

ORIGINAL RESEARCH

Morphological and Morphometric Analysis of Jugular Foramen: A Study on Dry Human Skulls in Southern Rajasthan

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ABSTRACT**Background:** Jugular foramen is an irregular foramen at the base of the skull. Surgical approach to the jugular foramen has become very frequent in recent times due to the advancement in microsurgical techniques. Anatomical complexity of the jugular foramen makes surgical procedures thereon difficult. This requires thorough knowledge of morphological and morphometric anatomy of the foramen.**Objective:** To study the morphology and morphometry of the jugular foramen in dry human skulls of Southern Rajasthan region.**Materials and Methods:** The study was conducted in the department of Anatomy, RNT Medical College, Udaipur, Rajasthan. 100 jugular foramina (50 dry human skulls of unknown age and sex) were examined, and various measurements were taken with digital vernier calipers.**Results:** Mean transverse diameter of jugular foramen on right side was 15.25 mm and on left side 14.60 mm. Mean anteroposterior diameter of the foramen on the right side was 9.80 mm and on the left side 7.85 mm. The foramina were larger on the right side. Intra-jugular septa were incomplete in most of the foramina (95 percent) and complete in 5 percent. Jugular foramina were oval in 78% and round in 22%.**Conclusion:** Comprehensive knowledge of anatomy of jugular foramen is of prime importance for radiologists and neurosurgeons as this area is laden with important neurovascular structures.**Key words:** Skull, Jugular Foramen, Digital vernier caliper.

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INTRODUCTION

The skull base provides support and protection to the brain. It also serves as passage for major neurovascular structures. Jugular foramen is one of the important foramina of the base of skull, as it is the main route of venous outflow from the skull [1]. It is a large irregular opening at the base of the skull lying at the posterior end of petro-occipital suture, situated above and lateral to foramen magnum. It is bounded anteriorly by the jugular fossa (formed by the petrous part of temporal bone) and posteriorly by jugular process of occipital bone. [2]. It is subdivided into three compartments by two bony spicules known as intrajugular processes [3]. The anterior compartment is vascular which transmits inferior petrosal sinus that drains into the superior bulb of internal jugular vein. Middle compartment contains

glossopharyngeal, vagus, and spinal accessory nerves with meningeal branches of the ascending pharyngeal and occipital arteries. Posterior compartment is vascular, accommodating the internal jugular vein [4, 5]. Any pathological conditions involving posterior cranial fossa eg, meningiomas, schwannomas, paragangliomas and glomus jugulare tumor and the inflammatory lesions of inner ear may infiltrate these structures [6, 7]. Various syndromes involving the jugular foramen eg. Vernet syndrome, Tapia syndrome, Schmidt syndrome, Avellis syndrome etc. affect neurovascular structures of the jugular foramen IX, X, and XI cranial nerves [8, 9]. With the advancement of microsurgical procedures, neurosurgeons have started approaching this region, which necessitates thorough knowledge of the region. Excessive use of new modern

diagnostic procedures around Jugular foramen also demands detailed anatomical studies about this foramen.

MATERIALS AND METHODS

100 jugular foramina from 50 dry skulls of unknown age and sex were studied in the department of Anatomy, RNT Medical College, Udaipur (Rajasthan).

INCLUSION CRITERIA

All the skulls selected were adult, dry, completely ossified and showed intact jugular foramina.

EXCLUSION CRITERIA

Broken skulls or those with pathological changes involving jugular foramen were excluded from the study.

Skulls were studied for morphology and morphometry of jugular foramina.

Morphological study was done by scrupulous inspection for-

- 1. Shape of the foramen- (1) Round (2) Oval
- 2. Intra jugular process/septum-present or absent and if present - (1) complete (2) Incomplete

Photographs were taken and the observations were recorded on prepared proformas.

For morphometric study following measurements were taken with digital vernier caliper (with an accuracy of up to 0.01mm)--

1. Transverse diameter of jugular foramen– the distance between lateral most and medial most points of the jugular foramen with skull in anatomical position.

2. Anteroposterior diameter of jugular foramen-- maximum anteroposterior distance with skull in anatomical position.

Readings were taken and all the records were maintained on proformas. All the findings were compiled on Microsoft Excel sheet and analyzed statistically.

OBSERVATIONS AND RESULTS

100 Jugular foramina were studied for their morphology and morphometry. Mean transverse diameter of jugular foramen on right side was 15.25 mm (range 11.40 - 22.25 mm) and on left side 14.60 mm (range 8.30-21.05 mm). Mean anteroposterior diameter of the foramen on the right side was 9.80 mm (range 7.33 mm - 16.60 mm) and on the left side 7.85 mm (6.30-11.85 mm). Intra-jugular process or septum was incomplete in 95% and complete in 5% of jugular foramina (4 % on right side and 1 % on left side).Shape of the jugular foramen was oval in 78% and round in 22%.



Figure 1: Right side: Incomplete septum; Left side: Complete septum



Figure 2: Right side: Round jugular foramen and complete septum; Left side: Oval jugular foramen and incomplete septum

Table 1: Measurements of jugular foramen

Parameters	Mean (Range) in mm	
	Right (50)	Left (50)
Transverse diameter (Mediolateral diameter)	15.25 (11.40-22.25)	14.60 (8.30-21.05)
Anteroposterior diameter (Sagittal diameter)	9.80 (7.33-16.60)	7.85 (6.30-11.85)

Table 2: Septation of the jugular foramen

Septation	Right		Left	
	No.	Percentage	No.	Percentage
Complete septation	04	04%	01	01%
Partial septation	46	46%	49	49%
Absent septation	0	0	0	0

Table 3: Shape of the jugular foramen

SrNo.	Shape of jugular foramen	Right side (%)	Left side (%)
1.	Round	16	6
2.	Oval	34	44

Table 4: Comparison of size of jugular foramen

S No.	Authors	No. of jugular Foramen	Mean transverse diameter in mm		Mean Anteroposterior diameter in mm	
			Right	Left	Right	Left
1.	Cicekcibasi et al	120	13.00	12.41	7.71	6.69
2.	Ukoha U et al	170	18.73	17.33	13.20	11.72
3.	Ekinci and Unur et al	140	15.5	16	8.4	7.6
4.	Kumar et al	60	17.48	16.83	10.72	9.53
5.	Khanday et al	324	14.6	13.9	10.06	8.9
6	Singla et al	100	15.57	14.85	9.32	7.34
7.	Gupta C et al	100	16.52	16.02	11.22	9.52
8.	Patel R et al	100	12.17	11.0	7.9	6.2
9.	Das SS et al	90	13.72	13.07	9.37	6.88
10.	Shruthi et al	500	24.48	21.24	7.51	7.16
11.	Hussain sahib et al	250	23.62	22.86	7.83	6.83
12.	Present study	100	15.25	14.60	9.80	7.85

Table5: Comparison of septation of jugular foramen with various studies

Sr no.	Authors	Complete septum %		Incomplete septum %		Absent septum %	
		Right	Left	Right	Left	Right	Left
1.	Ukoha et al	8.2	11.2	20.6	20.6	21.2	18.2
2.	Patel R et al	16	14	29	25	-	-
3.	Das SS et al	10	3	90	97	-	-
4.	Hatiboglu et al	5.6	4.3	2.6	19.6	-	-
5.	Sturrock et al	3.2	3.2	1.3	10.9	-	-
6.	Amudha et al	5	1.5	45	43.5	0	0
7.	Patel M M et al	23.10	17.6	49.5	58.4	-	-
8.	Vijisha et al	10	6.7	63.3	70	-	-
9.	Anbumani et al	0	1.51	50	48.5	0	0
10.	Present study	4	1	46	49	0	0

Table 6: Comparison of shape of jugular foramen with various studies

Sr. No	Authors	Oval		Round		Total	
		Right	Left	Right	Left	Oval	Round
1.	Sakthive K M et al	15.2	26	34.7	23.9	58.6	41.2
2.	Ukoha et al	43.5	33.5	6.5	16.5	77	23
3.	Present study	34	44	16	6	78	22

DISCUSSION

The size and shape of the jugular foramen have close association to the size of the internal jugular vein and

the presence or absence of a prominent superior bulb of the internal jugular vein, which is usually larger on the right side. This dissimilarity in size of the right and left

internal jugular veins is probably due to differences in the pattern of development of brachiocephalic veins of right and left side [6].

Transverse diameter and anteroposterior diameter:

In the present study, mean transverse and anteroposterior diameters of jugular foramen were found to be in accordance with the study of Singla et al [10]. Mean transverse diameter was higher than studies of Cicekcibasi et al [11], Patel R et al [16] and Das SS et al [17] and lower than those of Ukoha et al [12], Gupta et al [15], Shruthi et al [18] and Hussain et al [19].

Mean anteroposterior diameter was higher than the studies of Cicekcibasi et al [11], Patel R [16], and Hussain et al [19] and lower than those of Ukoha et al [12] and Gupta et al [15].

Intra Jugular Process (Septation): In the present study septation was complete in 5% and incomplete in 95 % foramina. These findings were similar to the study of Amudha et al [23].

Incidence of complete septation was lower than the studies of Ukoha et al [12], Patel R et al [16], Patel MM et al [24] and Vijisha et al [25] while higher than that of Anbumani TL [26] et al.

Incidence of incomplete septation was lower than the studies of Patel MM et al [24], Vijisha et al [25], while higher than those of Ukoha et al [12], Patel R et al [16], Hatiboglu et al [21], Sturrock et al [22].

Shape of the jugular foramen: In the present study 78% foramina found to be oval and 22% were round which correlated with the study of Ukoha et al [12], while Sakthive K M et al found 58.6% oval and 41.2% round foramina [27].

CONCLUSION

Right jugular foramina are usually larger as compared to left side and incomplete bony septum of this foramen also common among most of the Indian population. But even among Indian population variations are noted, in their size, shape and septum. Hence the knowledge of morphometry of the jugular foramen is important for assessing normal and pathological variations of the jugular foramina. Findings of such studies can be helpful for radiologists and neurosurgeons in predicting the chances of preserving neurovascular structures during surgical procedures.

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