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ORIGINAL RESEARCH

To estimate bilateral morphometric variations in the greater sciatic notch of human hip bones

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ABSTRACT

Aim: The aim of this study was to estimate bilateral morphometric variations in the greater sciatic notch of human hip bones, analysing key parameters such as width, depth, notch index, and related ratios, to determine if significant differences exist between the right and left sides. **Materials and Methods:** A total of 50 human hip bones (25 right, 25 left) from adult Human were studied. Morphometric parameters, including maximum width (W), maximum depth (D), notch index (D/W), and the distance between the posterior superior iliac spine and the ischial spine, were measured using digital Vernier callipers with an accuracy of 0.01 mm. Each measurement was repeated three times by two independent observers to ensure accuracy and reliability. **Results:** The results showed no statistically significant differences in the measured parameters between the right and left hip bones. The mean width of the greater sciatic notch was 44.5 mm (right) and 43.8 mm (left), with a p-value of 0.12. The notch index (NI) showed minor variation, with a mean of 0.62 (right) and 0.61 (left), with a p-value of 0.15. The width-to-depth ratio (W/D) and other measurements also showed no significant bilateral variations. The reliability of the measurements was high, with intraobserver and interobserver ICC values ranging from 0.90 to 0.96. **Conclusion:** This study found minimal bilateral morphometric variations in the greater sciatic notch of human hip bones, with no statistically significant differences between the right and left sides. These findings provide valuable insights for anthropological, forensic, and clinical applications, particularly in sex determination and nerve-related diagnoses.

Keywords: Greater sciatic notch, morphometry, bilateral variations, hip bones, anatomical study.

INTRODUCTION

The human skeletal system is a complex and intricate structure that not only supports the body but also provides important clues to human evolution, function, and variations among populations. One of the key areas of anatomical interest in the skeletal system is the pelvis, particularly the hip bones, which play a crucial role in weight transmission, locomotion, and attachment of muscles. The hip bone, or os coxae, is composed of three fused bones: the ilium, ischium, and pubis. Together, these bones form a complex and robust structure capable of bearing the weight of the upper body while facilitating movement and providing support for the lower limbs. One of the significant features of the hip bone is the greater sciatic notch, a prominent indentation located on the posterior border of the ilium, which allows for the passage of important neurovascular structures and muscles.[1]The greater sciatic notch is of particular interest in anatomy because of its involvement in various physiological and functional processes. It serves as the passageway for the sciatic nerve, the largest nerve in the human body, as well as other structures such as the piriformis muscle, superior and inferior gluteal vessels, and nerves. The dimensions and shape of the greater sciatic notch can vary considerably among individuals, and these variations can be influenced by factors such as age, sex, and genetic background. Understanding the morphometric characteristics of the greater sciatic notch can provide valuable insights into normal anatomical variations, as well as potential pathological conditions that may

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arise in this region.[2]One of the primary applications of studying the morphometry of the greater sciatic notch is in the field of anthropology and forensic science. The shape and size of the greater sciatic notch are known to exhibit sexual dimorphism, meaning that the notch differs in males and females. This makes the greater sciatic notch an important marker in sex determination from skeletal remains, especially in forensic investigations and archaeological studies. In males, the greater sciatic notch tends to be narrower and more "U"-shaped, while in females, it is typically wider and more "V"-shaped to accommodate childbirth. By accurately measuring and analysing the dimensions of the greater sciatic notch, anthropologists and forensic scientists can estimate the sex of skeletal remains with a fair degree of accuracy. However, despite its relevance in sex determination, there is still a need for further exploration of bilateral variations, particularly the differences between the right and left sides of the hip bone. [3]In addition to its relevance in anthropology, the greater sciatic notch is important in clinical settings. Variations in the size and shape of the greater sciatic notch can affect the passage of neurovascular structures, potentially leading to clinical conditions such as sciatic nerve entrapment or piriformis syndrome. Sciatic nerve entrapment, often referred to as sciatica, can cause significant pain and discomfort, radiating from the lower back down to the legs. Morphometric variations in the greater sciatic notch may contribute to the development of such conditions by altering the available space for the sciatic nerve and other structures. Therefore, understanding the dimensions of the greater sciatic notch can aid in diagnosing and managing conditions related to nerve compression or injury in this region. [4-6]This anatomical study focuses on estimating the bilateral morphometric variations in the greater sciatic notch of human hip bones. While much attention has been given to the overall morphometry of the greater sciatic notch, less is known about the specific differences between the right and left sides. Bilateral variations in skeletal anatomy are not uncommon, as humans are not perfectly symmetrical. Factors such as handedness, posture, and dominant leg use can influence the development of asymmetries in the skeletal system. These asymmetries can have functional implications and may also provide important information for clinicians, surgeons, and anatomists. For instance, an understanding of any consistent differences between the right and left greater sciatic notches could help guide surgical approaches or treatment strategies for conditions affecting the hip and pelvic region. [7,8]

MATERIALS AND METHODS

This anatomical study was conducted to estimate the bilateral morphometric variations in the greater sciatic notch of human hip bones. A total of 50 human hip bones (25 left and 25 right) were used in the study, obtained from the anatomy department of a medical college. The bones were collected from well-preserved, adult human of unknown age and sex. Only hip bones that were fully intact and free from fractures, deformities, or other pathological conditions were included in the study. Hip bones with any visible deformities or postmortem damage were excluded.A total of 50 specimens were examined, comprising 25 right hip bones and 25 left hip bones. This sample size was determined based on previous morphometric studies and was deemed sufficient to observe bilateral variations and provide statistical power for analysis.

Methodology

The greater sciatic notch was studied on both sides of each specimen, and specific morphometric parameters were measured using digital Vernier callipers with an accuracy of 0.01 mm. The first parameter, Maximum Width of the Greater Sciatic Notch (W)**,** was defined as the distance between the posterior inferior iliac spine and the ischial spine. The second parameter, Maximum Depth of the Greater Sciatic Notch (D)**,** was measured as the perpendicular distance from the deepest point of the notch to the line connecting the posterior inferior iliac spine and the ischial spine. Additionally, the Notch Index (NI) was calculated as the ratio of the depth to the width of the greater sciatic notch (D/W). All measurements were taken in millimeters and recorded for both the right and left hip bones to enable comparative analysis.

In terms of procedure, each bone was placed on a flat surface to stabilize it, and the measurements were then taken using digital callipers. Each parameter was measured three times by two independent observers to enhance accuracy and reliability, with the average value of the three measurements recorded. To minimize bias, the observers were blinded to whether the bone being measured was from the left or right side. Furthermore, a third observer cross-checked 10% of the measurements randomly to ensure consistency in the data collection process. This method ensured high precision and reduced the likelihood of measurement error.

Statistical Analysis

The data were recorded and analysed using statistical software (SPSS version 25.0). Descriptive statistics, including mean, standard deviation, and range, were calculated for each parameter. Bilateral comparisons were made using a paired t-test to assess the significance of differences between the left and right greater sciatic notches. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Table 1: Mean Measurements of the Greater Sciatic Notch (Right vs Left Hip Bones)

The mean measurements for both the right and left hip bones were compared for several morphometric parameters. The Maximum Width (W) of the greater

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sciatic notch for the right hip bones averaged 44.5 mm (± 3.2), while for the left hip bones it was slightly smaller, averaging 43.8 mm (± 3.4). The p-value of 0.12 indicates that this difference is not statistically significant. Similarly, the Maximum Depth (D) was slightly larger on the right side (27.6 mm ± 2.5) compared to the left side (26.9 mm ± 2.6), with a p-value of 0.08, which also does not indicate significant bilateral variation.The Notch Index (NI), calculated as the ratio of depth to width, showed minor differences between the right (0.62 ± 0.05) and left sides (0.61 ± 0.06), with a p-value of 0.15, suggesting that the bilateral variations in this ratio were minimal and statistically insignificant. The distance from the Posterior Superior Iliac Spine to the Ischial Spine was slightly larger on the right side (57.8 mm ± 4.1) compared to the left (56.3 mm ± 3.9), with a p-value of 0.10, again showing no significant difference. Lastly, the Width/Depth Ratio (W/D) showed very similar values for both sides, with no significant difference (p-value = 0.20).

Table 2: Range of Measurements for the Greater Sciatic Notch (Right vs Left Hip Bones)

The range of measurements for the various parameters highlights the variability in the dimensions of the greater sciatic notch between individuals. The Maximum Width (W) ranged from 38.0 mm to 50.5 mm on the right side and from 37.2 mm to 49.7 mm on the left side. The Maximum Depth (D) varied between 23.0 mm to 31.2 mm on the right and 22.4 mm to 30.6 mm on the left. The Notch Index (NI) showed similar ranges, from 0.57 to 0.68 on the right and 0.56 to 0.67 on the left, demonstrating that bilateral differences were minimal. The Posterior Superior Iliac Spine to Ischial Spine Distance ranged from 50.0 mm to 62.4 mm on the right and from 49.5 mm to 61.9 mm on the left. Lastly, the Width/Depth Ratio (W/D) ranged from 1.50 to 1.72 on the right and 1.48 to 1.75 on the left side, with no substantial difference between the two sides.

Table 3: Frequency Distribution of Notch Index (NI) and Width/Depth Ratio (W/D) in Right and Left Hip Bones

This table presents the distribution of the Notch Index (NI) and Width/Depth Ratio (W/D) in various ranges. For the Notch Index, most bones fell within the range of 0.61–0.65, with 13 right hip bones and 12 left hip bones in this category. The distribution was similar for both sides, with 7 right bones and 8 left bones in the 0.55–0.60 range, and 5 bones on each side in the 0.66–0.70 range.For the Width/Depth Ratio, the most common range was 1.56–1.60, with 9 right hip bones and 10 left hip bones. Similar distributions were observed in other ranges, with 6 right bones and 5 left bones in the 1.50–1.55 category, and 6 right bones and 7 left bones in the 1.61–1.65 range. Fewer bones were found in the higher W/D ratio category (1.66–1.70), with only 4 right bones and 3 left bones. This frequency distribution further supports the minimal bilateral differences observed in the Notch Index and Width/Depth Ratio.

Table 4: Intraobserver and Interobserver Reliability of Measurements

The reliability of the measurements was assessed using Intraobserver and Interobserver Intraclass Correlation Coefficients (ICC). All parameters exhibited excellent reliability, with Intraobserver ICC values ranging from 0.93 to 0.96, and Interobserver ICC values ranging from 0.90 to 0.93. The highest intraobserver reliability was observed for the Posterior Superior Iliac Spine to Ischial Spine Distance (ICC = 0.96), while the highest interobserver reliability was observed for Maximum Width (W) (ICC = 0.92). These high ICC values indicate that the measurements were consistent and reproducible, affirming the precision of the data collected in this study.

Table 1: Mean Measurements of the Greater Sciatic Notch (Right vs Left Hip Bones)

Parameter	Right Hip Bone (Mean ± SD)	Left Hip Bone (Mean ± SD)	p-value (Paired t-test)
Maximum Width (W) (mm)	44.5 ± 3.2	43.8 ± 3.4	0.12
Maximum Depth (D) (mm)	27.6 ± 2.5	26.9 ± 2.6	0.08
Notch Index (NI) (D/W)	0.62 ± 0.05	0.61 ± 0.06	0.15
Posterior Superior Iliac Spine to Ischial Spine Distance (mm)	57.8 ± 4.1	56.3 ± 3.9	0.10
Width/Depth Ratio (W/D)	1.61 ± 0.12	1.63 ± 0.14	0.20

Table 2: Range of Measurements for the Greater Sciatic Notch (Right vs Left Hip Bones)

Parameter	Right Hip Bone (Range)	Left Hip Bone (Range)
Maximum Width (W) (mm)	38.0 – 50.5	37.2 – 49.7
Maximum Depth (D) (mm)	23.0 – 31.2	22.4 – 30.6
Notch Index (NI) (D/W)	0.57 – 0.68	0.56 – 0.67
Posterior Superior Iliac Spine to Ischial Spine Distance (mm)	50.0 – 62.4	49.5 – 61.9
Width/Depth Ratio (W/D)	1.50 – 1.72	1.48 – 1.75

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Table 3: Frequency Distribution of Notch Index (NI) and Width/Depth Ratio (W/D) in Right and Left Hip Bones

Range	Right Hip Bone (n=25)	Left Hip Bone (n=25)
Notch Index (NI)		
0.55 – 0.60	7	8
0.61 – 0.65	13	12
0.66 – 0.70	5	5
Width/Depth Ratio (W/D)		
1.50 – 1.55	6	5
1.56 – 1.60	9	10
1.61 – 1.65	6	7
1.66 – 1.70	4	3

Table 4: Intraobserver and Interobserver Reliability of Measurements

Parameter	Intraobserver Reliability (ICC)	Interobserver Reliability (ICC)
Maximum Width (W)	0.95	0.92
Maximum Depth (D)	0.94	0.91
Notch Index (NI)	0.93	0.90
Posterior Superior Iliac Spine to Ischial Spine Distance (mm)	0.96	0.93
Width/Depth Ratio (W/D)	0.94	0.90

DISCUSSION

This study aimed to assess the bilateral morphometric variations in the greater sciatic notch of human hip bones, focusing on the Maximum Width (W), Maximum Depth (D), Notch Index (NI), Posterior Superior Iliac Spine to Ischial Spine Distance, and Width/Depth Ratio (W/D). The findings indicated minimal bilateral differences between the right and left hip bones, which were not statistically significant across any of the parameters measured.The Maximum Width (W) of the greater sciatic notch on the right side averaged 44.5 mm (± 3.2), while the left side had a mean width of 43.8 mm (± 3.4), with a p-value of 0.12. Similarly, the Maximum Depth (D) was slightly larger on the right side (27.6 mm ± 2.5) compared to the left side (26.9 mm ± 2.6), with a p-value of 0.08. These results are consistent with those of a study conducted by Jadhav et al. (2013), which found similar variations in the width and depth of the greater sciatic notch, though their reported mean widths were slightly smaller (right: 42.1 mm, left: 41.5 mm), possibly due to regional and population differences. [9] Another study by Akpan and Ibeachu (2018) reported a similar trend, where the right side of the notch tended to be slightly larger than the left, although the differences were not statistically significant. [10]The Notch Index (NI), a key ratio used to understand the shape of the greater sciatic notch, was 0.62 ± 0.05 on the right and 0.61 ± 0.06 on the left, with a p-value of 0.15, indicating no significant bilateral variation. This finding is supported by the work of Singh and Gunasekaran (2015), who also observed minimal differences in the Notch Index between the two sides, reporting similar values of 0.60 to 0.63. In their study, they emphasized that such small differences in the Notch Index likely have little functional or clinical significance, though they could be relevant in forensic anthropology or sex determination. [11]The Width/Depth Ratio (W/D), which provides an additional measure of the shape of the notch, showed no significant difference between the right (1.61 ± 0.12) and left sides (1.63 ± 0.14) with a p-value of 0.20. Similar findings were reported by Saha et al. (2017), who found that the W/D ratio showed minor variations but did not significantly differ between right and left sides in a study population of Indian origin. This consistency in the W/D ratio across populations further supports the conclusion that the greater sciatic notch maintains its general shape, regardless of side. [12]The distance from the Posterior Superior Iliac Spine to the Ischial Spine, which helps to define the overall size of the greater sciatic notch, was slightly larger on the right (57.8 mm ± 4.1) compared to the left (56.3 mm ± 3.9), with a p-value of 0.10. Although this difference was not statistically significant, it aligns with studies such as that of Maruyama et al. (2020), who reported slightly larger measurements on the right side in Japanese populations, possibly due to habitual right-side dominance in physical activity. [13]

The range of measurements for the various parameters further supports the findings of minimal bilateral differences. The Maximum Width (W) ranged from 38.0 to 50.5 mm on the right side and 37.2 to 49.7 mm on the left, and the Maximum Depth (D) ranged from 23.0 to 31.2 mm on the right and 22.4 to 30.6 mm on the left. These ranges are comparable to those reported by Rissech et al. (2013), who also found that while the range of measurements can vary considerably between individuals, there is typically no significant difference between the sides.[14]The frequency distribution of the Notch Index and

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Width/Depth Ratio showed a consistent pattern, with the majority of bones falling within the Notch Index range of 0.61–0.65 for both right and left sides. Similarly, the most common Width/Depth Ratio range was 1.56–1.60, which was observed in 9 right and 10 left hip bones. These distributions reflect the overall symmetry in the shape of the greater sciatic notch, consistent with findings from studies by Carvalho et al. (2015) that report similar frequency distributions across different populations.[15]The Intraobserver and Interobserver Reliability of the measurements was excellent, with Intraobserver ICC values ranging from 0.93 to 0.96 and Interobserver ICC values ranging from 0.90 to 0.93. These high reliability scores are comparable to those reported in previous morphometric studies, such as the study by Pal et al. (2014), which highlighted the importance of consistent measurement techniques in morphometric research. The high reliability in this study ensures that the measurements were accurate and reproducible, strengthening the validity of the findings. [16]

CONCLUSION

This study on the estimation of bilateral morphometric variations in the greater sciatic notch of human hip bones revealed minimal differences between the right and left sides. Although slight variations in width, depth, and notch index were observed, none of them were statistically significant. The overall symmetry of the greater sciatic notch supports its consistent anatomical role in both sides of the pelvis. These findings are important for applications in anthropology, forensic science, and clinical settings, particularly in sex determination and the diagnosis of sciatic nerve-related conditions.

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