ORIGINAL RESEARCH

A Morphometric and Morphological Assessment of Dry Adult Cuboid Bones: A cross-sectional study

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Received: 21 March, 2021 Accepted: 24 April, 2021

ABSTRACT

Background: The cuboid bone, which has a cuboidal shape and smooth articular surfaces for connections with other bones secured by ligaments, is located on the lateral side of the distal row of tarsal bones as well as tendons. The present study was conducted to assess morphological and morphometric analysis in adult dry cuboid bone.

Materials & Methods: 50 cuboid bone of both genders were taken. Parameters such as medial length, lateral length, cuboid height, peroneal groove depth and length index were measured. The greatest vertical and transverse diameters of both calcaneal and metatarsal articular facet was also recorded.

Results: Metatarsal articular facets were plane in 5 right and 6 left, concave in 6 right and 3 left and convex in 14 right and 16 left cases. The difference was significant (P< 0.05). On right and left side, mean medial length (mm) was 33.2±2.1 and 33.1±4.5, lateral length (mm) was 19.5±4.2 and 19.2±1.1, height (mm) was 26.5±3.7 and 26.1±6.4, peroneal groove depth (mm) was 0.73±0.2 and 0.71±0.3, vertical diameter of calcaneal facet (mm) was 25.7±2.7 and 25.2±3.6, transverse diameter of calcaneal facet (mm) was 17.3±4.2 and 17.2±4.3, vertical diameter of metatarsal facet (mm) was 22.6±1.8 and 22.4±2.3 and transverse diameter of metatarsal facet (mm) was 14.9±2.7 and 14.6±2.5 respectively. The difference was non- significant (P>0.05).

Conclusion: The morphological characterization and morphometric analysis of the articular facet of the cuboid contribute to understanding the movement degree at the calcaneocuboid joint, along with its related pathologies and instabilities.

Keywords: cuboid bone, calcaneus, metatarsal facet

INTRODUCTION

The cuboid bone, which has a cuboidal shape and smooth articular surfaces for connections with other bones secured by ligaments, is located on the lateral side of the distal row of tarsal bones as well as tendons.[1] At the front, it connects with the bases of the fourth and fifth metatarsal bones, while at the back, it connects with the calcaneus (heel bone), forming what is known as the calcaneocuboid joint. This joint plays a crucial role in stability, load transfer, and foot and ankle movement. The joints created by the cuboid bone and secured by ligaments include the calcaneocuboid, cuboideo-navicular, cuboideometatarsal, and long plantar ligaments in conjunction with the tibialis posterior tendon.[2]

The transverse tarsal (Chopart) joints consist of the talonavicular and calcaneocuboid joints. Due to the robust structural support provided by the ligaments around the joints, isolated dislocations of transverse tarsal joints are uncommon.[3] The transverse tarsal joints are stabilized by the inferior calcaneocuboid ligament, calcaneonavicular (spring) ligament, and bifurcate ligament, which also play a crucial role in supporting the foot arch. As a result, dislocations toward the dorsal side are uncommon and necessitate the breaking of these plantar ligaments. The cuboid, which is involved in tarsometatarsal

joints (Lisfranc's joint), connects with the fourth and fifth metatarsals. This connection allows for essential gliding and adjustments while walking on irregular surfaces.[4]

In understanding joint stability and the factors that disrupt it, the morphological variation of the metatarsal articulating surface is significant.[5] On the plantar surface, an oblique ridge divides the cuboid into two sections: an anterior grooved part known as the peroneal groove and a posterior sloping part.[6] The Peroneus Longus tendon will pass through this anterior groove (osseo fibrous tunnel). When the cuboid bone shifts position, it can lead to a loss of motion as the bone becomes 'locked' in place. Due to the fact that the surfaces of the connecting bones are no longer aligned, the joint has lost its congruence.[7]

AIM AND OBJECTIVES

The present study was conducted to assess morphological and morphometric analysis in adult dry cuboid bone.

MATERIALS AND METHODS

Study Design

This was a descriptive cross-sectional study involving morphological and morphometric evaluation of the adult dry cuboid bone. The study aimed to assess specific dimensions and features of the bone and analyze their variations statistically.

Study Population

- A total of 50 adult dry cuboid bones were examined.
- The bones were sourced from unidentified skeletal remains available in the anatomy department.
- Only fully ossified and intact cuboid bones were included.
- Bones showing any signs of deformity, fractures, or pathological changes were excluded.

Study Place

The study was conducted in the Department of Anatomy, Major SD Singh Medical college, farrukhabad Uttar Pradesh, India.

Study Period

The study was carried out over a period of one year and two months, from January 2020 to February 2021.

Inclusion Criteria

- Adult human dry cuboid bones of unknown gender.
- Fully ossified bones without any visible deformities.
- Well-preserved bones free from damage or wear that could affect measurements.

Exclusion Criteria

- Bones with visible fractures, deformities, or pathological changes.
- Incomplete or eroded bones that hinder accurate morphometric measurements.
- Bones with previous surgical modifications or artifacts.

Ethical Considerations

- Ethical clearance was obtained from the Institutional Ethics Committee (IEC) before commencing the study.
- Since this study was conducted on dry bones (not living human subjects), there were no direct ethical concerns related to patient consent.
- The bones used for research were obtained from authorized anatomical collections, ensuring compliance with institutional guidelines.

Study Procedure

Each cuboid bone was assessed for the following morphological and morphometric parameters:

A. Morphological Analysis

General shape and surface features of the cuboid bone were examined.

The presence and variation in the peroneal groove were noted.

B. Morphometric Measurements

The following dimensions were recorded using digital Vernier calipers (accuracy of 0.01 mm):

1. Medial Length (ML) – Distance from the medial aspect of the bone.
2. Lateral Length (LL) – Distance from the lateral aspect.
3. Cuboid Height (CH) – Maximum vertical height of the cuboid.
4. Peroneal Groove Depth (PGD) – Depth of the groove for the peroneus longus tendon.
5. Length Index (LI) – Ratio of medial and lateral lengths.
6. Additionally, measurements of the articular facets were recorded:
    - Greatest Vertical and Transverse Diameters of the Calcaneal Articular Facet.
    - Greatest Vertical and Transverse Diameters of the Metatarsal Articular Facet.

Outcome Measures

Descriptive statistics of all morphometric parameters.

Identification of any significant asymmetry or variation in the cuboid bone.

Assessment of clinical and anatomical relevance of the peroneal groove.

Statistical Analysis

The collected data were entered into Microsoft Excel and analyzed using SPSS (Statistical Package for the Social Sciences) version 25.0. Mean, standard deviation (SD), and range were calculated for all morphometric parameters. Student's t-test was used to compare differences in measurements (if comparing between groups). P-value < 0.05 was considered statistically significant.

RESULTS

Table 1: Different Types of Metatarsal Articular Facets

Types	Right (25)	Left (25)	P value
Plane	5	6	0.05
Concave	6	3	
Convex	14	16	

Table 1 shows that metatarsal articular facets were plane in 5 right and 6 left, concave in 6 right and 3 left and convex in 14 right and 16 left cases. The difference was significant (P< 0.05).

Table 2: Morphometric Values on Cuboid of both right and left sides

Parameters	Right	Left	P value
Medial length (mm)	33.2±2.1	33.1±4.5	0.75
Lateral length (mm)	19.5±4.2	19.2±1.1	0.62
Height (mm)	26.5±3.7	26.1±6.4	0.12
Peroneal groove depth (mm)	0.73±0.2	0.71±0.3	0.47
Vertical diameter of calcaneal facet (mm)	25.7±2.7	25.2±3.6	0.83
Transverse diameter of calcaneal facet (mm)	17.3±4.2	17.2±4.3	0.94
Vertical diameter of metatarsal facet (mm)	22.6±1.8	22.4±2.3	0.51
Transverse diameter of metatarsal facet (mm)	14.9±2.7	14.6±2.5	0.76

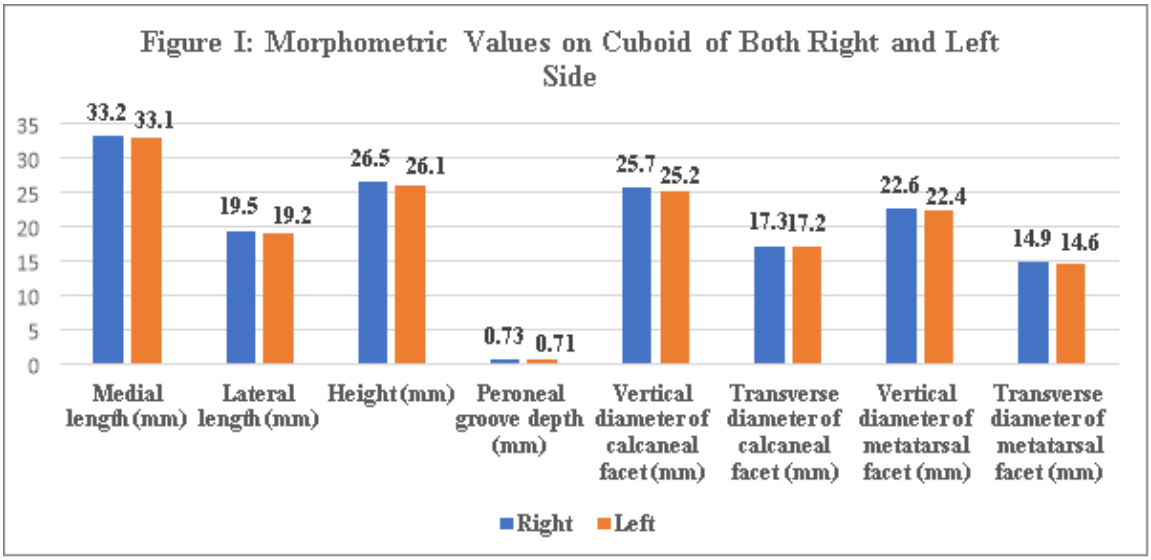

Table 2, figure I shows that on right and left side, mean medial length (mm) was 33.2±2.1 and 33.1±4.5, lateral length (mm) was 19.5±4.2 and 19.2±1.1, height (mm) was 26.5±3.7 and 26.1±6.4, peroneal groove depth (mm) was 0.73±0.2 and 0.71±0.3, vertical diameter of calcaneal facet (mm) was 25.7±2.7 and 25.2±3.6, transverse diameter of calcaneal facet (mm) was 17.3±4.2 and 17.2±4.3, vertical diameter of metatarsal facet (mm) was 22.6±1.8 and 22.4±2.3 and transverse diameter of metatarsal facet (mm) was 14.9±2.7 and 14.6±2.5 respectively. The difference was non- significant (P>0.05).

DISCUSSION

When the cuboid bone shifts position, it can lead to a loss of motion as the bone becomes 'locked' in place. The joint has lost its congruence as the surfaces of the connecting bones no longer align. It results in discomfort along the lateral (outer) side of the foot.[8] The effect along with the accompanying symptoms is known as Cuboid Syndrome.[9] Other designations include Cuboid Fault Syndrome, Dropped Cuboid, Sublaxed Cuboid, Locked Cuboid, Peroneal Cuboid Syndrome, and Lateral Plantar Neuritis.[10] Cuboid Squeeze or Cuboid Whip involves treating by manipulating bones. The physical therapist applies force to a specific area in order to shift the bone back into its normal position in the affected foot.[11] The present study was conducted to assess morphological and morphometric analysis in adult dry cuboid bone.

We found that metatarsal articular facets were plane in 5 right and 6 left, concave in 6 right and 3 left and convex in 14 right and 16 left cases. MOITRA S[12] studied about morphological and morphometric analysis using 60 dry cuboid bones. Each bone was observed for its morphometric analysis as well as its pattern of calcaneal and metatarsal articular facets. Mean medial length of cuboid was 33.41 mm, lateral length was 19.73 mm, height was 26.17 mm, length index was 169.33, vertical and transverse diameters of calcaneal articular facet were 24.24 mm and 16.45

mm respectively, vertical and transverse diameters of metatarsal articular facet were 21.32 mm and 13.85 mm respectively, depth of peroneal groove was 0.63mm. Concavo-convex facet with posteromedial projection and oval or reniform in shape (Type 1A) was the most common calcaneal articular facet and convex pattern was the most common metatarsal articular facet of cuboid.

We found that on right and left side, mean medial length (mm) was 33.2±2.1 and 33.1±4.5, lateral length (mm) was 19.5±4.2 and 19.2±1.1, height (mm) was 26.5±3.7 and 26.1±6.4, peroneal groove depth (mm) was 0.73±0.2 and 0.71±0.3, vertical diameter of calcaneal facet (mm) was 25.7±2.7 and 25.2±3.6, transverse diameter of calcaneal facet (mm) was 17.3±4.2 and 17.2±4.3, vertical diameter of metatarsal facet (mm) was 22.6±1.8 and 22.4±2.3 and transverse diameter of metatarsal facet (mm) was 14.9±2.7 and 14.6±2.5 respectively. Prakash KG et al[13] determined the incidence of calcaneal facet pattern and incidence of enthesophytes in calcaneum. Pattern I morphologic variant was the most frequently encountered type (25 out of 34). Pattern V not observed. Enthesophytes were observed in 21 (61.7%) bones, with medial predominant medial enthesophytes. One bone showed two enthesophytes. Mean cuboidal facet surface area was 386 (±46) square mm.

Mini MP et al[14] compared the pattern of talar articular facets of different human calcanei. 50 adult human calcanei were obtained irrespective of age and sex and evaluated one by one. Three types of calcaneus that has distinct talar facets as Types A, B and C and sub types were defined. Results: The study reveals the following results; Out of 50 calcanei 13 were of Type A (26%) 37 were of Type B (74%) and None were of Type C. The mean intersecting angle of Type A calcaneum is 121.50 and the mean intersecting angle of Type B calcaneum is 151.60 This study reveals that the talar facet configuration of calcanei and angle between the anterior and middle facet influences the stability of the subtalar joint.

LIMITATIONS OF THE STUDY

The study was conducted on dry bones, so soft tissue associations could not be evaluated.

The sex and age of the bones were unknown, limiting demographic correlations. The sample size of 50 bones may not be large enough to represent wider population variations.

Some minor measurement errors could have occurred despite using precise instruments.

CONCLUSION

Authors found that the morphological characterization and morphometric analysis of the articular facet of the cuboid contribute to understanding the movement degree at the calcaneocuboid joint, along with its related pathologies and instabilities.

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