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Metric Analysis of Different Variables at Anterior Border of Hip Bone for Determination of Sex

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Abstract **Original Research Article**

Introduction: Determination of sex is one of the most important steps in reconstruction of identity of skeletal remains. Various studies have reported metric analysis of different measurements for sexing of hip bone. Very few studies have been carried out on its anterior border. ***Objective:*** The present study has been carried out to evaluate the metric analysis of different variables at anterior border of hip bone for determination of sex from hip bone. ***Methods:*** A cross sectional study on 140 undamaged hip bones (108 males and 32 females) was carried out in the department of Anatomy at our medical institue, which is an Apex medical center for medicolegal examination of bones. Nine different variables (distance between two points) from anterior border of hip bones obtained from this Apex centre were measured using vernier calipers. The three ratio of notch length were also calculated. These variables were compared using student t-test to analyse the significance. ***Results:*** It was found that the mean value for these variables was more in males except the distance between ASIS-AIIS, AIIS-SS, IE-PT and IE-SS, but statistically significant differences in relation to sex were found in only 2 variables (distance between AIIS-IE and IE-SS), which also shows greater sexual dimorphism as compared to other variables. All the ratio of distance was found to be statistically significant except ratio C. ***Conclusions:*** These variables at anterior border could be used for determination of sex even from fragmented hip bones in association with other conventional measurements.

Keywords: Hip bone, anterior border, metric measurement, determination of sex.

INTRODUCTION

Determination of sex is one of the most important steps encountered in reconstruction of identity of an unknown individual particularly in skeletonised/ charred body and in disaster victims as it halves the number of probability. It is also of paramount interest in anthropological and anatomical examination. Sex can easily be differentiated from the skeletal remains by visual method from their characteristic morphological features of the individual bones. The sex can be predicted with 100% accuracy if whole skeleton is available; but from hip bone alone, it can be predicted with 95% accuracy [1]. The introduction of simpler metric method not only removes the observer bias [2] and also provides more accurate method over the morphological method [3,4]. Many studies have evaluated various metrical analysis for estimation of sex in the hip bone pertaining to its posterior border and inferior border [5-14] but very few focused on anterior border [15-18]. So the present study has been carried out to evaluate metric measurement of different parameters at anterior border of hip bone for determination of sex.

MATERIALS AND METHODS

A cross-sectional study on 140 undamaged hip bones was conducted during the period July 2018 - June 2019 in the department of Anatomy at our medical institute. It is an Apex medical centre for medicolegal examination of bones. All the bones included in the study were fully ossified (adult) and free from any pathological condition. These bones were first subjected for morphological confirmation and then metrical measurement of the different variables at anterior border of hip bone was taken by vernier calipers with a resolution of 0.02 mm. Thus the study consists of 108 male and 32 female dry and complete hip bones. All the

measurements were taken by single examiner to eliminate inter-observer error. The intra-class correlation coefficient was found to be 99.99%. For each hip bone, the following nine variables were measured in millimeter (mm).

1. Distance between Anterior Superior Iliac Spine to Superior end of symphysial surface: ASIS- SS
2. Distance between Anterior Superior Iliac Spine to Pubic Tubercle: ASIS- PT (Figure 1 – B)
3. Distance between Anterior Superior Iliac Spine to Ilio-pubic Eminence: ASIS- IE
4. Distance between Anterior Superior Iliac Spine to Anterior Inferior Iliac Spine: ASIS- AIIS
5. Distance between Anterior Inferior Iliac Spine to Ilio-pubic Eminence: AIIS- IE (Figure 1 – A)
6. Distance between Anterior Inferior Iliac Spine to Pubic Tubercle: AIIS- PT
7. Distance between Anterior Inferior Iliac Spine to Superior end of symphysial surface: AIIS- SS
8. Distance between Ilio-pubic Eminence to Pubic Tubercle: IE-PT (Figure 1 – C)
9. Distance between Ilio-pubic Eminence to Superior end of symphysial surface: IE- SS

Figure no 1. (A)--- AIIS- IE, (B)---- ASIS- PT, (C) ---- IE-PT

From the above parameters, three ratios were also calculated as follows:

1) Ratio A: distance between ASIS-AIIS/ distance between AIIS-IE x 100
2) Ratio B: distance between AIIS -IE/ distance between IE-PT x 100
3) Ratio C: distance between ASIS-AIIS/ distance between IE-PT x 100

The data thus obtained for all the above variables and ratios were analysed statistically to find their range, mean, SD, SEM in both the sexes. Three different ratio of distance is also calculated. The student t-test (unpaired) was applied to know whether these differences were statistically significant or not (P value <0.05). Limiting point for each variable was calculated from their range value and % of sex identified from it was also analysed.

Sexual dimorphism of each variable was calculated as follows: 19

Sexual dimorphism= [(Xm/Xf) – 1] x100

Where, Xm= mean of each variable in male; Xf= mean of each variable in female

RESULTS

Table 1 shows the mean, SD, SEM for each variable at anterior border of hip bone of both sexes with their significance level (p value). The mean value of each variable was greater in males except the distance between ASIS-AIIS, AIIS-SS, IE-PT and IE-SS in which the mean value was more in females. The mean value for distance between AIIS-IE and IE-SS was statistically significance when sexes were compared.

Table 1: Statistical comparison of different variables at anterior border

Variables	Sex	Mean	SD	SEM	t-value	P-value
ASIS-SS	M	118.34	9.52	0.92	-0.37	0.70912
	F	117.66	7.56	1.34		
ASIS-PT	M	105.81	8.71	0.84	-1.67	0.09808
	F	102.94	8.06	1.43		
ASIS-IE	M	65.25	6.90	0.66	-1.47	0.1441
	F	63.36	4.29	0.76		
ASIS-AIIS	M	28.23	6.68	0.64	1.13	0.2615
	F	29.62	3.49	0.62		
AIIS-IE	M	36.95	4.36	0.42	-2.56	0.0117
	F	34.81	3.43	0.61		
AIIS-PT	M	80.88	6.54	0.63	-1.58	0.1158
	F	78.78	6.64	1.17		
AIIS-SS	M	93.66	7.10	0.68	0.50	0.6152
	F	94.37	6.81	1.20		
IE-PT	M	46.03	5.75	0.55	0.99	0.3224

Variables	Sex	Mean	SD	SEM	t-value	P-value
	F	47.26	7.24	1.28		
IE-SS	M	58.98	6.20	0.60	2.71	0.0075
	F	62.36	6.19	1.09		

Table 2 shows the sexual dimorphism in different variables. It is interpreted that the distance between AIIS-IE has been found to exhibit greater sexual dimorphism (6.15%) as compared to other variable. This is followed by distance between IE-SS (5.42%) and ASIS-AIIS (4.68%). The distance between ASIS-SS and AIIS-SS shows least sexual dimorphism.

Table 2: Sexual dimorphism in different variables

Variables	Sex	Mean±SD	P-value	Sexual Dimorphism
ASIS-SS	M	118.34±9.52	0.70912	0.58
	F	117.66±7.56		
ASIS-PT	M	105.81±8.71	0.09808	2.79
	F	102.94±8.06		
ASIS-IE	M	65.25±6.90	0.1441	2.99
	F	63.36±4.29		
ASIS-AIIS	M	28.23±6.68	0.2615	4.68
	F	29.62±3.49		
AIIS-IE	M	36.95±4.36	0.0117	6.15
	F	34.81±3.43		
AIIS-PT	M	80.87±6.54	0.1158	2.65
	F	78.78±6.64		
AIIS-SS	M	93.66±7.10	0.6152	0.76
	F	94.37±6.81		
IE-PT	M	46.03±5.75	0.3224	2.59
	F	47.26±7.24		
IE-SS	M	58.98±6.20	0.0075	5.42
	F	62.36±6.19		

Table 3 shows the statistical values of different ratio of distance at anterior border of hip bone. All the ratios were statistically significant (P<0.05) when sexes were compared except ratio C. the mean value of all the three ratios were more in females except ratio B, where the mean value was more in males.

Table 3: Statistical measurement of different ratio of distance

RATIO OF DISTANCE	Sex	Mean	SD	SEM	t-value	P- Value
RATIO A	M	76.86	18.22	1.75	2.64	0.0093
	F	86.23	15.62	2.76		
RATIO B	M	81.22	12.34	1.19	-2.31	0.0225
	F	75.36	13.57	2.40		
RATIO C	M	61.49	13.92	1.34	0.70	0.4334
	F	63.55	9.12	1.61		

DISCUSSION

Determination of sex from skeleton remains is of great medicolegal and anthropological importance. Hip bone is considered a more suitable bone in the body for identification of sex because of its marked sexual dimorphism.20, 21 In the present study, different variables on anterior border of hip bone were measured by vernier caliper. The mean value of each variable was greater in males as compared to females except the distance between ASIS-AIIS, AIIS-SS, IE-PT and IE-SS; but statistically significant difference (P value < 0.05) in relation to sex were found in only 2 variables (distance between AIIS-IE and IE-SS). Pellico and Camacho15 (1992) also noted greater mean value in males in all the variables except the distance between ASIS-AIIS and IE-SS; but the statistical significant difference in relation to sex were found in distance between ASIS-PT, AIIS-IE and AIIS-PT. Thus, the greater mean value of AIIS-SS and IE-PT in male is inconsistence with the present study. However, the mean value of all variables was more in both the sexes as compared to the present study.

Kanabur17 (2012) studied 3 variables (distance between ASIS-SS, ASIS-PT and ASIS-IE) and found greater mean value in males almost similar to the present study. Rajasekhar *et al*18 (2017) also found that the mean distance between IE-PT was 50.8 mm in males and 52.7

mm in females. Thus, the greater mean value in females is highly consistent with the present study. Sharma and Vijayvergiya11 (2013) studied only 2 variables, noticed that the mean distance between ASIS-IE was 68.0 mm and 64.9 mm in males and females respectively; whereas, that of ASIS-PT was 105.6 mm and 102.5 mm in males and females respectively. These values are very consistent with that of present study. However, Sachdeva *et al*16 (2011) noticed that the measurement of all the 9 variables were more in males with statistical significant difference in relation to sex were seen in distance between ASIS-SS, ASIS-PT, AIIS-SS and AIIS-PT. thus, the significant greater mean value of AIIS-SS in male is in sharp contrast to the present study.

Even though the hip bone shows greater sexual dimorphism as compared to other bones, the different variables of hip bones were not studied for sexual dimorphism. In the present study, the distance between AIIS-IE has shown greater sexual dimorphism (6.15%) as compared to other variables at anterior border of hip bone. This is followed by distance between IE-SS and ASIS-AIIS.

In the present study, three ratio of distance was calculated and it was found to be statistically significant when sexes were compared except ratio C. Such ratio of distance was not studied previously, hence could not be compared.

Summary and conclusions:

Among the nine metric measurements and three ratios pertaining to the anterior border of hip bone, 5 were found to be more in males. These were distance between ASIS-SS, ASIS-PT, ASIS-IE, AIIS-IE and AIIS-PT. But the distance between AIIS-IE and IE-SS was significantly longer in males (P=0.0117) and females (P=0.0075) respectively. These 2 variables also show greater sexual dimorphism as compared to other measurements. Thus, it is concluded that the anterior border of hip bone could be used for determination of sex from hip bone in combination with other conventional variables. It can also be helpful in fragmented hip bone.

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REFERENCES

1. Krogman WM, Iscan MY. The Human Skeleton in Forensic Medicine. 2nded, 1986, Springfield: Charles C Thomas, 352-75.
2. Bruzek J. A method for visual determination of sex using the human hip bone. Am J Phys Anthropol. 2002; 117: 157-68.
3. Singh G, Singh S, Singh SP. Identification of sex from tibia. J Anat Soc India 1975; 24: 20-24.
4. Raju PB, Singh S. Sexual dimorphism in scapula. J Indian Acad Forensic sci 1978; 17 (2): 23-33.
5. Washburn SL. Sex diffeences in the pubic bone. Am. J. Phy. Anthrop. 1948;6, 199-207
6. Jovanovic S, Zivanovic S. The establishment of sex by greater sciatic notch. Acta Anat. 1965;61, 101-107.
7. Singh S, Potturi BR. Greater sciatic notch in sex determination. J.Anat. 1978; 125,619-624.
8. Isaac B. Biometry of the posterior border of the human hip bone: normal values and their use in sex determination. J Anat. Soc. India. 2002; 51(1) 43-46.
9. Pal GP, Bose S, Choudhary S. Reliability of criteria used for sexing of hip bones. J Anat Soc India. 2004; 53(2): 58-60.
10. Nagesh KR, Kanchan T, Bastia BK. Sexual dimorphism of acetabulum– pubis index in South – Indian population. Leg Med 2007; 9: 305-308.
11. Sharma G, Vijayvergiya T. Evaluation the various criteria of sex determination of hip bone of Jhalawar region of Rajasthan, India. J Pharm Biomed Sci. 2013; 26(26): 330-5.
12. Dnyanesh S, Dnyanesh DK, Phaniraj S, Mallikarjun M, Vijayashri BH, Amgain K. Study of greater sciatic notch in sex determination of hip bone by metric method. J Dental and Med Sci. 2013; 10(4): 18-23.
13. Siddapur KR, Siddapur GK. Pelvic bone indices as effective parameters of sex determination in skeletal remains: a cross-sectional study. Int J Res Med Sci. 2014;2(4):1526-9.
14. Ahmed MM, Jeelani M, Tarnum SA. Sexual Dimorphism of Human Hip Bone with Respect to Chilotic Index in North Karnataka Region. Internat J Scientific Study. 2015; 3(6): 14-7.
15. Pellico LG, Camacho FJ. Biometry of the anterior border of the human hip bone: normal values and their use in sex determination. J Anat 1992; 181: 417-422.
16. Sachdeva K, Singla RK, Kalsey G. The role of the anterior border of the hip bone in sexual dimorphism: a morphometric study in the North Indian population. Med Sci Law. 2011 Oct; 51(4):208-14.
17. Kanabur V. Identification of the sex of human hip bone by metric analysis of its anterior border. Biomedical Research. 2012; 23(2): 211-4.
18. Rajasekhar SSSN, Vasudha TK, Aravindhan K. Sex Determination by Biometry of Anterior Features of Human Hip Bones in South Indian Population Journal of Clinical and Diagnostic Research. 2017 Jun, Vol-11(6): AC13-AC16.
19. Garn SM, Lewis AB. Buccolingual size asymmetry and its developmental meaning. Angle Orthod. 1967; 37(1):186-93.
20. Bruzek J, Murail J. Methodology and reliability of sex determination from the skeleton. France : Humana Press; 2007.p.225-242
21. Murail P, Bruzek J, Houët F, Cunha E. DSP: A tool for probabilistic diagnosis using worldwide variability in Hip-bone measurements: Bulletins and dissertations of the Society of Anthropology of Paris [Internet] 2005;17(3-4):167–76.