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Original Article

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Estimation of morphometric variations in greater sciatic notch of human hip bones: An anatomical study

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Abstract

***Background & Aims*:** Hip bone is an enigmatic bone and has surprised investigators every time they tried to determine sex by using any part of hip bone. On the other hand, some parts of the hip bone are liable for decomposition and this makes sex determination of deceased more difficult. Thus, in current study we planned to establish the greater sciatic notch as reliable sex indicator.

***Materials & Methods*:** The present study was conducted on 50 adult dry human hip bones of unknown age and sex procured from the postgraduate department of anatomy, Government Medical College, Jammu, India. Later, the sex of bones were identified and various parameters under study including width of notch (AB), depth of notch (OC), posterior segment width of notch (OB), total angle of notch (ACB), posterior angle of notch (BCO), Index I of notch (depth/width×100), and Index II of notch (posterior segment/width ×100) were measured and data were analyzed. The data collected was recorded in Microsoft Excel Spreadsheet, compiled and thus subjected to the appropriate analytical statistical tests (t-test) using SPSS v.17 statistical software. P value below 0.05 was considered as significant.

***Results*:** The results of the current study concluded that the maximum width of the notch (AB), total angle of notch (ACB), posterior segment width of notch (OB), Index I of notch (depth/width×100), and Index II of notch (posterior segment/width ×100) were highly indicative of sexual difference as compared to the depth of the notch (OC) and posterior angle of notch (BCO) (p-values below 0.05).

***Conclusion*:** From the results of the current study it is clearly evident that various morphometric measurements of the greater sciatic notch can also be utilized for sex determination, wherein width, depth, posterior segment of the width, total angle, posterior angle, index I and index II can determine the sex of the individual.

***Keywords*:** Greater Sciatic Notch, Hip Bone, Morphometric Measurements

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Introduction

Apart from Anatomy, in forensic science as well as in archaeological context; gender, age, and stature are considered as the three main factors in Taxonomy and the very first step of identification of any individual includes the determination of sex from its skeletal

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remains (1). The pelvis and the skull are the most dependable sources for determination of sex amongst human bone fragments (2). The hip bone or pelvic girdle has universally been accepted as the most dimorphic bone and the most reliable sex indicator. These sexual differences exhibited by human hip bone are present right from the fetal stage (3).

The pelvis is one of the most massive parts of the skeleton that decomposes at a slightly slower pace than others and can thus serve these purposes, as proven in a number of recent studies. But even so, some portions are more susceptible to damage than others because it is shielded by only a thin, fragile shell of cortical bone (4, 5). However, the greater sciatic notch (GSN) and acetabulum which is located in the central portion of the hip bone are well-preserved anatomical structures that are resistant to damage, and thus can often be scored for identification of deceased with poorly preserved skeletal remains. They exhibit a high degree of sexual dimorphism (SD) among the human population (5, 6). Furthermore, the upper part of greater sciatic notch can be used as a reliable sex indicator as it is not damaged even in pathological conditions (7). It has already been proven in the first half of the twentieth century that the pelvis, particularly the upper and lower openings of pelvis, greater sciatic notch, and sub-pubic angle; have a significant role in determining gender (8, 9).

The greater sciatic notch is especially valuable for determination of sex because it has significant sexual differences. Female sciatic notches are wider, open and have lower width to depth ratio; while in males, the greater sciatic notch tends to be narrow and U- shaped (5, 10, 11). Coherently, males and females have different greater sciatic notch shapes due to a sex-linked adaptation of the pelvis for locomotion and reproduction in the context of a large brain size and encephalization of the fetus during evolution (1, 5, 12). With this much background, it is clearly evident that human hip bones (os coxae) can be widely used as a reliable indicator for sex determination.

Traditionally, non-metric methods were used to assess sex from the hip bones of deceased but these methods have their own limitations like inter and intra-observer variation, expertise, standardization errors, etc. In light of above facts regarding hip bone as reliable indicator for sex determination and limitations of non-metric methods; through this study, it was attempted to objectify the morphometric differences in greater sciatic notch of both sexes and develop the morphometry as a reliable tool for sexual assessment of human hip bones.

Materials & Methods

The current descriptive observational study was conducted on 50 dry adult human hip bones of unknown sex and age which were procured from the postgraduate department of anatomy, Government Medical College, Jammu, India. The bones included in the study were completely ossified, were devoid of any malformations (both congenital as well as pathological), and were not broken or incomplete with intact greater sciatic notch. At first, the sex of the hip bones was decided on the basis of certain morphological features. The morphological features used for assessing sex were acetabular diameter, obturator foramen, ischiopubic ramus, ischial tuberosity, and pre-auricular sulcus. For measuring the variables under study, three points were marked on the bone i.e., point A- as Ischial spine, point B- as Piriformis Tubercle, and point C- as Deepest point of greater sciatic notch. Later, for each of the hip bones, the following seven variables confined to the grater sciatic notch were measured with the help of sliding vernier calipers:

1. Width of notch (AB)
2. Depth of notch (OC) where O is the point where perpendicular drawn from C intersects the imaginary line joining A and B.
3. Posterior segment width of notch (OB)
4. Total angle of notch (ACB)
5. Posterior angle of notch (BCO)
6. Index I of notch (depth/width×100)
7. Index II of notch (posterior segment/width×100)

The data collected was recorded in Microsoft Excel Spreadsheet, compiled and thus subjected to the appropriate analytical statistical tests (t-test) using SPSS v.17 statistical software.

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Results

50 human dry hip were studied. Out of which 25, were of male and 25 were of female. There was a significant difference observed in all the parameters under study between male and female hip bones. There was highly and statistically significant differences for maximum width of notch (AB), depth of notch, maximum posterior segment width of notch (OB), total angle of notch (ACB), index I (OC/AB X100), and index II (OB/ABX100).

The data obtained for different parameters under study of male and female hip bones were noted and tabulated as in Table 1. These results were then compared for sex determination; it was observed that there were variations in size of the various parameters. Conclusively, it was inferred that maximum width of greater sciatic notch (AB), posterior segment of width (OB), total angle of greater sciatic notch (ACB), index I, and index II were highly indicative of sex (p values <0.001) of unknown hip bones as compared to the maximum depth (OC) and posterior angle (BCO) of greater sciatic notch.

Table1: Comparison of all the parameters of greater sciatic notch in male and female hip bones

Parameters		N	Mean	Std. Deviation	Significance	
					t-value	p-value
Maximum width AB (in cm)	Males	25	3.6375	.25676	-12.035	<0.001
	Females	25	4.8917	.44126		
Maximum depth OC (in cm)	Males	25	2.6167	.28387	-3.169	0.003
	Females	25	2.9042	.34196		
Posterior segment of width OB (in cm)	Males	25	1.0667	.31021	-8.441	<0.001
	Females	25	1.8833	.35834		
Total angle ACB (in degree)	Males	25	64.312	4.63402	-5.388	<0.001
	Females	25	77.166	10.7285		
Posterior angle BCO (in degree)	Males	25	22.458	7.19287	-3.334	0.002
	Females	25	30.125	8.66935		
Index I (OC/AB X100)	Males	25	72.085	7.68689	5.601	<0.001
	Females	25	59.675	7.66432		
Index II (OB/AB X100)	Males	25	29.195	7.93581	-4.538	<0.001
	Females	25	38.424	6.02566		

Discussion

The present study was conducted on 50 dry human hip bones which were procured from the postgraduate department of anatomy, Government Medical College, Jammu, India. These bones were then classified as male and female depending upon various morphological parameters. Then the various parameters related to greater sciatic notch (GSN) were measured taking three landmarks into consideration i.e., point A- as Ischial spine, point B- as Piriformis Tubercle and point C- as Deepest point of GSN. The results were tabulated and it was statistically inferred that mean width of GSN was 3.6375± 0.25676 cm in case of males and 4.8917±0.44126 cm in case of females, which was a statistically significant variation (p<0.001). These findings were supported positively by evidence derived from the literature of Alizadeh et al. in 2013 (13), Dnyanesh et al. in 2013 (15), Hadzihalilovic et al. in 2021 (16), Manoj et al. in 2019 (18), and Kalsey et al. in 2011 (19), but the relationship was documented as statistically insignificant by some other authors like Singh et al.in 1978 (12), Sharma et al. in 2021 (14), and Davivongs et al. in 1963 (17). Also, in afore mentioned study it was concluded that GSN was wider in females

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as compared to males similar to the findings of Devades et al. (2017), Kalsey et al. (3), Singh et al. (12), Alizadeh et al. (13), Sharma et al. (14), Dnyanesh et al. (15), Hadzihalilovic et al. (16), Davivongs et al. (17), Manoj et al. (18), and Kalsey et al. (19). Howevwer, dimensions mentioned in these referred literature was variable which can be attributed to racial and ethnic differences.

While analyzing the observations of maximum depth of the greater sciatic notch, it was inferred that maximum depth was more in females as compared to males with mean standing out at 2.9042 ± 0.34196 cm in case of females and 2.6167 ± 0.28387 cm in case of males with significant p value of 0.003. These findings were negated by various investigators as they concluded that depth of greater sciatic notch was more in males as compared to females (1, 7, 12, 14, 15, and 18). However, the results of current study were in concordance with the observations of other authors including Alizadeh et al. (13), Hadzihalilovic et al. (16), Davivongs et al. (17), and Kalsey et al (19).

The results of the present study concluded that posterior segment of width of greater sciatic notch was 1.0667 ± 0.31021 cm in case of males and 1.8833 ± 0.35834 cm in females with a statistically highly significant difference ($p < 0.001$). The data however inferred that posterior segment of width of greater sciatic notch was greater in females as compared to males, and such difference was also documented in past literature as well including studies of Singh et al. (12), Alizadeh et al. (13), Dnyanesh et al. (15), Davivongs et al. (17), Manoj et al (18), and Kalsey et al (19).

The inference drawn from results of the current study about the total angle of greater sciatic notch (ACB) was that it is more in females as compared to males with highly significant p value below 0.001. This conclusion was in concordance with the findings of Takahashi et al. (4), Manoj et al. (6), Singh et al. (12), Sharma et al. (14), and Dnyanesh et al. (15). However, the posterior angle (BCO) of the greater sciatic notch was also more in females with respect to males but it carried only significant p value of 0.002. Various investigators also concluded that the posterior angle of the notch is more in case of females as compared to males like studies of Takahashi et al. (4), Manoj et al. (6), Singh et al. (12), Sharma et al. (14), and Dnyanesh et al. (15). However the p value quoted by them was highly significant which was not the case in present study.

The values of the indices of greater sciatic notch calculated from the observations of present study concluded that index I was more in males as compared to females but on the contrary, index II was more in females as compared to males, although both carried statistically highly significant p values of below 0.001. These results were in accordance with the results of Manoj et al. (6), Singh et al. (12), Sharma et al. (14), and Dnyanesh et al. (15), but Takahashi et al. (4) reported the results of indices in converse as they stated that index I is more in females as compared to males and index II being more in males as compared to females.

Conclusion

Hip bone has been the most reliable sex indicator of the skeletal remains of the deceased since ages. From the results of current study, it is evident that various morphometric measurements of the greater sciatic notch can also be utilized for sex determination wherein width, depth, posterior segment of the width, total angle, posterior angle, index I, and index II can determine the sex of the individual. Furthermore, width and the posterior segment of the width of the greater sciatic notch along with total angle, index I, and index II were more precise in assessing the sex of an individual. Thus, greater sciatic notch can be used as a tool for diagnosing the sex of a person from the skeletal remains.

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No Declared

Conflict of interest

No conflict of interest declaration between the authors.

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Ethical statement

The hip bones used in this study were obtained from the postgraduate department of anatomy, Government Medical College, Jammu, India, with their permission.

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