RESEARCH

TO STUDY THE DIAMETERS OF MEDIOLATERAL, ANTERIOPOSTERIOR AND AREA OF JUGULAR FORAMEN OF DRY SKULLS

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Abstract

Background: The present work is to understand the variations in and around the jugular foramen in adult human skull. Hence, the hypothesis of the present study is that no variation is present in and around of the jugular foramen in adult human skull. The aim of study is to identify normal range of variations in relation to size and shape of jugular foramina in terms with diameters of mediolateral, anteroposterior, and area. **Materials and Methods:** The present study commenced after getting approval from the Ethics committee of the Institution. Sixty normal skulls were procured from the Anatomy department of Index Medical College & Hospital, Indore, India. Measurement of the length, width and area of the jugular foramina was recorded. **Result:** On the right side the minimum diameter was 8.98 mm and the maximum diameter was 18.07 mm in this present study. The measurement range was 9.3 mm, with a mean of 12.67 mm and a standard deviation of 1.62 mm that we recorded. Foramen mediolateral diameter on the left side of the brain between 8.12 mm and 18.78 mm in diameter, we found a range. We measured a range of 10.22 mm, with a mean of 13.92 mm and a standard deviation of 2.02 millimeters. A total of 60 dry skulls of right Jugular Foramen anteroposterior diameter were analyzed in Table 2 of this study. Its minimum and maximum diameters were both measured to be 6.98 mm. With a range of 8 millimeters and a mean of 10.89 millimeters, with a standard deviation of 0.98 millimeters, Table 2 shows the APD of the left jugular foramen of 60 dry skulls. The smallest and largest diameters were 6.49 mm and 14.99 mm, respectively. For a measurement range of 6.84 mm, the standard deviation was found to be 1.88, with a mean value of 9.68 mm. The minimum diameter of area on right side was 69.44 mm, and the maximum diameter was 298.31 mm^2. A standard deviation of 47.98 was found for a range of 228.42 mm, with a mean measurement of 169.13 mm^2. Observations of 60 dry skulls with an area of left jugular foramen. The minimum diameter was 76.84 mm, and the maximum diameter was 288.19 mm^2. A standard deviation of 44.87 was found for a range of 210.35 mm^2, with a mean measurement of 147.57 mm^2. **Conclusion:** For accurate diagnosis and preoperative evaluation of lesions of the Jugular Foramen area, radiologists must understand morphometry of mediolateral diameter and anteroposterior diameter and along with those the area of the Jugular Foramen.

INTRODUCTION

Within each species, including humans, the anatomy of living organisms varies. Anatomy is the oldest medical scientific discipline. The first accepted logical and systematic dissections of a human dead body were approved in Alexandria in the third century B.C.[1] At the time, anatomists studied structural composition by dissecting animals, primarily pigs and monkeys.[2,3] Since then, modern anatomical science has advanced with new ideas and discoveries on a daily basis. Because of their clinical, surgical, anthropological, and racial significance, morphological variants of skull foramina have piqued the interest of numerous researchers for many decades.

Only the foramina of the cranium provide access to the rest of the body's central nervous system, which is otherwise sealed off. Knowing about the foramina at the base of the skull is critical because of the delicate neurovascular structures that pass through their narrow confines. The Jugular Foramen is a

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complicated intersection of neurovascular structures located in the base of the skull. It's possible that this is due, at least in part, to a lack of anatomical knowledge regarding variations among clinicians who are currently in practice. The decrease in curriculum hours and faculty members dedicated to gross anatomy during undergraduate medical education may be to blame for this knowledge gap.[4,5] Nevertheless, regardless of the cause, there is a need to improve the foundation of anatomical knowledge among practicing physicians by enhancing the methods through which anatomical information is synthesized and presented to the medical community. This is because variant anatomy is a significant factor in a significant number of malpractice claims.[6]

The present work is to understand the variations in and around the jugular foramen in adult human skull. Hence, the hypothesis of the present study is that no variation is present in and around of the jugular foramen in adult human skull. The aim of study is to identify normal range of variations in relation to size and shape of jugular foramina in terms with diameters of mediolateral, anteroposterior, and area.

MATERIALS AND METHODS

The present study commenced after getting approval from the Ethics committee of the Institution. Sixty normal skulls were procured from the Anatomy department of Index Medical College & Hospital, Indore, India. Measurement of the length, width and area of the jugular foramina were recorded, and diameters were taken using vernier calipers. Each dimension was measured thrice, and the mean figure was recorded. Differences in the sides would be analyzed. The presence of jugular fossa and septation is also observed. Inclusion criteria was that Adult human dry skulls of unknown sex and well-defined skull sutures skulls are taken into the present study. On the other hand, the exclusion criteria were that damaged skulls with unidentifiable features of jugular foramen were not included in the present study. 60 human adult dry skulls of unknown sex. Digital Vernier Caliper, Flexible wire, 25G Spinal needle and rubber stopper. Maximum mediolateral diameter of Jugular Foramen: The distance between the medial most and lateral most points of the Jugular Foramen. This corresponds to the length of the Jugular Foramen. Maximum anteroposterior diameter of Jugular Foramen: The distance between the anterior most and posterior most points of the Jugular Foramen. This corresponds to the breadth of the Jugular Foramen. Area of Jugular Foramen: Derived as the length of Jugular foramen multiplied by the breadth of Jugular Foramen.

Statistical Analysis

At the base of the skull, both hemispheres were analyzed for all parameters. Each metric and derived metric's mean, SD, and range were tallied up. The paired t-test was used to examine the statistical significance of the differences between the right and left sides. P values of less than 0.05 were considered statistically significant in this study The correlation coefficient was used to examine the relationship between two continuous variables.

RESULTS & DISCUSSION

Anatomical variations are not limited to variants or anomalies; they also include the fascinating field of physiological variations among individuals. Anatomical variations must be considered an essential component of anatomy education because knowledge of common variants reflects the ability to recognize the diverse clinical reality of anatomy, which has important surgical and other medical implications.

Table 1: Comparison of Mediolateral Diameter (MLD) of Jugular Foramina of Present study with other Studies

Sl. No	Author/s	Right side in millimeters	Left side in millimeters
1	Skrzat et al 2016,[7]	22	23.1
2	Anuradha et al 2017,[8]	15.06	14.02
3	Vidya et al 2017,[9]	17.33	15.30
4	Ukoha et al 2018,[10]	18.73	17.33
5	Hasan et al 2019,[11]	12.62	12
6	Manawy et al 2019,[12]	17.2	14.6
7	Baisakh et al 2021,[13]	14.17	13.22
8	Present study	12.67	13.92

Mediolateral Diameter of Jugular Foramen

The Jugular Foramina diameter discrepancies between the left and right hemispheres were investigated by Skrzat et al 2016.[7] When measured, the jugular foramen's smallest MLD on the right side was 7.8 millimeters, and the smallest on the left was 10.1 millimeters. Jugular foramen MLD measured at 22.0 mm on the left side and 23.1 mm on the right side. According to their findings, the MLD increases the size of the jugular foramen dramatically. All 50 Jugular Foramen from 50 adult dry skulls were examined by Anuradha et al 2017,[8] in their study at Stanley Medical College in Chennai, India. The average MLD was 15.06mm on the right and 14.02mm on the left. More often than not, the right foramen were larger than the left, while the left foramen were larger in only 12% of cases and the right and left foramen were equal in size in 25% of cases. They found that in their study of 30 adult dry skulls, right MLD was 17.33mm and left MLD was 15.30mm, with the right MLD being slightly larger than the left one. Using morphometric analysis of 85 Nigerian dry skulls of unknown gender, Ukoha et al (2018),[10] investigated the

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jugular foramen. The right side had a mean MLD of 18.73 mm 3.5 mm, while the left had a mean MLD of 17.33 mm 3.1 mm and the difference was significant. The average MLD for both sides was 18mm. Hasan et al,[11] 2019 conducted a comparative study of the Jugular Foramen anatomy and its variations in dried adult human skulls from the Sri Lankan population. A descriptive study was carried out on a total of 27 skulls, regardless of the gender of the subjects, to describe the morphometry of the jugular foramen. Mean MLD of the jugular foramen on the right side was 12.62 mm larger than the left side, which measured 12 mm, according to the results of the study. It is possible that the remaining differences are due to constitutional, racial, gender-related, or genetic factors based on previous research. Several studies have provided evidence to back up the validity of this claim. Dry skulls from Egypt were studied by Manawy et al,[12] 2019 for the Jugular Foramen anatomical variation. It varies from person to person (24 mm to 9 mm). The mean MLD for the right Jugular Foramen was higher than the mean MLD for the left Jugular Foramen. There is a mean MLD of (17.2 mm) in the right and a mean of (14.6 mm) in the left. More than 80% of the time (20 to 15 mm). There are a few numbers with MLDs below 10 mm. Wide foramina MLD greater than or equal to 21 millimeters are present in more than 10% of patients, mostly on the right side. The Jugular Foramen's mediolateral diameter differed significantly between males and females. Baisakh et al,[13] 2021 conducted a morphological and morphometric study of the Jugular Foramen in Eastern Indian human dry skulls. According to their findings, the MLD on the right side ranged from 12.5mm to 21mm, while the MLD on the left side ranged from 11.3mm to 15.6mm, with mean values of 14.17mm and 13.22mm, respectively. In the present study the findings have been given in [Table 1]. On the right side the minimum diameter was 8.98 mm and the maximum diameter was 18.07 mm in this present study. The measurement range was 9.3 mm, with a mean of 12.67 mm and a standard deviation of 1.62 mm that we recorded. Foramen mediolateral diameter on the left side of the brain between 8.12 mm and 18.78 mm in diameter, we found a range. We measured a range of 10.22 mm, with a mean of 13.92 mm and a standard deviation of 2.02 millimeters.

Anterolateral Diameter of Jugular Foramen

The Jugular Foramen on the right and left had mean APDs of 12.11mm and 11.09mm respectively. Adult dry skulls of the Mysuru-based population studied by Vidya et al., 2017, showed that the APD was 9.9mm and 7.9mm on the right and left sides, respectively. Using morphometric analysis of 85 Nigerian dry skulls of unknown gender, Ukoha et al.[10] (2018) investigated the jugular foramen. There was a significant difference in mean APD values between the right and left sides, with 13.20 mm 2.8 mm on the right and 11.7±2 2. mm on the left. APD had a mean of 12.5 mm when both sides were considered. Hasan et al,[11] 2019 studied the anatomy of the Jugular Foramen and its variations in dried adult human skulls from the Sri Lankan population. A descriptive study was carried out on a total of 27 skulls, regardless of the gender of the subjects, to describe the morphometry of the jugular foramen. The left Jugular Foramen had an average APD of 7.62 mm, while the right Jugular Foramen had an APD of 6.92 mm. We can infer from the above data that the Jugular Foramen and Jugular Fossa are morphometrically distinct, at least in the APD, and should be treated as two separate anatomical structures rather than the fossa being included in the Jugular Foramen. Dry skulls from Egypt were studied by Manawy et al,[12] 2019 for the Jugular Foramen anatomical variation. It spans from to (10mm to 3mm). The mean APD in the right jugular foramen was higher than in the left jugular foramen. Both sides have an average APD of (6.4±2.39 mm) on the right and (5.4±1.58 mm) on the left. More than seventy-five percent of the time (7 to 5mm). Slit-like foramina (3 mm wide) are found on the left side of a small percentage of the population. As many as 20% have an APD greater than 9 mm, especially on the right side, according to the study. When comparing the two sides, there was no discernible difference. Baisakh et al,[13] 2021 conducted a morphological and morphometric study of the Jugular Foramen in Eastern Indian human dry skulls. There is a wide range of APD on the right and left sides, with the mean values of 9.35mm and 7.63mm, respectively, on both sides of the body. A total of 60 dry skulls of right Jugular Foramen anteroposterior diameter were analyzed in [Table 2] of this study. Its minimum and maximum diameters were both measured to be 6.98 mm. With a range of 8 millimeters and a mean of 10.89 millimeters, with a standard deviation of 0.98 millimeters, [Table 2] shows the APD of the left jugular foramen of 60 dry skulls. The smallest and largest diameters were 6.49 mm and 14.99 mm, respectively. For a measurement range of 6.84 mm, the standard deviation was found to be 1.88, with a mean value of 9.68 mm.

Table 2: Comparison of Anteroposterior Diameter (APD) of Jugular Foramina of Present study with other Studies

Sl.No	Author/s	Right side in millimeters	Left side in millimeters
1	Vidya et al., 2017	9.9	7.9
2	Ukoha et al., 2018	13.20	11.72
3	Hasan et al., 2019	17.62	6.9
4	Manawy et al., 2019	6.8	5.4
5	Baisakh et al., 2021	9.3	7.63
6	Present study	10.89	9.68

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Area of Jugular Foramen

Baisakh et al,[13] 2021 conducted a morphological and morphometric study of the Jugular Foramen in Eastern Indian human dry skulls. There is a wide range of APD on the right and left sides, with the mean values of 9.35mm and 7.63mm, respectively, on both sides of the body. A total of 60 dry skulls of right Jugular Foramen anteroposterior diameter were analyzed in [Table 3] of this study. Its minimum and maximum diameters were both measured to be 6.98 mm. With a range of 8 millimeters and a mean of 10.89 millimeters, with a standard deviation of 0.98 millimeters, [Table 4] shows the APD of the left jugular foramen of 60 dry skulls. The smallest and largest diameters were 6.49 mm and 14.99 mm, respectively. For a measurement range of 6.84 mm, the standard deviation was found to be 1.88, with a mean value of 9.68 mm.

Idowu,[14] 2004 researchers looked at 40 Jugular Foramina in 20 Nigerian skulls and found that the mean Jugular Foramen area on the right side of the head measured 437.49 mm^2 while the mean Jugular Foramen area on the left side measured 419.48 mm^2. Saheb et al,[15] 2010 according to their findings which was conducted on 125 dry skulls, the average length of the Jugular Foramen on the right and left was 23.62 mm and 22.86 mm, respectively, with widths of 7.83mm and 6.83mm. The average area on the right was 584.36mm^2 and 493.30 mm^2 on the left. In 89.6 percent of cases, one of the two foramina predominated. The right had a 64.8 percent advantage, while the left had a 24.8 percent advantage. 10.4 percent of the cases were balanced on both sides. In the area of Jugular Foramina, there was statistical significance between the two sides. Khanday et al,[16] 2013 analyzed 648 Jugular Foramen of 324 skulls and found out that the mean area of Jugular Foramen on right side was 118 mm^2 and on left side was 90 mm^2. Vijisha et al,[17] 2013 the area of the right Jugular Foramen was 210.87 mm^2 and the area of the left Jugular Foramen was 141.93 mm^2 in their study of 30 adult dry skulls. Gupta et al,[18] 2014 these researchers examined 50 adult dry skulls and discovered that the mean area of the Jugular Foramen on the right and left sides was 187.34 mm^2 and 153.2 mm^2 respectively. Observations of 60 dry skulls with an area of the right jugular foramen are shown in [Table 3]. The minimum diameter of area on right side was 69.44 mm, and the maximum diameter was 298.31 mm^2. A standard deviation of 47.98 was found for a range of 228.42 mm, with a mean measurement of 169.13 mm^2. Observations of 60 dry skulls with an area of left jugular foramen. The minimum diameter was 76.84 mm, and the maximum diameter was 288.19 mm^2. A standard deviation of 44.87 was found for a range of 210.35 mm^2, with a mean measurement of 147.57 mm^2.

Table 3: Comparison of Area of Jugular Foramina of Present study with other Studies

Sl. No	Author/s	Right side in millimeter^2	Left side in millimeter^2
1	Idowu 2004,[14]	437.49	419.48
2	Saheb et al 2010,[15]	584.36	493.30
3	Khanday et al 2013,[16]	118	90
4	Vijisha et al 2013,[17]	210.87	141.93
5	Gupta et al 2014,[18]	187.34	153.2
6	Present Study	169.13	288.19

CONCLUSION

For accurate diagnosis and preoperative evaluation of lesions of the Jugular Foramen area, radiologists must understand morphometry of mediolateral diameter and anteroposterior diameter and along with those the area of the Jugular Foramen. Neurosurgeons and otologists dealing with space-occupying lesions in the Jugular Foramen will find the database useful.

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