Fauth et al.¹⁰ on the study of anatomical based investigations on the total ankle arthroplasty.

The mean values of the length of superior trochlear surface of talus irrespective of the sex on the medial, lateral and central part are 34.30 mm, 33.16 mm and 33.89 mm. In males, the mean measurements are 37.67 mm, 36.6 mm and 38.6 mm with a standard deviation of 3.18 mm, 2.2 mm and 2.44 mm. In females, the mean measurements are 28.9 mm, 29.72 mm and 30.57 mm with a standard deviation of 2.46 mm, 1.33 mm and 1.17 mm.

The mean values of the width of superior trochlear surface of talus on the anterior, posterior and central part are 29.89 mm, 22.48 mm and 28.86 mm. In males, the mean measurements are 32.2 mm, 23.42 mm and 31.4 mm with a standard deviation of 2.62 mm, 2.99 mm and 2.48 mm. In females, the mean measurements are 31.3 mm,

21.52 mm and 26.32 mm with a standard deviation of 1.70 mm, 3.27 mm and 1.11 mm.

Irrespective of the sex, the mean values of the anterior, middle and the posterior radius on the lateral articulating surface are 22.4 mm, 23.43 mm and 23.16 mm. In males, the mean measurements are 23.7 mm, 25 mm and 25.02 mm with a standard deviation of 4.36 mm, 4.77 mm and 4.71 mm. In females, the mean measurements are 21.17 mm, 21.85 mm and 21.3 mm with a standard deviation of 1.88 mm, 1.95 mm and 2.31 mm.

Irrespective of the sex, the mean value of the anterior height on the medial side is 13.34 mm. In males, the mean measurement is 14.97 mm with a standard deviation of 2.70 mm. In females, the mean measurement is 11.7 mm with a standard deviation of 1.79 mm.

The study is in agreement with the study of Adrew. R. Fauth et al.¹⁰ except that the measurements of trochlear surface of the talus in females are more in the study when compared to the study by Adrew. R. Fauth et al.¹⁰

In the study conducted by Adrew. R. Fauth et al.,¹⁰ the measurements in males are uniformly more than that of females.

The difference found in our specimens, could be a characteristic of our population, but no previous studies exist to compare our findings.

Morphometry of articulating cartilage of tibia: The measurements are similar on both sides.

The measurements in males and females are similar. According to Andrew R. Fauth et al.¹⁰ on the study of anatomical based investigations on the total ankle arthroplasty. Irrespective of the sex, the mean values of the length of the tibial plafond on the medial, central and lateral part are 22.60 mm, 27.72 mm and 26.28 mm. In males, the articular mean measurements are 25.19 mm, 31.27 mm, and 27.39 mm with a standard deviation of 2.26 mm, 1.93 mm and 4.25 mm. In females, the articular mean measurements are 19.99 mm, 24.15 mm and 25.15 mm with a standard deviation of 1.45 mm, 0.93 mm and 0.77 mm.

Irrespective of the sex, the mean values of the width of tibial plafond on the anterior, central and posterior part are 28.28 mm, 26.96 mm, and 23.56 mm. In males, the articular mean measurements are 30.89 mm, 28.62 mm, and 23.83 mm with a standard deviation of 3.85 mm, 1.57 mm and 2.44 mm. In females, the articular mean measurements are 25.66 mm, 25.29 mm and 23.29 mm with a standard deviation of 2.97 mm, 1.80 mm and 3.09 mm.

Irrespective of the sex, the mean measurements of wide width, narrow width and the height of the medial malleolus are 11.48 mm, 22.11 mm and 15.81 mm. In males, the articular mean measurements are 23.79 mm, 12.23 mm, and 16.74 mm with a standard deviation of 2.21 mm, 3.76 mm and 6.99 mm. In females, the articular mean measurements are 20.41 mm, 10.73 mm and 14.86 mm with a standard deviation of 1.73 mm, 0.77 mm and 0.75 mm.

The articular surface measurements are more in males than in females.

The study is in agreement with that of Adrew. R. Fauth et al.¹⁰ except the tibial plafond measurements in the study are higher in females than the study conducted by Adrew. R. Fauth et al.¹⁰

In the study conducted by Adrew. R. Fauth et al,¹⁰ the measurements are uniformly more in males when compared to females.

This may be because of the fact that, the study conducted in our studies is in "South Indian West Coastal Population".

The difference found in our specimens could be a characteristic of our population, but no previous studies exist with which to compare our findings.

Morphometry of articular cartilage in Fibula: The measurements are almost similar on both sides.

In males, the measurements are consistently higher than that of females.

According to Andrew R. Fauth et al.¹⁰ on the study of anatomical based investigations on the total ankle arthroplasty. Irrespective of sex, the mean value of the height of the articulating surface of the fibula is 21.99 mm. In the males, the mean measurement is 24.29 mm, with a standard deviation of 5.36 mm. In the females, the mean measurement is 19.69 mm, with a standard deviation of 3.15 mm.

Irrespective of the sex, the mean value of the breadth of the articulating surface of fibula is 20.14 mm. In the males, the mean measurement is 20.99 mm, with a standard deviation of 2.52 mm. In the females, the mean measurement is 19.27 mm, with a standard deviation of 1.26 mm.

The measurements in the study is in agreement with the study of Andrew R. Fauth et al.¹⁰

CONCLUSION: The morphometry of the cartilage has been successfully done and this may be of immense value to the surgeon in reconstruction works. The work has a lot of potential in the future. Individual variations can be of great value in Forensic Science and in Physical Anthropology.

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