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Original Research Article.

A Morphometric Analysis of Hip Bone for Sex Determination

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ABSTRACT

Background: Pelvic bone is the most sexually dimorphic area in adult skeleton, which provides sufficient evidence for sex determination even when fragmentary and is of great use in both medico-legal and archaeological settings. Recent development of quantitative methods is an effort to decrease ambiguity in assessment methods. Present study aims to determine the Morphometric parameters of dry hip bone and to assess difference in these parameters between male and female hip bone.

Materials and Methods: A descriptive observational study was conducted in the Department of Anatomy, SMS Medical College, Jaipur. Measurements were taken from 100 mature hip bones of known sex.

Results: Maximum width of Posterior superior iliac spine (PSIS) to superior border of ischial tuberosity (PSIS - IT); Maximum width and Posterior segment of width had significantly higher value in female hip bone as compared to male. Index1 (depth (OC)/ width (AB) x 100) was significantly higher in males as compared to females.

Conclusion: These morphometric measurements of hip bone, either alone or in combination can prove to be accurate, quantitative method for sex determination.

Key words: Hip Bone, Pelvis, Sex Determination, Sexual Dimorphism, Morphometric Measurement.

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INTRODUCTION

Ascertaining a biological profile from the skeleton is a vital component in both medico-legal and archaeological settings and one of the prime attributes to identify is the individual's sex. Sexual dimorphism, or size and shape differences between the male and female can be best observed primarily on the cranium and pelvis of human. Innominate is the most sexually dimorphic area in adult skeletal material, which provides sufficient evidence for sex determination even when fragmentary.[1-3]

Most early studies of the pelvis dealt with the size and structure of the pelvic inlet, assessing the pelvic bowl as a single element.[4-6] Later studies incorporated the entire pelvis, with common features reviewed including the greater sciatic notch breadth and angle, subpubic angle, ventral arc, pubic bone length, preauricular sulcus, subpubic concavity, and the ischio-pubic index.[7-9] These feature variations reflect functional differences on the pelvis to allow for childbirth in women. In general, the female pelvis flares more laterally, with wider sciatic notch openings to allow for a wider birth canal, while the male pelvis tends to be more compressed and narrow. Unfortunately, due to the overlap of values between the sexes, no feature is 100% accurate.[10-12]

The development of quantitative methods had been attempted in an effort to decrease ambiguity in assessment methods.[13-15]

A small amount of overlap, usually less than 5%[10], does occur between males and females in these features, so that some individuals fall into an ambiguous or intermediate category.[16] While some regional variation of sexually dimorphic traits had been noted, researchers suggest that this difference did not affect sex determination.[17,18]

Present study aims to determine the Morphometric parameters of dry hip bone and to assess difference in these parameters between male and female hip bone.

MATERIALS AND METHODS

A descriptive observational study was conducted in the Department of Anatomy, SMS Medical College, Jaipur. 100 mature hip bones of known sex were taken for study (50 right and

50 left sided). Sample size was calculated at 95% Confidence level assuming standard deviation of 1.23 cm in width of PSIS as per study of Dr. Sarita R. Margam et al[19] at allowable error of 0.25 cm in width of PSIS minimum. After obtaining ethical clearance from institution's Research Review board, Data collection was done using predesigned Performa. Only that Hip Bones with intact ischial spine and with complete ossification were included in study. Measurements were done using Sliding vernier caliper, Inextensible thread, Standardized steel scale with the help of a diagram of posterior border of human hip bone in centimeters. Mean value of the readings taken by three methods was taken as final reading.

The Various Parameters Measured Were

- **(a)** The maximal width of the posterior border of greater sciatic notch (PSIS-IT) in cm - measured from the Posterior superior iliac spine (PSIS) to superior border of ischial tuberosity (IT). (Figure 1)
- **(b)** The distance from posterior inferior iliac spine to the superior border of ischial tuberosity (PIIS-IT) in cm
- **(c)** Maximal Width i.e. Distance between a tubercle of marking attachment of Piriformis muscle to tip of ischial spine (AB) in cm.
- **(d)** Maximal depth: i.e. perpendicular to the width (OC) in cm.
- **(e)** Posterior segment of the width (OB) in cm.
- **(f)** Index 1: depth (OC) /width (AB) x 100
- **(g)** Index 2: Posterior segment (OB) / width x 100

Statistical Analysis

Morphometric Parameters were expressed as mean and standard deviation and significance of difference was assessed using student-t-test. Statistical significance was taken at P value <0.05. All analysis were done using 'Primer' software

RESULTS

A total of 68 male and 32 female bones were included in the study. Half of the bones were of right and half of left side. Table 1 shows various Morphometric hip bone measurements. Right and left side hip bone did not vary significantly in any of the Morphometric measurements (Table 2). Maximum width of PSIS to IT; Maximum width and Posterior segment of width had significantly higher value in female hip bone as compared to male (Table 3). Index 1 (depth (OC)/ width (AB) x 100) was significantly higher in males as compared to females .

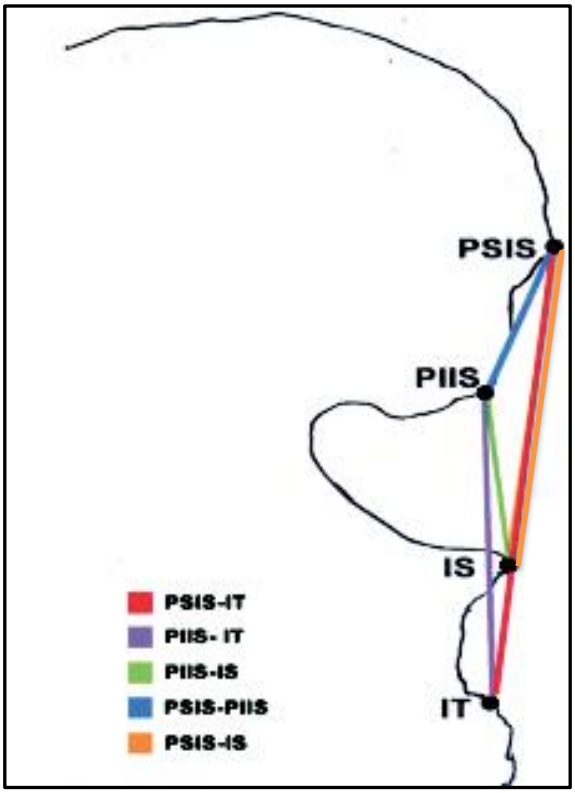

Figure 1: Parameters Measured in present study[19]

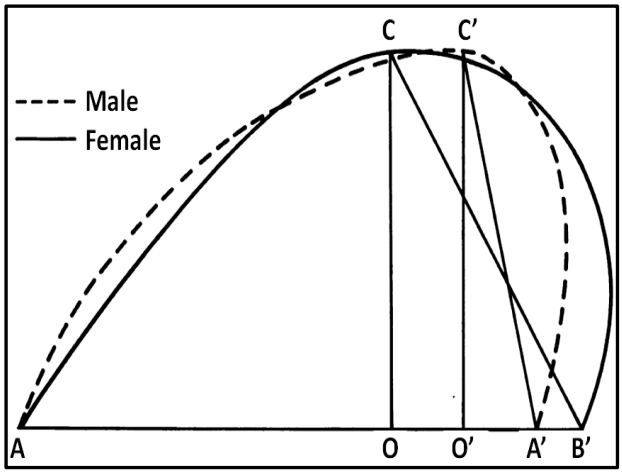

Figure 2: Measurements of greater sciatic notch (Interrupted curve shows greater sciatic notch of male & Continuous curve shows greater sciatic notch of female)[22]

Table 1: Hip bone measurements

PARAMETERS	Minimum	Maximum	Mean	Std. Deviation
Maximum width of PSIS to IT(cm)	8.22	11.73	9.834	0.65
Distance from PIIS to superior border of IT(cm)	5.32	8.90	7.36	0.63
Maximum width(cm)	3.62	6.81	5.49	0.44
Maximum depth perpendicular to width (OC)(cm)	2.01	4.07	3.31	0.5
Posterior segment of width (OB)(cm)	1.96	3.03	2.6	0.28
Index 1= depth(OC)/width(AB) x 100	37.78	82.50	60.7	10.37
Index 2 = Posterior segment OB/AB x 100	33.68	64.09	47.53	5.34

Table 2: Side wise Distribution of Various Parameters

VARIABLE	Sex	N	Mean	Std. Deviation	P value
Maximum width of PSIS to IT(cm)	**Left**	50	9.75	.56	0.21
	Right	50	9.91	.73	
Distance from PIIS to superior border of IT(cm)	**Left**	50	7.4	.53	0.622
	Right	50	7.33	.72	
Maximum width (cm)	**Left**	50	5.39	.3	0.954
	Right	50	5.39	.51	
Maximum depth perpendicular to width(cm)	**Left**	50	3.04	.41	0.28
	Right	50	2.95	.44	
Posterior segment of width (cm)	**Left**	50	2.52	.29	0.302
	Right	50	2.58	.25	
Index 1= depth(OC)/width (AB) x 100	**Left**	50	56.70	8.312	0.35
	Right	50	55.1134	8.81	
Index 2 = Posterior segment OB/AB x 100	**Left**	50	46.93	5.34	0.26
	Right	50	48.15	5.55	

Table 3: Comparison of Male and female Hip bone Measurements

VARIABLE	Sex	N	Mean	Std. Deviation	P value
Maximum width of PSIS to IT(cm)	**Male**	68	9.51	0.41	**<0.001**
	Female	32	10.52	0.54	
Distance from PIIS to superior border of IT(cm)	**Male**	68	7.3	0.67	0.138
	Female	32	7.5	0.53	
Maximum width (cm)	**Male**	68	5.42	0.38	**0.03**
	Female	32	6.62	0.53	
Maximum depth perpendicular to width (cm)	**Male**	68	3.35	0.53	0.25
	Female	32	3.26	0.41	
Posterior segment of width (cm)	**Male**	68	2.55	0.29	**0.017**
	Female	32	2.69	0.23	
Index 1= depth(OC)/width(AB) x 100	**Male**	68	62.11	11.2	**0.047**
	Female	32	57.71	7.66	
Index 2 = Posterior segment OB/AB x 100	**Male**	68	47.17	5.23	0.32
	Female	32	48.30	5.59	

DISCUSSION

Although 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. The hip bone is the most reliable skeleton in sexual dimorphism.

In present study the maximum width of PSIS to IT (cm) was significantly higher in females (10.5 cm) as compared to males ((9.5 cm). The result of present study was in accordance with the study by Margam S[19]; however Issac et al[20] and Doshi et al.[21] found it to higher in males as compared to females.

Mean distance from PIIS to Superior border of IT (cm) in this study was higher for females as compared to males but this difference was not statistically significant. Similar findings were reported in studies by Margam S et al.[19], Issac et al[20] and Doshi et al.[21]

Females were found to have significantly higher maximum width as compared to males. Shah et al.[22] and Dnyanesh et al[23] also found maximum width to be higher in females. Maximum depth perpendicular to width were lower for females than males but the difference was not statistically significan. Shah S et al[22] and Dnyanesh S et al.[23] also found similar results. Index 1 value was significantly lower in females in present study as was similarly reported by Shah S et al[22] and Dnyanesh S et al.[23] Index 2 value was higher in females as compared to male but the difference was not statistically significant. Shah [S22], Dnyanesh[23] also found value of index 2 was higher for females than males.

CONCLUSION

The Maximum width of PSIS to IT; Maximum width; Posterior segment of width and Index1 (depth (OC)/ width (AB) x 100) were

found to be significantly different in male and female. These morphometric measurements of hip bone, either alone or in combination can be useful in sex determination. Further studies are required to determine the critical cutoff values to differentiate between male female bones and to determine the best combination of morphometric measurements for sex determination.

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