Original Article

Morphometric Assessment of the Weight, Length, Width and Coxal Index of the Adult Human Dry Hip Bones

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Abstract:

Background: Skeletal remains provide probably the most dependable information for identifying an unknown individual because of their relative durability with which they can be preserved and studied. In this respect, metrical studies of the hip bones are more useful than mere physical examination. **Objectives:** The objective of this study was morphometricassessment of the adult human dry hip bones to evaluate weight, length, width and coxal index of hip bones. **Method**: This study was a cross sectional study done in Anatomy department of Rangpur Medical College between January' 2017 and December' 2017. Two hundred adult human dry hip bones (101 right and 99 left hip bones) of unknown sex were collected randomly from 1st and 2nd year MBBS student, Department of Anatomy, Rangpur Medical College and Armed Forces Medical College, Rangpur. The weight, length and width of the hip bone were measured and coxal index was calculated for each hip bone. From the raw data, range, mean, standard deviation of mean was determined for each parameter by SPSS version 16. The difference between hip bone of right and left side were compared by unpaired "t" test. **Result:** Length, width and coxal index of hip bone were similar between right and left sides. However, bones of right side were heavier than left side but values did not vary significantly.**Conclusion**: The hip bone usually displays differences in morphology independent in size due to different sexual and reproductive functions which are influenced by sex hormones. Therefore study of hip bone regarding measurements of different morphological parameters is not only valuable for anatomists but also for all anthropologist, and forensic experts.

Indexing words: Hip bone, Length, Width, Weight, Coxal index

Introduction:

Humans are the only mammals who are unique among the primates, to assume an upright posture and a bipedal mode of locomotion. The two hip bones articulate posteriorly with sacrum and form bony pelvis, which transmit the body weight through the acetabulum to the lower limb and at same time mediate the propulsive thrust from the lower limb to the body[1]. The hip bone is one of the most informative bones in the skeleton because it is formed by three independent elements during the sub adult life and is directly involved with childbirth[2]. The four main features of biological identity are sex, age, stature and ethnic background. Though many bones of the skeleton present sex, age and race related differences, the distinctive morphology of the human hip bone makes it of interest from anatomical, anthropological and forensic point of view[3]. The hip bone is the most reliable indicator for the sex determination because of the pattern of sexual dimorphism is common to whole human race[4]. As it forms pelvis which adapted for child bearing in female, resulting in a number of gender related anatomical differences. For this reason, some special criteria of female hip bone provide the highest accuracy levels for sex determination. Morphometry of the hip bone is important for the anatomist as well as for the anthropologist for population studies. Moreover, specimen identification and sex determination

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from skeletal remains has great importance in forensic medicine. Therefore, awareness of the average dimensions of the hip bone in both sexes would also help in early detection of disputed sex by forensic experts[5,6,7]. The different morphology of human hip bone and its sexual dimorphism is of great importance in various fields of research and judgment. The metric and non-metric differences in skeletal component among populations are evident and that are related to genetic and environmental factors[8]. Morphometric measurements done on right and left side indicate that there was bilateral asymmetry of hip bone[9,10,11]. Dhinsha et al[12] stated that right hip bone is robust. Racial differences in Thais, Chinese, Nigerians and other populations have been compared[13,14]. It has long been customary among anatomists, anthropologists and forensic experts to judge the sex of skeletal material by non-metric observations. Lately, sexual divergence has been based on actual measurements in different bones; such as, hipbone, sacrum, femur, humerus, clavicle, sternum, mandible, skull, etc. But among all, current opinion regards only the hipbone as providing the highest accuracy level for sex determination[15]**.**

Singh & Potturi[16] identified the sex of hip bone from several measurement e.g. width, lengths & breadth of hip bone, in 200 adult hip bones from Varanasi zone. Coxal index was calculated. Others studies[3,17] considered Coxal index (CI) of hip bones very valuable parameters in determining sex, in North-Western India.

The introduction of precise measurement methods not only provides simplicity and accuracy but allows no individual variation and is therefore entirely an objective assessment. In spite of this not much work has been done in the Bangladeshi population, therefore, the need for the present study to be carried out was felt. The present study would provide valuable information about the parameters and indices of human dry hip bone in Bangladeshi population which would help to differentiate the sex of human hip bone. It would be useful in anatomical, anthropological, archaeological and forensic studies.

Objectives:

To measure the weight, length and width of hip bone and to calculate the coxal index; to differentiate between bones of right and left side.

Methods:

This was a cross sectional analytical study, conducted from January 2017 to December 2017in the Department of Anatomy, Rangpur Medical College, Rangpur. This study was performed on 200 human dry hip bone of unknown sex collected from 1stand 2nd year MBBS students of Rangpur Medical College and Armed Forces Medical College, Rangpur, after proper declaration of present author and consent of the students. Completely ossified, grossly normal adult human dry hip bones were included. Deformed, malunited, incomplete bones and bones with congenital anomalies were excluded. Among the 200 hip bones of unknown sex, 101 were right and 99 were left hip bones. Weight of hip bone (in grams) was measured by electrical weighing machine (Fig. 1); Length and width of hip bone was measured by osteometric board (Fig. 2 and 3). The osteometric board was prepared from carpenter for the present study according to Singh et al[3]. Coxal index was calculated by formula: width of hip bone/length of hip bonex100.All the measurements were taken three times for each parameter at different times and the average of these three measurements was recorded as the measurement of the parameter. Photographs of all hip bones were taken during measurement of the samples.



Fig.1 Measurement of weight of hip bone by electric weigh machine

Measurement of Length of Hip Bone: It is the maximum distance from the most superior point on the iliac crest to a plane drawn along the inferior end of the ischial tuberosity. It was measured with the help of an osteometric board and the measurements were recorded in centimeters. The most superior point of the iliac

crest was placed in contact with the fixed end of the board and the inferior end of the ischial tuberosity was placed against the movable arm (Fig.2). Length was measured on the scale by adjusting the moveable arm[3,17].



Fig.2: Measurement of length of hip bone by osteometric board



Fig.3:Measurement of width of hip bone by osteometric board

Measurement Width of Hip Bone: It is the maximum distance between the anterior superior iliac spine and the posterior superior iliac spine. It was measured with the help of an osteometric board and the measurements were recorded in centimeters. The posterior superior spine was placed in contact with the fixed end of the board and the anterior superior spine was placed against the movable arm (Fig.3). Width of hip bone was measured on the scale by adjusting the moveable arm[3,18]**.**

The data collected from the morphological studies were processed according to their distributions, central tendencies and dispersions. Results were the prepared from these data as ranges, mean values, standard deviations (SD) etc. as applicable. Mathematical relationship between measurements of right and left sides was compred by Student's unpaired't' test. In all statistical analyses, the level of significance was set at p ≤0.05 at 95% confidence intervals. All the statistical analysis was done by using the SPSS software package for windows version 16.0.

Results:

Table I shows the weight of hip bones of both sides. The mean ±SD of weight of right hip bones was 117.42±33.12 gm and that of left hip bones were 115.05±28.28 gm. Though right hip bones were heavier than the left but these but no significant differences was found between the bones of both sides.

The ranges and mean ± SD of length, width of hip bone and coxal index of both sides are shown in Table II.

The mean ± SD of length of right and left hip bones were 18.88±1.26 and 18.88±1.21 cm respectively.

Regarding the mean ± SD of width of hip bones, it was 13.49±.89 and 13.54±.82 cm respectively in right and left hip bone.

The mean ± SD of coxal index were 71.54±3.59 and 71.79±3.70 in right and left side of bone respectively (Table II). However, no difference was found between these variables of right and left sides were found.

Table I: Weight (gram), Length, width and coxal index of 200 hip bones (right 101 and left 99)

Variables and site of hip bone			Range	Mean ± SD	p-value
Measurements	Weight of hip bone	Right	73 – 158.26	117.42±33.12	.130
		Left	79.75 – 149.97	115.05±28.28	
	Length	Right	17.28 – 20.33	18.88± 1.26	.721
		Left	17.23 – 20.43	18.88 ±1.21	
	Width	Right	12.53 – 14.40	13.49 ± .89	
		Left	12.62 – 14.40	13.54 ± .82	.462
Coxal index		Right	66.68 – 76.16	72.54 ± 3.59	.852
		Left	66.70 – 76.90	71.79 ± 3.70	

Results are shown as Range and Mean ± SD.
p- value reached from unpaired independent t' test.

Discussions:

The present work was undertaken to study various morphometric variables of hip ones to establish a data bank for our own and to verify these data to reference values of other parts of the world to identify population-specific characteristics. Another aim of this study was to find out variations between right and left sided hip bone.

In present study the mean ±SD of weight of right hip bones was 117.42±33.12 gm and that of left hip bones were 115.05±28.28 gm. Though the bones of right sides were heavier than the bones of left sides, the value did not vary significantly.

The mean weight of hip bone was 134.94gm observed by Singh and Raju[5] and 130.77 gm by Singh et al[3] but both authors found that weight was higher on right side than on left side like the present study. Khushale et al[18] studied 160 hip bones and were found the weight of male right hip bone varied from 120 to 198 gm with an average of 147.22±28.11 gm, while female bones weighed from 70 to 112 gm only had mean value 91.34±18.18. In male left hip bone mean weight is 133.91±15.32 gm, while female bone weight from 83-128 gm with means value 99.15±18.11 ($p< 0.001$).

So, the findings of the present study were more consistent with two study findings[3,5] than Khushale et al[18] in whose study the values of males were more than the present study but values of females were less than the present study.

In a study of lower limb that bones were heavier in right side, suggesting of right dominance. He suggested that right dominance was considered to be a genetic phenomenon guided by contralateral dominant left cerebral hemisphere[19].

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A comparative discussion of the length, width and coxal index with that of different authors and researchers of abroad is mentioned in Table II.

It was found that findings of the present study were similar to some study findings[18,20,21]. All these workers were Indian origin. But two study findings[22,23] for white males of South Africa were higher than all the previous workers as stated above may be due to they were from European country.

It was found that the length of hip bones was higher in males than females in all the studies. Regarding width of hip bone, it was similar or slightly higher in males. Regarding the Coxal index, it was significantly higher in females found in all studies.

Authors	Length of hip bone (cm)		Width of hip bone (cm)		Coxal index	
	Male	Female	Male	Female	Male	Female
Davivongs[24] (Australian Aborigins)	19.77	18.20	14.80	14.22	74.77	78.04
	-	-	14.40	14.16	-	-
Kimura[25] (Japanese/American	-	-	14.40	14.16	-	-
White/ American Black)	-	-	15.98	15.47	-	-
	-	-	15.30	15.07	-	-
Patriquin et al[23] (South Africa)	22.04	20.71	16.31	16.10	-	-
White vs Black	20.39	19.09	15.01	14.54	-	-
Arsuanga & Carrtero[22] (Spain)	21.19	19.59	15.56	15.29	-	-
Gomez-Valdes et al[26] (R/L)	20.06	19.03	15.14	14.68	-	-
(Mexico)	20.69	19.04	15.16	14.73	-	-
Gupta and Arora[21] (India)	19.38	17.94	13.73	13.32	70	74
Siddapur& Siddapur[20] (India)	-	-	-	-	67.7	70.8
Khushale et al[17] (India)	18.60	18.13	13.62	13.61	70.52	76.81
In present study (Bangladesh)	19.30	18.36	13.51	13.58	70.05	74.06

Conclusions:

The hip bone usually displays differences in morphology independent in size due to different sexual and reproductive functions which are influenced by sex hormones. Therefore, study of hip bone regarding measurements of different morphological parameters is not only valuable for anatomists but also for all anthropologist, and forensic experts. There is no study of human hip bones in the northern zone of Bangladesh. So, this study would help us to gather a sound knowledge of various parameters of the hip bone, which would be helpful for the anatomists, forensic experts.

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