Original Research Article

ASSESSMENT OF RELIABILITY OF VARIOUS CRITERIA USED IN ADULT HIP BONE SEX DIFFERENTIATION

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ABSTRACT

Background: Confirmation of the identity of an individual from fragmentary pieces of bones after considerable time lapsed since death is very crucial in medico legal cases. Hip bone is considered as one of the ideal bones for sex determination as it not only reflects the general differences between two sexes but also shows special adaptation of female hip bone for childbearing.

Materials and Methods: 178 Adult hip bones (54 of females and 124 of males) of both sides were examined with special reference to chilotic line index, Ischiopubic index and Acetabulopubic index. All the hip bones were dry, free of damage or deformity and fully ossified. The personal record of all the hip bones for sex and race are all available with the bone bank (Govt Medical College Aurangabad).For all the six parameters and three indices, we measured range, mean, standard deviation, P value and demarcating points. All the observations were tabulated and analyzed statistically and compared with the previous studies. All the parameters and indices are statistically significant.

Observations and Results: It was observed that when we applied univariate analysis only a few numbers of hip bones were correctly identified. Further we combined three indices in a single group and applied multivariate analysis. From our study it become very clear that very large number of hip bones can be identified correctly i.e. 85.5% of males and 83.3% females (mean 84%).

Conclusion: Thus the sex of hip bones can be identified correctly in 84% cases by using these indices.

KEY WORDS: Hip bone,Chilotic line index, Ischiopubic index and Acetabulopubic index.

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INTRODUCTION

The distinctive morphology of the human hip bone (os coxae) and its clear sexual dimorphism make it of interest from anatomical, anthropological and forensic points of view. It is acknowledged that the hip-bone is by far the best non-population-specific indicator for reliable sex determination.

According to Krogman and Ýþcan, 95% accuracy can be obtained if the pelvis is complete, altho-

ugh Bruzek found that accuracies ranged from 59% to 96%. However, it has widely been recognized that skeletal characteristics vary among populations and due to this regional variability; each population should have specific standards to optimize the accuracy of identification [1].

Numerous sex determination techniques have been proposed based either on examination of specific parts of the hip bone including the pubic bone [2], sciatic notch [3-8], sacro-iliac joint [9], acetabulum [10] or on examination of the whole hip bone [11-13].

The present study assesses the reliability of various criteria used in the determination of sex of hip bone. i.e. Chilotic line index by Derry(1923) [14], Ischio-Pubic index by Washburn (1949) [15] and Acetabulo-Pubic index by Schulter and Ellis (1983) [10]. We obtained the demarcating points of various parameters for determination of sex of hip bone and study the overlapping zone in observed parameter and indices.

We derived the multivariate formula that will help in establishing the sex of hip bone. Finally we compared the results of univariate analysis with that of multivariate analysis.

MATERIALS AND METHODS

178 Adult hip bones of known sex available in Bone bank of the department of Anatomy, Government Medical College, Aurangabad, were used in the present study. Out of 178 hip bones 54 were of females and 124 of males. All the hip bones are dry, free of damage or deformity and are fully ossified. Unossified, Broken or damaged hip bones were excluded from the study. The personal record of all the hip bones for sex and race are all available with the bone bank.

The instruments which were used for the measurements of various parameters are Scale, Sliding vernier caliper, Divider and threads, marker pencil and pens.

For each hip bone following Parameters were measured.

1. Length of sacral part of chilotic line i.e. Part of chilotic line extending from the nearest point on the anterior margin of the auricular surface of ilium to the iliac crest. It is measured by mark-

ing the above fixed points with a marking pencil and running a non elastic thread along the distance. The length of the thread is then recorded on the scale in cms.

2. Length of pelvic part of chilotic line i.e. part of chilotic line extending from iliopubic imminence to the nearest point on the anterior margin of the auricular surface of ilium. It is measured by marking the above fixed points with a marking pencil and running a non elastic thread along the distance. The length of the thread is then recorded on the scale in cms.

3. Chilotic line index: this index is obtained by using formula as:

$$\frac{\text{Sacral part of chilotic line} \times 100}{\text{Pelvic part of chilotic line}}$$

4. Length of pubic bone i.e. length from the superior most aspect of the public symphysis to the nearest rim of the acetabulum, is measured in centimeters by using sliding vernier caliper.

5. Length of ischial bone i.e. the vertical distance from the anterior aspect of the ischialtuberosity to the nearest rim of the acetabulum, is measured in centimeters by using sliding vernier caliper.

6. Ischio-pubic index: It is obtained by using following formula.

$$\frac{\text{Length of pubic bone} \times 10}{\text{Length of Ischial bone}}$$

7. Acetabular diameter: The maximum transverse diameter between two rims of acetabulum, is measured in cms. by using sliding vernier calliiper.

8. Pubo-acetabular length: Length from the superiormost aspect of the public symphysis to the nearest rim of the acetabulum,is measured in cms. by using sliding vernier calliiper.

9.Acetabulo - pubic index : It is obtained by using following formula.

$$\frac{\text{Acetabular diameter} \times 100}{\text{Pubo - Acetabular Length.}}$$

As the first part of the study all the values were tabulated and analyzed statistically by routine methods. The values of mean, range, and standard deviation were obtained, demarking points obtained and subsequently P value is obtained for each of these 6 parameters and three indices.

For the second part of the study a standard computer program,which analyzes the values like mean, range, and standard deviation etc. and is prepared according to "Multivariate Linear discriminant function" as proposed by Armitage (1971) [16] was used.

Fig. 1: Measuring the sacral part of chilotic line.

Fig. 2: Measuring the Pelvic Part of Chilotic line.

Fig. 3: Measuring the length of Body of Pubic bone.

Fig. 4: Measuring the length of Body of Ischium.

Fig. 5: Measuring the Acetabular Diameter.

OBSERVATIONS AND RESULTS

Table 1: Statistical analysis of various indices used in the present study.

		Chilotic line index	Ischio-pubic index	Acetabulo - pubic index
MALE	**Range**	83.07-151.1	84.75-138.05	78.39-131.07
	Mean	120.22	116.87	90.51
	Standard Deviation	14.07	9.05	7.85
	D.P.	> 144.1	<90.70	>109.02
	% Identified	3.22%	1.61%	0.80%
FEMALE	**Range**	72.3-160.8	98.93147.91	67.15-101.94
	Mean	97.5	128.14	81.75
	Standard Deviation	15.52	12.48	8.09
	D.P.	<78	>144.02	<66.98
	% Identified	3.30%	13%	1.85%
	P value	P <0.001	P <0.001	P <0.001

Table 2: Percentage of hip bones accurately sorted by multivariate analysis.

GROUP OF VARIABLES	Percentage of hip bones sorted		
	FEMALE	**MALE**	**OVERALL**
GROUP	83.30%	85.50%	84.80%

Table 3: Comparative analysis showing Percentage of hip bones identified correctly by using demarcating points.

	Chilotic line index		Ischio-pubic index		Acetabulo-pubic index	
	Male	Female	Male	Female	Male	Female
Mewalal (1993) [18]	53	2.5	57	53	8.3	2.5
G P Pal (2004) [19]	9.09	11.29	27.27	17.7	12.5	Zero
Present study (2016)	3.22	3.3	1.61	13	0.8	1.8

All the hip bones were measured for six parameters and three indices and observation were statistically analyzed by using t-test. The values for range, mean, Standard Deviation and demarcating points (D.P.) were tabulated.

From the table NO. 1 it was quiet obvious that

by using individual indices very few numbers of hip bones can be identified correctly. All the three indices are statistically significant (P<0.001), Hence even with the knowledge of demarcating points for specified population the number of hip bone which can be identified correctly are very less.

As a second part of study, multivariate linear discriminant functional analysis is applied to a group of variables designated under one group, and the respective differential functional score as Z. The indices used in the group are,

1) Chilotic line index

2) Ischio-pubic index

3) Acetabulo - pubic index

SPSS (sum of products and sum of squares) was used for applying multivariate linear discriminant analysis.

Discriminant functional score is calculated for all the hip bones and each was analyzed. It is observed that 106 out of 124 male hip bones scored on the male side of Z_0 and 45 out of 54 hip bones scored on the female side of Z_o. Thus 151 of 178 are accurately sorted.

DISCUSSION

Scientists all across the world have made several attempts to identify sex from individual bones. However the usual metrical methods of the earlier workers have been confined to finding the range, mean value of certain parameters of male and female bones and limiting points of these ranges have been taken as identification points. But this method of using identification points for determination of sex is not useful for unknown skeleton. Later on Jit and Singh (1966) [17] invented "Demarking point" (D.P.) based on statistically calculated ranges of various measurable characters of Punjabi clavicles, which identified sex with 100% accuracy. Though the D.P. evolved by Jit and Singh (1966) do not provide a miracle for identification of sex in 100% of cases but do so with accuracy in whatever number is identified.

Derry (1923)[14] claimed that by using chilotic line index he could identify sex of 40% of hip bones. While Washburn (1948) [15] claimed 84% male and 100% female sorting of hip bones with ischio-pubic index only. Schulter Ellis (1983) [10]

could determine sex in 97% of cases in both American, white and blacks by using acetabulo-pubic index alone. These workers have used limiting points of their samples and not subjected their data for further statistical analysis; hence they claimed to identify correctly such large number of bones correctly.

As shown in Table 3, Compares the hip bones identified correctly by using demarcating points. In our study very few numbers of hip bones could be identified correctly.

So it becomes necessary to apply complicated statistical tests to obtain more accuracy. The method of obtaining demarcating points is very easy but the results obtained are very poor. Hence in our study we grouped all three indices and applied multivariate analysis. From our study it become very clear that very large number of hip bones can be identified correctly i.e. 85.5% of males and 83.3% of females (mean 84%) when we apply multivariate analysis to our data.

The distinct difference in male and female pelvis after puberty suggests that the sex hormones play their role in the development. This dimorphism is genetically determined and continues to develop in response to sex hormones into sexual maturity. However hereditary, nutritional and other possible unknown possible factors may play a role.

Conflicts of Interests: None

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