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MEASUREMENTS OF CALCANEUM IN NORTH INDIAN POPULATION

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Abstract

Calcaneum is the largest tarsal bone in the foot, which participate in the formation of subtalar joint.

Aims and objectives The difference in the anatomical structure of calcaneum plays an important role in dynamic, kinetic, and static of the foot. Hence this study was planned.

Material and methods. Present study was conducted in Pt. B. D. Sharma University of health sciences on 54 pair of dry human calcanei in which linear measurements were taken using digital vernier caliper with accuracy of 0.01mm and Bohler's angle (BA) was measured with goniometer. Correlation of Bohler's angle and maximum antero-posterior length (MXL) with another parameter were seen.

Results. In present study no significant difference was seen in the measurements of right and the left calcanei. Correlation of MXL of calcaneum with other parameters was done which came out to be significant except for CFH (right side) and DAFW (right side). Presented findings suggest that the MXL of the calcaneum bone can sometimes be calculated from its other parameters if well preserved, which could be helpful for forensic experts.

Conclusion. Present study on morphometric parameters of calcaneum would provide useful information for orthopaedic surgeries. Also, the knowledge of morphometry of this bone would be useful for forensic experts, foot rehabilitation procedure, and this study would contribute to the anatomic literature and clinical fields.

Keywords: calcaneum, Bohler's angle, antero-posterior length.

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1. Introduction

Calcaneum is the largest tarsal bone in the foot, which participate in the formation of subtalar joint. It is irregular lycuboidal, its long axis is inclined distally upwards and laterally. Its superior surface is divided into 3 parts while posterior part is rough and concavo-convex. Its middle one third has posterior articular facet which is oval and convex antero-posteriorly. Anterior to posterior articular facet there is depression which narrows into groove on medial side, called as sulcus calcanei medial to this groove is an elongated area called as sustentaculum tali [1]. There are 3 calcaneal facets which might have some variation in their morphology [2–6]. Some of these variations are the reason to cause degeneration leading to joint instability or may even be the cause of osteoarthritis [3, 7]. Furthermore, it is one of the bones used in forensic sciences as it is preserved well and abundant [8]. Some scientist reported that specific morphology of calcaneotalar facet resulted in asymmetric wear pattern leading to osteoarthritis which caused heavy pain in the joint. The subtalar and tibiotalar joint were habitually inclined when patient walked [9, 10].

The difference in the anatomical structure of calcaneum plays an important role in dynamic, kinetic, and static of the foot [11].

The aim of the research was to difference in the anatomical structure of calcaneum plays an important role in dynamic, kinetic, and static of the foot. Hence this study was planned to see the difference in morphometry of the calcaneum of both the sides.

2. Material and methods

Present study was conducted in Pt. B. D. Sharma University of health sciences in year **2022** on 54 pair of dry human calcanei with well-preserved calcaneal facets.

Calcanei with distorted facets were excluded and following parameters were measured using a digital vernier caliper with the accuracy of 0.1 mm for linear measurements and a goniometer was used in measurement of Bohler's angle.

1. Maximum antero-posterior length (MXL) – distance between the most prominent point on the articular face for the cuboid (anteriorly) and the most prominent point on the tuber calcaeni (posterior) **(Fig. 1)**.

2. Maximum width (MXW) – this is the maximum width projected through the body of the calcaneum. It is measured as most prominent point on the sustentaculum tali and the point opposite to it **(Fig. 2)**.

3. Body height (BH) – it is measured as the lowest point on the tuber calcanei to the highest point opposite to it **(Fig. 1)**.

4. Cuboid facet height (CFH) – it is measured as lowest point on the facet for cuboid and point opposite to it **(Fig. 1)**.

5. Load arm length (LAL) – it is the distance between the most prominent point on the articular surface for the cuboid (anteriorly) and most prominent point on the posterior facets for the talus (posteriorly) **(Fig. 1)**.

6. Dorsal articular facet length (DAFL) – maximum width taken transversely (medial most point on the posterior articular facet and the point opposite to it **(Fig. 2)**.

7. Dorsal articular facet width (DAFW) – length taken antero-posteriorly (posterior most point on posterior articular facet and point opposite to it **(Fig. 2)**.

8. Width of sulcus calcanei (WSC) – narrowest distance between posterior articular facet and the middle articular facet **(Fig. 2)**.

9. Bohler's angle (BA) – a) superior margin of posterior articular facet to superior margin on anterior process; b) superior margin of posterior facet to superior margin of tuberosity **(Fig. 3)**.

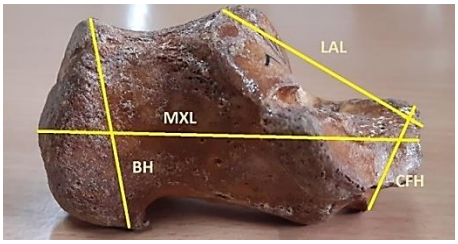

Fig. 1. Showing linear measurement

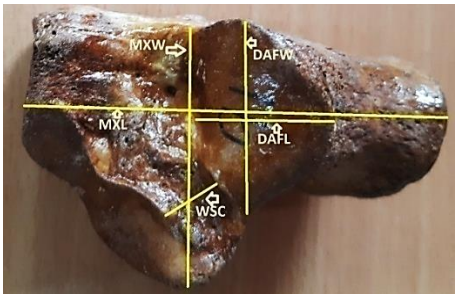

Fig. 2. Showing linear measurements

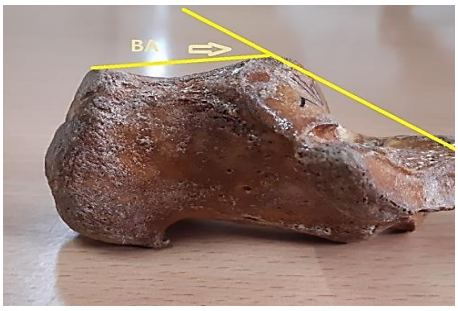

Fig. 3. Showing Boehler's angle

Consent was not required as study was performed on anonymous bones, by which it is impossible to identify a person. Further, authors confirm compliance with Code of Ethics (Declaration of Helsinki).

Data was entered on excel spreadsheets and t-test was used for statistical analysis.

3. Results

Present study was done in the department of Anatomy at Pt. B. D. Sharma Post-graduate Institute of Medical Sciences, Rohtak. Total of 57 pair of dry human well preserved calcanei were taken and various parameters were recorded and then analyzed to determine the right and left differences. Correlation of Bohler's angle and maximum antero-posterior length (MXL) was done with other parameters of the calcanei bone.

Table 1

Measurement of calcaneum

Parameters	Side	Mean	*p*-value
MXL	R	73.29±13.87	0.41
	L	73.84±13.44	
BH	R	40.85±7.69	0.23
	L	39.79±7.4	
CFH	R	22.98±5.28	0.100
	L	21.81±4.1	
LAL	R	44.01±8.81	0.39
	L	43.58±8.80	
MXW	R	37.78±6.91	0.24
	L	36.78±8.31	
DAFW	R	32.28±4.75	0.06
	L	23.75±5.30	
DAFL	R	23.06±4.79	0.29
	L	23.57±4.91	
WSC	R	5.87±1.55	0.34
	L	5.75±1.55	
BA	R	23.73±5.09	0.20
	L	24.56±5.12	

Table 2
Linear regression analysis of antero-posterior length of calcaneum with other bone measurements

	Parameters	Side	*p*-value
MXL	BA	R	<0.01
		L	<0.01
	BH	R	<0.01
		L	<0.01
	CFH	R	0.53
		L	<0.01
	LAL	R	<0.01
		L	<0.01
	MXW	R	<0.01
		L	<0.01
	DAFW	R	0.334
		L	<0.01
	DAFL	R	<0.01
		L	<0.01
	WSC	R	<0.01
		L	<0.01

4. Discussion

There are so many complex foot disabilities which are treated with different treatment procedures as osteotomy, anatomic reduction, or soft tissue relation for which the knowledge of anatomy of foot is very important.

There are so many feet disease such as talocalcaneal arthritis, coalition, intra-articular breaks, flat foot that relate to talus or calcaneum and other bones of the foot. So, detailed knowledge about the anatomy of calcaneum might facilitate alternative treatment procedures and calcaneum measurements are necessary for osteotomy [12].

In present study morphometrical parameters were taken on well preserved calcaneum bone. Then the measurements were evaluated. In present study no statistical difference was found in right and left calcaneum which was found to be different from the study of Ari and Kafu [13] where they reported the significant difference in DAFB and DAFL measurement of calcaneum, whereas Koshy reported the significant difference in the measurement of MXW. Findings of the present study (**Table 1**) were in accordance with Gualdi and Russo where they also reported that there was no significant difference in the measurements of right and the left calcaeni [14].

Calcaneum participate in the formation of subtalar joint. Calcaneum breaks are the most common tarsal breaks. Many breaks are obviously distinct, however breaks which are diagnosed hardly can be diagnosed with low Bohler's angle. Bohler's angle shows the strongest relationship for walking dynamic and produces clinical information for the researched issues [15]. Knowledge of Bohler's angle is very important for the diagnosis and treatment of calcaneal breaks. Decrease in Bohler's angle is very important for breaks.

In present study Bohler's angle (**Table 1**) was found to be in between 15–34° which was in accordance with the study done in Caucasia region [16] where they reported the Bohler's angle to be 25–40° and between 28–38° in Nigeria [17] and between 20–40° in Uganda [18]. It was

seen that the relationship of Bohler's angle varied among different population. In present study no statistically significant co-relation of BA was seen with other calcaneal measurements which was in accordance with the study done in turkey.

Correlation of MXL of calcaneum with other parameters was done which came out to be significant except for CFH (right side) and DAFW (right side) which was different from the study done in turkey [19] where they found the correlation of MXL with all the parameters except for the BA and WSC (**Table 2**). The standardized measurements from bones enable us to obtain information such as population affinity, gender, age, history of the individual before death and time of death [20]. So present findings also suggest that the MXL of the calcaneum bone can sometimes be calculated from its other parameters if well preserved, which could be helpful for forensic experts.

Study limitations. As sex of bones was unknown hence the sexual differences could not be evaluated in this study.

Prospects for further research. Further study couuld be conducted on known sex, where sexual dimorphism in morphometric parameters of calcaneum may be evaluated.

5. Conclusion

Present study suggests that there is no significant difference in right and left calcaeni**.** Present study on morphometric parameters of calcaneum would provide useful information for orthopaedic surgeries, for making of prosthesis these measurements would be of very much use. Also, the knowledge of morphometry of this bone would be useful for forensic experts, foot rehabilitation procedure, and also this study would contribute to the anatomic literature and clinical fields.

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