RESEARCH ARTICLE

DETERMINATION OF SEX FROM THE ANTERIOR BORDER OF THE HUMAN HIP BONE

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ABSTRACT

Background: The distinctive biometry of the anterior border of the human skeleton and its clear sexual dimorphism make it of interests from anatomical, forensic, obstetrical, radiological, archaeological and anthropological point of view for examination of skeleton remains.

Aims & Objective: To determine the sex of human being from the anterior border of the hip bone.

Material and Methods: For the present study total 306 normal dry human hip bones, out of which 202 are of male and 104 are of female, 141 are of Right side, 165 of Left side were studied. Osteometric board with graph paper and Sliding Vernier Calliper are used for all measurement.

Results: Statistically highly significant($P \leq 0.001$) differences were detected between means in relation to sex for 6 variables (The maximal width of the anterior border notch, The distance from the anterior superior iliac spine to the pubic tubercle , The distance from the anterior inferior iliac spine to the iliopubic eminence , The distance from the anterior inferior iliac spine to the pubic tubercle , The length of the notch between the anterior inferior iliac spine and the iliopubic eminence, The depth of the notch between the anterior inferior iliac spine and the iliopubic eminence), Statistically very significant differences($p \leq 0.005$) were detected between means in relation to sex for 2 variables(Index of widening of the anterior interspinous notch, The depth of the anterior interspinous notch), Statistically significant differences($P \leq .01$) were detected between means in relation to sex for 1 variable (Index of widening of the notch between the anterior inferior iliac spine and the iliopubic eminence). These variables could be used for sex determination from the human hip bone or its fragments.

Conclusion: Therefore we consider that these 6 variables are the best of the variables studied for sexing human hip bone ($P < 0.001$).

KEY-WORDS: Hip Bone; Anterior Border; Biometry; Sex Determination

Introduction

Biometry is the branch of statistics which is concerned with applications in the biological sciences. Sex determination is an important first step in the development of a biological profile in human osteology. Without an accurate determination of sex, we cannot accurately estimate age at death, as rates of growth, development, and degeneration vary by sex as well as population.

Most of the studies done either to features relating to its total size or to those of various components, such as its inferior border, the greater sciatic notch, the symphysial surface, the acetabulum, the obturator foramen, the arcuate line, or the distance between defined morphological points on its borders [Jovanovic S, Zivanovic S (1965)[1]; Kelley MA (1979)[2]; Maclaughlin SM, Bruce MF (1986)[4]; Milne N (1990)[5]; Schulter-Ellis FP, Hayek LAC (1988)[6]; Singh S, Pottri BR (1978)[7]; Tague RG (1989)[8]; Washburn SL (1948)[9]]. The present study forms part of a larger systematic analysis of the construction of the human hip bone and this type of study was not done including large no. of human hip bones.

Materials and Methods

For the present study total 306 normal dry human hip bones were studied out of that 202 human hip bones are of male and 104 human hip bones are of female, 141 are of Right side, 165 of Left side. They were undamaged and no pathological alterations. Their side and sex were determined

by keeping standard sex determine by experts. For measurement Osteometric board with graph paper, Sliding callipers, Inextensible thread, 2 metallic squares capable of being held in one plane, Metallic millimetre ruler, Pencil were used. The following parameters of the Anterior border of Hip bone were considered: (1) The maximal width of the anterior border notch, i.e. the distance from the anterior superior iliac spine to the superior end of the symphysial surface (ASIS-SS), (2) The distance from the anterior superior iliac spine to the pubic tubercle (ASIS-PT) (3) The maximum width of the anterior interspinous notch, i.e. the distance from the anterior superior iliac spine to the anterior inferior iliac spine (ASIS-AIIS) (4) The distance from the anterior inferior iliac spine to the iliopubic eminence or maximal width of the notch between these points (AIIS-IE), (5) The distance from the anterior inferior iliac spine to the pubic tubercle (AIIS-PT), (6) The depth of the anterior interspinous notch (depth AIN) (7) The length of the notch between the anterior inferior iliac spine and the iliopubic eminence (arch AIIS-IE) (8) The depth of the notch between the anterior inferior iliac spine and the iliopubic eminence (depth AIIS-IE) (9) The depth of the anterior border (depth AB). All linear measurements were made in millimetres on the intact parts of normal bones. From above measurements following indexes are calculated: (1) Index of widening of the anterior border (Index I), i.e. Depth x 100/maximum width of the anterior border (2) Index of widening of the anterior interspinous Notch (Index II), i.e. Depth x 100/maximum width of the notch between the anterior superior iliac spine and the anterior inferior iliac spine (3) Index of widening of the notch between the anterior inferior iliac spine and the iliopubic eminence (Index III), i.e. Depth x 100/maximum width of this notch. The total sample then subdivided by sex and side to obtain two sub samples from the females and males & right and left respectively. For each variable, its mean, Standard Deviation (S.D.), Standard Error of Mean (S.Em), maximum and minimum values were calculated. The existence of Significant differences between the means (d) for the 2 sub samples (with an accuracy of 95% at least) was first analyzed by comparing the equality of variance with Levene's F test and then by Student

t test. All results and observation put in tabular form.

Figure-1: Method for Measuring the Depth of the Anterior Border (Depth AB)

Figure-2: Method for Measuring the Length of the Notch between the Anterior Inferior Iliac Spine and the Iliopubic Eminence (Arch AIIS-IE)

Figure-3: Method for Measuring the Distance from the Anterior Inferior Iliac Spine to the Iliopubic Eminence (AIIS-IE)

Results

For the present study total 306 normal dry human hip bones were studied Out of which 202 human hip bones are of male and 104 human hip bones are of female, 141 are of Right side, 165 of Left

side. Table 1 shows every parameter of total samples, the mean, SD and lower limit and upper limit are noted (variables in mm & indices in %). Table 2 and 3 shows division according to gender and side of every parameter, respectively.

Table-1: Mean, SD, SEM, Lower Limit and Upper Limit for Parameters of Total Samples

Parameters	N	Mean	SEM	SD	Lower Limit	Upper Limit
Distance AIIS-IE	306	35.81	0.25	4.39	35.31	36.31
Arch AIIS-IE	306	41.02	0.29	5.07	40.44	41.60
Distance AIIS-PT	306	80.44	0.41	7.19	79.62	81.27
Distance ASIS-PT	306	109.36	0.51	8.96	108.33	110.38
Distance ASIS-SS	306	122.71	0.53	9.31	121.65	123.78
Distance ASIS-AIIS	306	34.93	0.34	6.07	34.24	35.63
Depth AIN	306	6.90	0.10	1.71	6.71	7.10
Depth AIIS-IE	306	8.67	0.12	2.08	8.43	8.91
Depth AB	306	28.35	0.24	4.24	27.87	28.84
Index I	306	23.23	0.22	3.88	22.79	23.68
Index II	306	20.07	0.28	4.97	19.50	20.63
Index III	306	24.35	0.32	5.66	23.70	24.99
Valid N (list wise)	306					

Table-2: Mean, SD, SEM, Lower Limit and Upper Limit for Parameters of Total Samples according to Gender

Parameters	Sex	N	Mean	SD	SEM
Distance AIIS-IE	Male	202	36.96	4.15	0.29
	Female	104	33.57	3.96	0.39
	Total	306	35.81	4.39	0.25
Arch AIIS-IE	Male	202	42.52	4.63	0.33
	Female	104	38.11	4.60	0.45
	Total	306	41.02	5.07	0.29
Distance AIIS-PT	Male	202	81.40	7.41	0.52
	Female	104	78.58	6.37	0.62
	Total	306	80.44	7.19	0.41
Distance ASIS-PT	Male	202	110.71	8.47	0.60
	Female	104	106.72	9.32	0.91
	Total	306	109.36	8.96	0.51
Distance ASIS-SS	Male	202	124.04	8.78	0.62
	Female	104	120.13	9.79	0.96
	Total	306	122.71	9.31	0.53
Distance ASIS-AIIS	Male	202	34.95	6.46	0.45
	Female	104	34.91	5.25	0.52
	Total	306	34.93	6.07	0.34
Depth AIN	Male	202	7.10	1.74	0.12
	Female	104	6.52	1.58	0.16
	Total	306	6.90	1.71	0.10
Depth AIIS-IE	Male	202	9.17	2.01	0.14
	Female	104	7.69	1.87	0.18
	Total	306	8.67	2.08	0.12
Depth AB	Male	202	28.36	4.61	0.32
	Female	104	28.32	3.44	0.34
	Total	306	28.35	4.24	0.24
Index I	Male	202	22.98	4.07	0.29
	Female	104	23.73	3.44	0.34
	Total	306	23.23	3.88	0.22
Index II	Male	202	20.67	5.10	0.36
	Female	104	18.88	4.52	0.44
	Total	306	20.07	4.97	0.28
Index III	Male	202	24.98	5.52	0.39
	Female	104	23.13	5.75	0.56
	Total	306	24.35	5.66	0.32

Table-3: Mean, SD, SEM, Lower Limit and Upper Limit for Parameters of Total Samples according to Side

Parameters	Sex	N	Mean	SD	SEM
Distance AIIS-IE	Right	142	35.99	4.61	0.39
	Left	164	35.65	4.18	0.33
	Total	306	35.81	4.39	0.25
Arch AIIS-IE	Right	142	41.31	5.24	0.44
	Left	164	40.77	4.91	0.39
	Total	306	41.02	5.07	0.29
Distance AIIS-PT	Right	142	80.54	7.25	0.61
	Left	164	80.36	7.16	0.56
	Total	306	80.44	7.19	0.41
Distance ASIS-PT	Right	142	108.78	9.01	0.76
	Left	164	109.86	8.91	0.70
	Total	306	109.36	8.96	0.51
Distance ASIS-SS	Right	142	122.58	9.09	0.76
	Left	164	122.82	9.52	0.74
	Total	306	122.71	9.31	0.53
Distance ASIS-AIIS	Right	142	34.93	5.59	0.47
	Left	164	34.94	6.47	0.51
	Total	306	34.93	6.07	0.34
Depth AIN	Right	202	7.10	1.74	0.12
	Left	142	7.05	1.78	0.15
	Total	164	6.78	1.64	0.13
Depth AIIS-IE	Right	202	9.17	2.01	0.14
	Left	104	7.69	1.87	0.18
	Total	306	8.67	2.08	0.12
Depth AB	Right	142	28.60	4.25	0.36
	Left	164	28.13	4.23	0.33
	Total	306	28.35	4.24	0.24
Index I	Right	142	23.46	3.88	0.33
	Left	164	23.04	3.88	0.30
	Total	306	23.23	3.88	0.22
Index II	Right	142	20.40	4.90	0.41
	Left	164	19.77	5.02	0.39
	Total	306	20.07	4.97	0.28
Index III	Right	142	24.33	5.56	0.47
	Left	164	24.37	5.76	0.45
	Total	306	24.35	5.66	0.32

Table-4: Levene's F test for Equality of Variance, Student-t Test and P-value for Male-Female & for Right-Left Side Difference

Parameters	Sex (p Value) Levene's F Test	Sex (p Value) Students' T Test	Side (p Value) Levene's F Test	Side (p Value) Students' T Test
Distance AIIS-IE	0.307	0.000***	0.079	0.498
Arch AIIS-IE	0.159	0.000***	0.594	0.35
Distance AIIS-PT	0.641	0.001***	0.911	0.835
Distance ASIS-PT	0.231	0.000***	0.993	0.294
Distance ASIS-SS	0.362	0.000***	0.455	0.814
Distance ASIS-AIIS	0.058	0.959	0.050	0.985
Depth AIN	0.085	0.005**	0.310	0.156
Depth AIIS-IE	0.638	0.000***	0.813	0.777
Depth AB	0.001	0.937	0.917	0.328
Index I	0.049	0.106	0.724	0.353
Index II	0.031	0.003**	0.876	0.271
Index III	0.622	0.006*	0.849	0.953

* Significant at P≤0.01, ** Very Significant at P ≤ 0.005; *** Highly Significant at P ≤ 0.001

Statistically highly significant (P ≤ 0.001) differences were detected between means in

relation to sex for 6 variables (The maximal width of the anterior border notch, The distance from the anterior superior iliac spine to the pubic tubercle, The distance from the anterior inferior iliac spine to the iliopubic eminence, The distance from the anterior inferior iliac spine to the pubic tubercle, The length of the notch between the anterior inferior iliac spine and the iliopubic eminence, The depth of the notch between the anterior inferior iliac spine and the iliopubic eminence).

Levene's F test for Equality of Variance, student-t test and P-value was calculated for male- female & for right-left side difference in table-4. Statistically very significant differences ($p \leq 0.005$) were detected between means in relation to sex for 2 variables (Index of widening of the anterior interspinous notch, The depth of the anterior interspinous notch), Statistically significant differences ($P \leq 0.01$) were detected between means in relation to sex for 1 variable (Index of widening of the notch between the anterior inferior iliac spine and the iliopubic eminence).

Discussion

As per result we got total 6 variables (ASIS-SS, ASIS-PT,AIIS-IE, AIIS-PT, arch AIIS-IE, depth AIIS-IE) which are highly significant ($P \leq 0.001$) for sex determination, while in study of L Gomez Pellico and FJ Fernandezcamacho.[3] Statistically significant differences ($P < 0.001$) between means related to sex were detected for 4 of variables (ASIS-PT, AIIS-IE, AIIS-PT, arch AIIS-IE) only. Also in addition to we got that two variables (Index II, depth AIN) are very significant ($p \leq 0.005$), and one variable (Index III) is significant ($P \leq 0.01$)in determination of sex in this study. These variables could be used for sex determination from the human hip bone or its fragments.

There is no significance ($P > 0.01$) of following three measurements: Index of widening of the anterior border (Index I); maximum width of the anterior interspinous notch (ASIS-AIIS); depth of the anterior border (depth AB)). We cannot determine side of human hip bone from these variables.

Conclusion

Therefore we consider that these 6 variables are the best of the variables studied for sexing human hip bone ($P < 0.001$).

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