



ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 5.2
IJAR 2017; 3(12): 430-433
www.allresearchjournal.com
Received: 10-10-2017
Accepted: 11-11-2017

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Study of calcaneum bone help to verdict in the medico-legal cases of Rajasthan

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Abstract

Determination of sex is the most important identification. This studied were provided additional reliable method of sex estimation via discriminate function analysis method, study has been done on 100 a adults calcaneum bone including male and female. Calcaneum help to known the sex and find out the best parameters for sex determination.

Keywords: Calcaneum, sex determination, discriminate function analysis method, criminal cases

1. Introduction

An accurate determination of sex is essential in the identification of human remain in forensic context. Determination of individuality of a person and the question of identification of the individual are of everyday occurrence in life, both in civil and criminal cases. Out of various parameters used for identification of a person, some of the important ones are the determination of age, sex, stature and race etc.

Human bones have long been explored all over the world mainly by anatomists, physical anthropologists, and physicians, all of them having interest in comparative analysis to determine their origin, sex, age, stature, race etc. The task of identification of human skeleton requires through knowledge, especially in the field of comparative osteology, craniometry and racial morphology, performing quantitative analysis of selective skeletal measurements.

Quantitative analysis can be performed even on fragmentary skeletal remains and therefore it can be useful in mass – disasters, natural calamities, charred bodies and criminal cases.

Calcaneum is small, stout bone and by virtue of its anatomical position resists, putrefaction better than other bones, can remain preserved for longer times under natural climatic conditions and is less likely to be fragmented further.

It is therefore, this study was undertaken to study the sex differences in adult calcaneum in Indian population using discriminate function Analysis and thus to be made available and used in future for determination of sex.

One of the first steps in identification of skeleton remain is to create a biological profile which includes the assessment and estimation sex when using the visual method.

The calcaneum bone is largest bone in foot the density of this bone as well as the fact that the tarsal and metatarsal bones are often enclosed with shoe and the majority of post mortem alteration [Bidmos and Asala 2003] researcher from [1998] have found measurement of calcaneum provide an additional reliable method for sex estimation via discriminate function analysis.

2. Aim and Objective

The aim of present study is to determine the sex of unknown calcaneum bone by applying values of morphometric parameters and formula generated by a present study on calcaneum to known sex and find out the best parameters for sex determination.

The following objectives will be helpful to achieve our aim of the study

- To study the sex-related difference in adult human calcaneum of right and left sides by anthropometry
- To study utility and limitation of various calcaneum parameters
- To find out identification points like maximum length, body height, minimum width, load arm width to calcaneum bone

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3. Material and Method

A Study has been in 100 adults in calcaneum including male and female with intact and well- preserved calcaneum in anatomy department of Jhalawar medical college only adult calcaneum with closed epiphysis will include in the analysis.

All measurement of calcaneum bone has been taken by anthropometric caliper graduate to 0.1 mm on anthropometric board.

Measurement of Calcaneum:-

Five measurements of calcaneum were taken-

1. Maximum length [ML]
2. Minimum width [MW]
3. Body height [BH]
4. Load arm length [LAL]
5. Load arm width [LAW]

1) Maximum length [ML]: The fixed arm of sliding caliper will be applied to the most posterior point of calcaneum tuberosity. The movable part will bring into contact with anterosuperior of calcaneum over its articular surface of cuboid the caliper will rotate from slide achieve maximum length.



Fig 1

2) Minimum width [MW]: The arm of sliding caliper will be applied the medial and lateral surface of calcaneum the caliper will rotate from side to side achieve maximum transverse diameter.



Fig 2

3) Body height [BH]: The fixed arm of sliding caliper will be applied to the most inferior point of calcaneum tuberosity. The movable part will bring into contact with a most superior point of calcaneum over its posterior talar articular surface caliper will rotate from slide achieve maximum height.



Fig 3

4) Load arm length [LAL]: The fixed arm of sliding caliper will be applied to the most posterior point of calcaneum over posterior talar articular surface and movable arm will bring into contact with a most anterosuperior point of its articular surface for the cuboid.



Fig 4

5) Load arm width [LAW]: The arm of sliding will be applied to the most medial point on a sustentaculum tail and the most lateral point on the posterior talar articular surface.

Inclusion Criteria: Well Preserved Calcaneum Bone

Exclusion Criteria: Fractured and damaged calcaneum Bone.

Detailed measurement (in Cm) of right and left side calcaneum done with including all 5 parameters, during the work all data written from largest to smallest measurement

Table 1: Range, mean, S.D of parameter of maximum length calcaneum bone of male

Side	Range	Mean	S.D
Right	6.5 – 8.0	7.934	0.387
Left	6.5 – 8.0	7.921	0.389

Table 2: Range, mean, S.D of parameter of maximum length calcaneum bone of female

Side	Range	Mean	S.D
Right	5.7 – 7.0	7.131	0.223
Left	5.5 – 6.5	7.121	0.234

Table 3: Range, mean, S.D of parameter of body height calcaneum bone of male

Side	Range	Mean	S.D
Right	3.5 – 4.0	5.024	0.454
Left	3.3 – 5.1	4.940	0.637

Table 4: Range, mean, S.D of parameter body height of calcaneum bone of female

Side	Range	Mean	S.D
Right	2.5 – 3.5	4.420	0.268
Left	2.0 – 3.3	4.380	0.381

Table 5: Range, mean, S.D of parameter minimum width of calcaneum bone of male

Side	Range	Mean	S.D.
Right	2.0 – 3.0	2.643	0.222
Left	1.9 – 3.0	2.718	0.590

Table 6: Range, mean, S.D. of parameter minimum width of calcaneum bone of female

Side	Range	Mean	S.D.
Right	1.5 – 2.5	2.423	0.192
Left	1.4 – 2.0	2.446	0.319

Table 7: Range, Mean, S.D. of parameter load arm length of calcaneum bone of male

Side	Range	Mean	S.D.
Right	3.8 – 5.2	4.862	0.222
Left	3.8 – 4.5	4.623	0.243

Table 8: Range, mean, S.D. of parameter load arm length of calcaneum bone of female

Side	Range	Mean	S.D
Right	2.8 – 3.8	4.189	0.237
Left	2.8 – 3.5	4.199	0.230

Table 9: Range, Mean, S.D. of parameter load arm width of calcaneum bone of male

Side	Range	Mean	S.D
Right	3.2 – 4.0	4.136	0.197
Left	3.2 – 4.5	4.117	0.217

Table 10: Range, mean, S.D. of parameter load arm width of calcaneum bone of female

Side	Range	Mean	S.D.
Right	2.0 – 3.2	3.510	0.294
Left	2.4 – 3.2	3.540	0.307

4. Observation and Discussion

It is observed that Maximum Length is more on right side in male, ranging from 6.5cm to 8.0 cm with a mean of 7.9 cm as compared to the left side having a range of 6.5 cm to 8.0 cm with a mean of 7.9cm. The same was found to be more on left side in females with the range of 5.5 cm to 6.5cm with a mean of 7.1 cm as compared to a right side having a range of 5.7 cm to 7.0 cm with a mean of 7.1 cm. The measurement is significantly more on either side, side in males as compared to females.

Univariate Discriminant function equation derived for maximum length is

For right side – $Y = (\text{Maximum length}) (0.317) + (-23.869)$

For left side – $Y = (\text{Maximum length}) (0.311) + (-23.418)$

Sex could be ascertained with 90% accuracy from right side and with 91% accuracy from the left side.

It is observed that Body Height is more on right side in male, ranging from 3.5cm to 4.0 cm with a mean of 5.0cm as compared to left side having a range of 3.3cm to 5.1cm with a mean of 4.9cm. The same was found to be more on left side in females with the range of 2.0cm to 3.3 cm with a mean of 4.4 cm as compared to right side having a range of 2.5 cm to 3.5 cm with a mean of 4.3 cm. The measurement is significantly more on either side, in males as compared to females.

Univariate Discriminant function equation derived for body height is

For right side - $Y = (\text{Body Height}) (0.317) + (-23.869)$

For left side – $Y = (\text{Body Height}) (0.311) + (-23.418)$

Sex could be ascertained with 87% accuracy from right side and with 89% accuracy from the left side.

It is observed that Minimum Width is more on right side in male, ranging from 2.0 cm to 3.0cm with a mean of 2.7 cm as compared to left side having a range of 1.9 cm to 3.0 cm with a mean of 2.6 cm. The same was found to be more on left side in females with the range of 1.4 cm to 2.0 cm with a mean of 2.4 cm as compared to right side having a range of 1.5cm to 2.5 cm with a mean of 2.4 cm. The measurement is significantly more either side, in males as compared to females.

Univariate Discriminant function equation for minimum width is

For right side - $Y = (\text{Minimum Width}) (0.337) + (-8.543)$

For left side – $Y = (\text{Minimum Width}) (0.311) + (-5.445)$

Sex could be ascertained with 65% accuracy from the right side and with 66% accuracy from the left side.

It is observed that Load Arm Length is more on right side in male ranging from 3.8 cm to 5.2 cm with a mean of 4.8 cm as compared to the left side having a range of 3.5 cm to 4.5cm with a mean of 4.8 cm. The same was found to be more on left side in females with the range of 2.8 cm to 3.5 cm with a mean of 4.1cm. The measurement is significantly more on either side, in males as compared to females.

Univariate Discriminant function equation derived for load arm length is

For right – $Y = (\text{Load arm length}) (0.436) + (-19.707)$

For left side – $Y = (\text{Load Arm length}) (0.422) + (-19.058)$

Sex could be ascertained with 93% accuracy from the right side and with 93% accuracy from left side.

It is observed that Load Arm Width is more on right side in male, ranging from 3.2 cm to 4.0 cm with a mean of 4.1 cm as compared to the left side having a range of 3.2 cm to 4.5 cm with a mean of 4.1 cm. The same was found to be more on left side in females with the range of 2.4 cm to 3.2 cm with a mean of 3.5 cm as compared to right side having a range of 2.0 cm to 3.2 cm with a mean of 3.5 cm as compared to right side having a range of 2.0cm to 3.2 cm with mean of 3.5 cm. The measurement is significantly more on either side, males as compared to females.

Univariate Discriminant function equation derived for load arm width is

For right side – $Y = (\text{Load Arm Width}) (0.399) + (-15.236)$

For left side - $Y = (\text{Load Arm Width}) (0.376) + (-14.389)$

Sex could be ascertained with 90% accuracy from the right side and with 86% accuracy from the left side.

Table 11: Equation of Univariant Discriminant function analysis

Bone	S.No	Parameter	Coefficient	Constant	Sectioning point	Accuracy
Right Calcaneum	1. LAL	$Y=(LAL)X$	0.436+	-19.707	0	93%
	2. LAW	$Y=(LAW)X$	0.399+	-15.236	0	90%
	3. ML	$Y=(ML)X$	0.317+	-23.869	0	90%
	4. BH	$Y=(BH)X$	0.268+	-12.664	0	87%
	5.MW	$Y=(MW)X$	0.337+	-8.534	0	65%
Left Calcaneum	1. LAL	$Y=(LAL)X$	0.422+	-19.058	0	93%
	2.LAW	$Y=(LAW)X$	0.376+	-14.389	0	86%
	3.ML	$Y=(ML)X$	0.311+	-23.418	0	91%
	4.BH	$Y=(BH)X$	0.191+	-8.882	0	89%
	5. MW	$Y=(MW)X$	0.211+	-5.445	0	66%

5. Conclusion

In conclusion in forensic anthropological cases in which the skull, pelvic and scapula bones are fragmentary or missing, sex can be assessed with a high degree of accuracy using another region of the skeleton. The present study has confirmed that accuracy of sex determination using calcaneum measurement of Rajasthan population can be improved by deriving a discriminate function, which utilizes a combination of five respective dimensions.

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