Role of Greater Sciatic Notch in Sexing Human Hip Bones

Rajashree Sheelawant Raut[1*], Prakash B. Hosmani [2], P. R. Kulkarni[3]

[1]Assistant Professor, Department of Anatomy, B. J. Government Medical College, Pune, Maharashtra, INDIA.

[2]Associate Professor, Department of Anatomy, Dr. V. M. Government Medical College, Solapur, Maharashtra, INDIA.

[3] Professor and Head, Department of Anatomy, Government Medical College, Latur, Maharashtra, INDIA.

[*]Corresponding Address:

drrautrajashree@gmail.com

Research Article

Abstract: Identification of the deceased person from bones is the most critical problem faced by anatomist, forensic science experts & anthropologists. Skeletal remains have been used for sexing the individual as bones of the body are last to perish after death. Hip bone, especially the greater sciatic notch is valuable in deformed bones because it is highly sexually dimorphic, is resistant to damage, and thus can often be scored in poorly preserved skeletons. In present study one hundred and eighty three adult hip bones of known sex (125 male and 58 female) are studied for various parameters of greater sciatic notch. Of all, total angle of greater sciatic notch, posterior angle of greater sciatic notch and posterior segment of greater sciatic notch are very useful for sex discrimination. The posterior segment length of greater sciatic notch and the posterior angle of greater sciatic notch in females are more than twice than in males. Width of greater sciatic notch is useful for identifying mainly female bones, but not useful for sex discrimination.

Key Words: greater sciatic notch, posterior angle, posterior segment of hip bone, sexing of hip bone.

Introduction

Identification of the deceased person from bones is the most common & critical problem faced by anatomist, forensic science experts & anthropologists. Skeletal remains have been used for sexing the individual as bones of the body are last to perish after death, next to enamel of teeth. Almost all bones of the body show some degree of sexual dimorphism [1].The accuracy of sex identification depends on skeletal completeness. According to workers who have studied previously, Krogman (1973) found - 100% accuracy with complete skeleton, 95% with pelvis alone, 92% with skull alone, 98% with both pelvis and skull together, 80% with long bones alone and 98% with long bones plus pelvis together.[2]. Hip bone is an ideal bone for sex determination because it not only reflects the general differences between the two sexes but also the special adaptation of female hip bone for child bearing. The pubis bone is the most reliable sex indicator in the human skeleton. Pubis bones, however, are fragile and susceptible to damage. Often they are so poorly preserved in archaeological collections that they cannot be used for sex determination. When pubic material is not preserved, sex determinations must be made using other less diagnostic features. The greater sciatic notch is especially valuable in such situations because it is highly sexually dimorphic, is resistant to damage, and thus can often be scored in poorly preserved skeletons[3]. Many attempts have been made to describe sex differences in the sciatic notch using measurements (DiBennardo and Taylor (1983)[4]; Davivongs (1963)[5]; Singh and Potturi (1978)[6];Kelley(1979)[7]; MacLaughlin and Bruce,(1986b)[8]). The present study is done to implicate the importance of greater sciatic notch in sexing skeletal remains from Maharashtra region by morphometric study.

Materials and Methods

One hundred and eighty three adult hip bones of known sex including 125 male and 58 female hip bones were used for the study. These all were obtained from skeletal collection of Government Medical College, Aurangabad. Care was taken to avoid damaged and pathologically deformed bones that could lead to error in measurement.

The following parameters were measured with the help of osteometric board, Stainless steel sliding caliper, Sliding compass and scale.

1) **Sciatic height** -

It is the perpendicular distance from the posterior inferior iliac spine to the adjacent border of sciatic notch measured with sliding caliper. (fig.1)

Figure 1

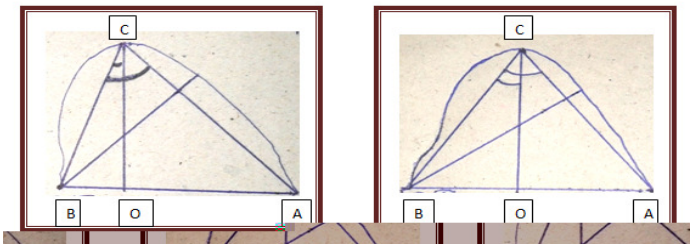
Measurements of greater sciatic notch -

For this, first pyriformis tubercle was defined. It is the pyramidal projection located at termination of the posterior border of greater sciatic notch and designated as point 'B'. It was taken as the posterior point of the width *l*(AB) while the tip of ischial spine was taken as the anterior point as 'A' of width. The curvature of greater sciatic notch was then plotted on paper. From the deepest point (C) of sciatic notch perpendicular line was drawn to the baseline (AB) which meets at 'O'. *l*(OB) is designated as the posterior segment. ΔABC was constructed on paper.

Diagrammatic representation of greater sciatic notch

A - Ischial Spine
B - Pyriformis tubercle
C - Deepest point of greater sciatic notch.
AB - Width of greater sciatic notch.
OB - Posterior segment of greater sciatic notch.
OC - Depth of greater sciatic notch.
∠ACB - Total angle of greater sciatic notch.
∠OCB - Posterior angle of greater sciatic notch.

Male **Female**



2) Width of greater sciatic notch -

It is the maximum distance between the pyriformis tubercle and tip of ischial spine measured with sliding caliper. (fig. no.2) *l*(AB)

Figure 2

3) Depth of greater sciatic notch *l*(OC) –

It is the perpendicular distance from the deepest point (C) of sciatic notch to the width line AB.

4) Length of posterior segment of greater sciatic notch –

It is the distance from the pyriformis tubercle to the point (O) at which the greatest depth line intersects the width line i.e. *l*(OB).

5) Total angle of greater sciatic notch -

It is denoted by ∠ACB in constructed triangle ABC.

6) Posterior angle of greater sciatic notch -

It is denoted by ∠BCO in the constructed triangle.

Each parameter was measured three times and mean value was calculated. All linear measurements were taken in millimeters and angle in degrees. From the data, actual range was recorded and analyzed statistically to find standard deviation for each parameter. Limiting points based on actual overlapping range of the samples were noted and called as I.P.(Identification Point). Though these I.P. can identify greater percentage of bones in given data can go wrong when applied to unknown cases. Hence Demarking Points (D.P.s) were worked out from calculated range i.e. mean $\pm$3 S.D. In medicolegal cases 100% accuracy is demanded, hence the range was calculated as mean $\pm$ 3 S.D. and these points have been named as 'Demarking Points'(D.P.). Percentage of bones identified by these D.P.s were noted.

Observation and Result

From the measurements mean, S.D., D.P., I.P.,C.V., Z value, P value are calculated. (Table no.1)

Table 1: Result and statistics for all parameters

Sr. No	Name of the parameter	Sex	Mean	S.D.	D.P.	I.P.	C.V.	Z Value	P Value
1	Sciatic height	Male	28.36	3.61	<16.54	<23	12.73	-5.32	P<0.001
		Female	32.44	5.30	>39.19	>38	16.33		
2	Width of GSN	Male	35.72	4.27	<25.16	<31	11.95	-8.74	P<0.001
		Female	43.5	6.11	>48.54	>45	14.04		
3	Depth of GSN	Male	27.06	3.53	>35.54	>32	13.06	3.03	P<0.05
		Female	25.41	3.37	<16.45	<16	13.28		
4	Length of posterior segment of GSN	Male	8.92	3.57	<0.52	<5	40.10	-10.37	P<0.001
		Female	17.93	6.15	>19.65	>22	34.31		
5	Total angle of GSN	Male	62.91	7.82	<51.22	<64	12.44	-11.83	P<0.001
		Female	79.93	9.56	>86.39	>86	11.97		
6	Posterior angle of GSN	Male	18.39	6.25	<6.71	<13	34.00	-12.13	P<0.001
		Female	34.77	9.35	>37.15	>36	26.89		

S.D.- Standard deviation , D.P.- Demarking point, I.P.- Identification point, C.V. - Coefficient of variance
Z value = Z test for testing significance, P = Probability of the difference between two means by chance.
P value < 0.001, *** statistically highly significant.
P value <0.05, *statistically significant.

Discussion

It is generally recognized that of all the elements of human skeleton, the innominate bone offers best prospect for identification of sex. Unfortunately, the features of innominate bone that exhibit highest levels of sexual dimorphism are frequently found to be damaged or missing in exhumed material. Sex identification is also complicated by morphological & metrical variation seen between and within human population. Hence it is important that the criteria used should be unequivocal and as free as possible from subjective bias which is achieved in this study by using demarking points.

However overlap can occur in all the parameters and indices during the study. The reason for this could be-

1) The considerable frequency of hypomusculinity in male and or hypofeminity in female bones.
2) The related factor could be genetic, nutritional, socioeconomic and physical stress in individuals.

The results of present study are compared with previous studies.

1) Greater sciatic height –

The mean sciatic height in present study is greater in females and is similar with previous results. The difference between the means is statistically significant. By using D.P. 12.06% female bones only can be sexed while using I.P. 6.4% males and 12.06% female bones can be identified. The values in present study are much less as compared to the previous study.

Table 2: Greater sciatic height

Study	Mean	
	M	F
Dibennardo et al(1983)[4]		
American Whites	48.6	51.7
Black	44.7	49.3
Present Study(2008)	28.36	32.44

2) Width of greater sciatic notch

Table 3: Width of greater sciatic notch

Study	Mean		D.P.		C.V.	
	M	F	M	F	M	F
Davivongs(1963)[5]	45.23	50.86	-	-	-	-
Singh et al (1978)[6]	44.75	47.83	<32.77	>59.87	-	-
Kelly (1979)[7]						
American White	42.8	46.7	-	-	11.68	10.06
Black	39.4	45.3	-	-	10.41	10.15
Indian	39.0	44.0	-	-	9.16	8.20
Maclaughlin & Bruce(1986)[8]						
English	38.52	42.0	-	-	11.47	10.88
Dutch	41.93	45.88	-	-	13.71	10.60
Rajangam et al(1991)[9]	41.4	44.1	-	-	-	-
Present Study(2008)	35.72	43.5	<25.16	>48.54	11.95	14.04

All the previous studies concluded that the width of greater sciatic notch is greater in females than males and also present study shows similar result that bones with width <25.16mm are males and >48.54mm are females. The difference between means is statistically significant. By using D.P. 22.41% female bones only can be sexed accurately. By using I.P. 12.8% male & 31.03% females bone can be sexed accurately. Thus sciatic notch is wider in females and useful for sexing female bones only.

3)Depth of greater sciatic notch –

According to Davivongs (1963)[5] the value is greater in females. But according to Singh et al[6] and Jovanovic et al.[10] the depth is greater in males and present study also shows similar result. However there is not much difference in the depth of greater sciatic notch in both males and females. By using D.P. no bone can be sexed correctly. By using I.P. 6.4% of male bones only can be identified. Thus depth of notch is poor sex discriminator.

Table 4: Depth of greater sciatic notch

Study	Mean		D.P.	
	M	F	M	F
Davivongs (1963)[5]	24.97	26.05	-	-
Jovanovic et al (1968)[10]	46.95	43.7	-	-
Singh et al (1978)[6]	25.77	25.41	>37.01	<14.8
Present Study (2008)	27.06	25.41	>35.54	<16.45

4)Posterior segment length of greater sciatic notch –

Table 5: Posterior segment of greater sciatic notch

Study	Mean	
	M	F
Davivongs(1963)[5]	6.11	17.27
Singh et al (1978)[6]	6.22	15.98
Present Study(2008)	8.92	17.93

According to Davivongs (1963)[5] & Singh et al (1978)[6] the posterior segment length is greater in females. Present study shows similar results. Also the difference between two means is statistically significant. The posterior segment in females is nearly double than that in males. By using D.P., 41.37% female bones only can be sexed accurately. By using I.P. 9.6% of male bones and 29.31% of female hip bones can be identified correctly. Thus posterior segment length is highly useful in sex determination.

5)Total angle of greater sciatic notch –

Table 6: Total angle of greater sciatic notch

Study	Mean		D.P.	
	M	F	M	F
Hanna & Washburn (1953)[2]	50.4^0	74.4^0	-	-
Singh et al (1978)[6]	65.73^0	83.05^0	<59.01	>86.83
Takahashi (2006)[11]	69.79^0	87.88^0	-	-
Present Study(2008)	62.91^0	79.93^0	<51.22	>86.39

According to all workers the total angle of the notch was greater in females than males. Present study also shows similar results. The difference between the two means is statistically significant. By using D.P., 5.6% of male and 29.31% of female hip bones can be sexed accurately. By using I.P. 51.2% male and 29.31% of female hip bones can be sexed correctly. Thus total angle of greater sciatic notch is very good sex discriminator.

6)Posterior angle of greater sciatic notch –

Table 7: Posterior angle of greater sciatic notch

Study	Mean	
	M	F
Singh et al (1978)[6]	13.06^0	32.15^0
Takahashi (2006)[11]	13.87^0	32.71^0
Present Study(2008)	18.39^0	34.77^0

According to Singh et al (1978), Takahashi (2006), and also in present study, the posterior angle is greater in females than males. The posterior angle of greater sciatic notch in females is more than twice the angle in males. The difference between the two means is statistically significant. By using D.P. 1.6% of male and 41.37% of female hip bones can be identified correctly. By using I.P. 21.6% male and 41.37% female hip bones can be sexed correctly. Thus, this parameter is very useful for sex determination.

Conclusion

To identify the sex of bone very accurately, it is not necessary that all parameters should cross the demarking point. If one parameter of hip bone crosses the demarking point, it determines the sex correctly. However the number of bones identified by D.P. is less than bones identified by I.P. various parameters of greater sciatic notch were measured .Total angle of greater sciatic notch, posterior angle of greater sciatic notch and posterior segment of greater sciatic notch are very useful for sex discrimination as the overlapping of the values is very less. Bones with total angle of GSN $<51.22^0$ are definitely male and $>86.39^0$ are definitely female. Bones with posterior angle $<6.71^0$ are definitely male and $>37.15^0$ are definitely female. Bones with posterior segment <0.52mm(by D.P.) and <5mm(by I.P.) are definitely male and >19.65mm are definitely female. The posterior segment length of greater sciatic notch and the posterior angle of greater sciatic notch both in females are more than twice that in males. Depth of greater sciatic notch is poor sex discriminator as not much difference in values for males and females and no bone can be identified correctly. Width of greater sciatic notch is useful for identifying mainly female bones, but not useful for sex discrimination.

Ethical Clearance

The research work is approved by ethical committee of Dr. V.M. Medical College, Solapur, Maharashtra.

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*Corresponding Author

Dr. Rajashree Sheelawant Raut

Assistant Professor, Department of Anatomy

B. J. Govt. Medical College, Pune- 01

Maharashtra, INDIA.

Email: drrautrajashree@gmail.com