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Original Research Article

Investigation of Different Parameters of Greater Sciatic Notch in Hip Bone for Sex Determination: An Observational Prospective Radiological and Morphometric Study Conducted In Eastern Bihar

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Abstract

Objective & Aim: Anatomical, forensic, obstetrical, radiological, and anthropological perspectives are all interested in the human skeleton because of its unique shape and obvious sexual dimorphism. The study's objective is to examine the morphometric relationship between sexual dimorphism in the North Indian population and the bigger sciatic notch of the dry hip bone.

Methods: For the investigation, 70 adult dry hip bones of known sex—42 male and 28 female—were gathered. Every bone was completely ossified and flawless. Measurements were taken with a triflanged stainless steel calliper, and data were collated by gender and statistically analyzed using the unpaired student t-test. The following Greater Sciatic Notch parameters were taken into account and measured in millimeters. The parameters include Index I and Index II, Posterior Segment Width (OB), Maximum Depth (OC), and Maximum Width (AB).

Results: The t test indicates that the posterior angle, Genoves' sciatic notch index, and the posterior segment of Greater Sciatic Notch are significant ($P < 0.001$). It was discovered that the larger sciatic notch's posterior angle was extremely important for identifying the hip bone's sex.

Conclusion: It was discovered that a hip bone's posterior segment, posterior angle, and index II were more useful in determining sex.

Keywords: Hip Bone, Sciatic Notches, Posterior segment, Posterior angle and.

Introduction

One of the crucial issues that is addressed when human skeletal remains are discovered in forensic investigations and historical demographic research is determining the sex of an unknown individual. Therefore, anthropologists, forensic specialists, and anatomists are all interested in the study of sexual dimorphism of bones in the human population [1].

Individual anatomical variations and deviations from established norms within each sex have been permitted by nature. Furthermore, a variety of etiological factors, including genetic, environmental, and cultural factors, influence these variances [2]. Because it not only illustrates the fundamental variations between the sexes but also the unique adaption of the female hip bone for childbearing, the hip bone is a perfect bone for determining sex. Because it is extremely sexually dimorphic and damage-resistant, the larger sciatic notch is particularly important in these circumstances and is frequently scored in skeletons that are not well preserved. Determining the sex of skeletal remains is now easier and more accurate because to the development of the metric approach, often known as the exact measurement method.

Sexing fragmented remains may be possible using methods that call for measuring the diameters, circumferences, or cross sectional areas of tubular bones [3,4]. Numerous recent studies have demonstrated that the pelvis can fulfill these functions because it is one of the largest and slowest-decomposing portions of the skeleton. However, because it is only protected by a thin, brittle layer of cortical bone, some parts are more vulnerable to destruction than others [5,6]. However, the acetabulum, which is situated in the middle part of the hip bone, and the greater sciatic notch (GSN) are both well-preserved anatomical structures that are resistant to deterioration. As a result, they may frequently be scored to identify deceased people whose skeletal remains are poorly preserved. Among the human population, they show a significant level of sexual dimorphism (SD) [6,7]. Furthermore, even under diseased situations, the upper portion of the greater sciatic notch remains intact, making it a dependable sex indication [8]. The pelvis, specifically the larger sciatic notch, sub-pubic angle, and upper and lower pelvic apertures, has been shown to play a major role in determining gender in the first half of the 20th century [9,10]. The study's objective is to examine the morphometric relationship between sexual dimorphism in the North Indian population and the bigger sciatic notch of the dry hip bone. According to the current study, the 'sex factor' has an effect on the shape of the hip bone's larger sciatic notch.

Materials & Methods

Seventy dry adult human hip bones were used in the current descriptive observational study. The bones were obtained from the postgraduate department of anatomy and FMT department at Jawahar Lal Nehru Medical College & Hospital, Bhagalpur, Bihar, India. The study's bones were fully ossified, free of congenital and pathological abnormalities, and had an intact greater sciatic notch. They were also not shattered or incomplete. Initially, specific morphological characteristics were used to determine the sex of the hip bones. Acetabular diameter, obturator foramen, ischiopubic ramus, ischial tuberosity, and pre-auricular sulcus were the physical characteristics utilized to determine sex. Three points—point A for the ischial spine, point B for the Piriformis Tubercle, and point C for the deepest point of the larger sciatic notch—were marked on the bone in order to measure the variables under investigation. Later, using sliding vernier calipers, the following seven characteristics specific to the grater sciatic notch were assessed for each of the hip bones:

1. Notch width (AB)
2. Depth of notch (OC), where O is the intersection of the imaginary line connecting A and B with the perpendicular drawn from C.
3. The notch's posterior segment width (OB)
4. The notch's total angle (ACB)
5. The notch's posterior angle (BCO)
6. The notch's index (depth/width) (100)
7. The notch's index (posterior segment/width 100).

On the complete portions of normal bones, all linear measurements were taken in millimeters. To find any intra- and inter-observer variability in these methods, two independent observers repeated each measurement twice.

Statistical Methods

Using statistical indicators, the results are explained, recorded, and displayed as absolute, relative, and statistical values. The normality of distribution for continuous variables was examined using the Shapiro-Wilk and Kolmogorov-Smirnov tests. The arithmetic mean, standard deviation, and standard error were utilized to display the mean values because there was no statistically significant divergence from the normal distribution ($p>0.05$). An independent t-test was then used to compare the two groups.

Pearson correlation tests were used to determine the direction and strength of the link between the variables. Microsoft Excel (version 11. Microsoft Corporation, Redmond, WA, USA) and SPSS for Windows (version 19.0, SPSS Inc., Chicago, Illinois, USA) were utilized for statistical analysis.

Results

Seventy hip bone from humans were examined. Of these, 42 belonged to men and 28 to women. All of the measures that were being examined showed a substantial difference between the hip bones of males and females. The maximum width of the notch (AB), depth of the notch, maximum posterior segment width of the notch (OB), total angle of the notch (ACB), index I (OC/AB X100), and index II (OB/ABX100) all showed substantially and statistically significant differences.

There are several morphometric differences between the male and female pelvic bones, according to our analysis of the different metrics used in this study to determine the sexual dimorphism of the pelvic bone. Male and female hip bone morphometric measurements of the greater sciatic notch differed significantly in this study, with the exception of bone depth.

Table 1: Findings for different greater sciatic notch parameters

Variable	Gender	N	Mean ± SD	t-value	p value
Breadth	Male	42	3.74±0.573	-13.318	<0.001
	Females	28	4.18±0.621		
Post Segment	Male	42	0.852±0.163	-2.989	<0.001
	Females	28	1.163±0.548		
GSI	Male	42	725.83±321.74	-9.251	<0.001
	Females	28	382.31±112.76		
Depth	Male	42	2.612±0.437	-6.211	<0.001
	Females	28	2.324±0.438		
Total Angle	Male	42	68.39±8.993	- 4.826	<0.001
	Females	28	79.89±10.272		
Posterior Angle	Male	42	17.02±6.296	-3.092	<0.001
	Females	28	30.01±7.743		

Table 2 depicts the comparable values (Mean ± SD) of the Mean of Index I for the right and left hip bones in men and women. With a p-value of less than 0.001, it was discovered that the male had considerably lower greater sciatic notch Index I and II than the female.

Table 2: Comparison of the Mean of Index I for the right and left hip bones in men and women

Variable	Gender	N	Mean ± SD	t-value	p value
Index I (Right)	Male	42	51.14±11.572	-4.239	<0.001
	Females	28	66.86±8.591		
Index I (Left)	Male	42	18.21±6.722	-6.022	<0.001
	Females	28	28.51±8.021		
Index II (Right)	Male	42	28.90 ±7.553	-5.038	<0.001
	Females	28	36.64 ±8.021		
Index II (Left)	Male	42	28.62 ±6.658	-7.008	<0.001
	Females	28	34.21 ±8.372		

Discussion

Even though the greater sciatic notch was first noticed in 1875, determining its width proved to be challenging. Regardless of the side of the bone, it was discovered that females had a substantially broader greater sciatic notch than males. There are a number of parameters that can be used with some degree of accuracy for determining gender using hip bones. One of the greatest bones for that is the hip, particularly when articulated in a full pelvis with the sacrum, which makes it a rich source of information for determining gender. Only a small number of these markers, thought to be the most specific for determining gender, were observed osteometrically for this study.

The breadth ranges for males and females in the current study are 3.74±0.573 and 4.18±0.621, respectively. Accordingly, women's mean values are higher than men's, which is consistent with Sing and Potturi's study [11]. Similar findings have previously been reported by Derry [12], Thomson [13], and Verneau [14]. Our research's mean values nearly equal those of the Sing and Potturi study [11]. The P value, which is substantial and consistent with earlier research, is 0.0001.The male posterior segment ranges in the current study are 0.852±0.163 and 1.163±0.548, respectively. Females have a mean posterior segment length that is twice as long. Therefore, the posterior section of the larger sciatic notch is further in females, which is consistent with Davivongs' findings [15].

In the current study, the likelihood of a difference in the posterior section of the larger sciatic notch between males and females occurring by chance is less than 0.0001. There is a statistically significant difference. Therefore, compared to men, women have a bigger posterior section of the greater sciatic notch. These results are consistent with the study conducted by Sing and Potturi [11].

In the current study, the GSI ranges for males and females are 725.83±321.74 and 382.31±1112.76, respectively. The following compares the findings of the current investigation with those of the earlier study. The P value is considerable and consistent with the findings of earlier research. By using the demarking point method, it was possible to identify the objective sex from hip bones using Genoves' Sciatic Notch Index with an accuracy of 99.75% in 21.4% of male hip bones.

The Depth of Greater Sciatic Notch mean values for males and females are 2.612±0.437 and 2.324±0.438, respectively. In males, both studies reveal a deeper notch. Similar to the previous study [11,16], the P value of Depth in this one is 0.001, indicating significance.

Although both had statistically significant p values below 0.001, the values of the greater sciatic notch indices derived from the current study's observations showed that index I was higher in males than in females, while index II was higher in females than in males. Manoj et al. [7], Singh et al. [11], Sharma et al. [18], and Dnyanesh et al. [19] all reported similar results. However, Takahashi et al. [5] reported the opposite, stating that index I is higher in females than in males and index II is higher in males than in females.With a highly significant p value < 0.001, the current study's findings on the total angle of larger sciatic notch (ACB) indicated that it is greater in females than in males.

Accordingly, the data above indicate that there are statistically significant differences between the hip bones of men and women (defined by the index of the upper part of the greater sciatic notch) in terms of both the overall width of the greater sciatic notch and the width of the upper part of the greater sciatic notch. Within our sample, there are no statistically significant differences between the larger sciatic notch depths of male and female bones. Weight, width, and length, as well as sexual differences in the pelvic index, were used by the authors of the Purohit et al. study to examine sexual differences in 57 pelvic bones. The authors came to the conclusion that while the mean weight of the right pelvic bones was lower in both genders than the mean weight of the left, the mean values of pelvic bone weight were bigger in men than in women. Compared to the right side, the left side had greater mean values for pelvic bone width and length. In comparison to the female pelvis, the male pelvis had a greater coxal index [20].

Lastly, we draw the conclusion that, in terms of osteometric features, there were statistically significant differences between the right and left hip bones in our entire sample. According to certain research, while identifying a person's gender from their hip bones, it's crucial to consider the skeleton's age. This was a drawback of our study because the isolated hip bones and pelvises came from individuals whose ages were unknown.

Numerous transitional forms in gender prediction should be included in anatomical-anthropological assessments of the human skeleton. For males, these can vary from hyperandroid to unandroidal type, and for females, from hyperginoid to unginoid type [21]. Osteometric-quantitative investigations are therefore more objective in their technique, which is why we chose to use it. Five factors were employed in one study on hip bones to develop precise models of their ideal appearance.

These criteria were divided into three categories based on appearance: transitional form, female, and male. By eliminating the subjective element, this system decreased the likelihood of prejudice. Preauricular surface, bigger sciatic notch, composite arch, lower pelvic edge, and ischiopubic percentage were the factors that were noted. A schematic universal male or universal female form appropriate for long-term longitudinal investigations was identified for each of these criteria, and they were further categorized into one of two groups. The form was categorized as transitional or indefinite if it did not match any of the provided universal forms. Gender prediction accuracy was 95% based on the analyzed data [22]. Specifically, several writers [23,24] estimate gender based on hip and pelvic bones using classical morphometry, which is also what we did.

It is also crucial to set population norms for gender determination [25]. According to a study conducted in Nigeria on 518 pelvises ranging in age from 17 to 78 years, variations in the characteristics obtained cannot be interpreted as significant for establishing gender. The study also recommended further research that takes into account different climates and compares the results. [26]. When applied to populations other than the one for which they were designed, discriminant functional analysis formulas for predicting gender dimorphism between, say, African Americans and Americans of European descent are less accurate [26]. Since our study focused on the pelvic and hip bones of the Bosnian population, we were guided by the proposal for forensic medical expertise based on the human skeleton [25], which is a guarantee of the most effective anthropological evidence when population criteria are followed.

Conclusion

The t test indicates that the posterior angle, Genoves' sciatic notch index, and the posterior segment of Greater Sciatic Notch are significant (P < 0.001). It was discovered that the larger sciatic notch's posterior angle was extremely important for identifying the hip bone's sex. Males' Posterior Angle of Greater Sciatic Notch ranged from 7° to 32°, while females' ranged from 10° to 41°. Our current research has demonstrated that the posterior region of the greater sciatic notch is where the majority of the widening of the notch, which causes the female pelvis to be broad, occurs. In males, the larger sciatic notch's total angle ranged from 50° to 90°, while in females, it ranged from 48° to 100°. Therefore, women's greater sciatic notch is wider than men's. Therefore, by measuring the Posterior Angle of Greater Sciatic Notch, we can accurately determine the sex of an unknown hip bone.

Article information

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Author contributions:

Ravish Ranjan: Conceptualization; Formal analysis; Methodology; Writing—original draft; data collection.
Waquar Ahmed: Conceptualization; Formal analysis; Methodology; Writing—original draft; data collection.
Nirmaja Jha: Conceptualization; Formal analysis; Methodology; Writing—original draft; data collection.
Santanu Pras: Conceptualization; Formal analysis; Methodology; Writing—original draft; data collection.

Conflict of interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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