

MORPHOLOGICAL VARIATION IN THE STRUCTURE OF THE JUGULAR FORAMEN IN ADULT HUMAN DRIED SKULL IN NORTH INDIA



Medical Science

KEYWORDS : Jugular Foramen (JF), Anteroposterior Diameter (APD), Transverse Diameter (TVD), Septation, Dome

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ABSTRACT

Jugular foramen being difficult to approach surgically, a detailed morphological and anatomical knowledge of it is required. 100 dried adult human skulls were examined. The foramen was larger on right side in 74%, on left side in 19% and equal in both sides in 7% cases. 68% skulls had complete septation on right and 21% on left side whereas 32% contained partial septation on right and 79% on left side respectively. Dome was found bilaterally, on right side only, on left side only and absent on both sides in 48%, 30%, 10% and 12% of the cases respectively. The mean±standard deviation of APD on the right and left sides were 6.92±1.53mm and 8.1±1.49 mm while the TVD measured 12.9±3.37 mm and 13.0±3.53 on the right and left respectively. APD was significantly greater on right side ($p < 0.0001$) and showed significant positive correlation with that of left. Similar was the case with TVD.

Introduction

The JF is a large irregular hiatus that lies at the posterior end of the petro occipital suture between the jugular process of the occipital bone posteromedially and the jugular fossa of the petrous part of the temporal bone anterolaterally [1]. It courses anteriorly, then laterally and finally inferiorly through the skull base. Anteriorly it is separated from the inferior carotid opening by a bony ridge called the carotico jugular spine. The JF is lateral to the hypoglossal canal and the two are separated by an osseous bar [2].

According to Gray's Anatomy, the lower posterior border of the foramen is smooth with the upper border being sharp and notched. Sometimes the margins of the notch extend to divide the foramen into 2 or 3 compartments. The anterior part is the petro-occipital fissure which extends forward to foramen lacerum. The remainder of the jugular foramen is jugular fossa which is divided into two parts by a bony projection called the jugular tubercle [3].

Three compartments of JF include :- Anterior compartment, a smaller venous compartment (petrosal part) containing the inferior petrosal sinus; Middle compartment, a neural compartment containing the CN IX to CN XI; Posterior compartment, a larger venous compartment (sigmoid part) containing the sigmoid sinus, jugular sinus meningeal branch of occipital & ascending pharyngeal arteries [4,5]. Within the jugular foramen the glossopharyngeal nerve gives off the glomus bearing tympanic branch called the nerve of Jacobson and the vagus nerve gives auricular branch called Arnold's nerve.

The sigmoid and petrosal parts are separated by:- (a) A bony process called as the inter jugular process, which originates from the opposing surfaces of the temporal and occipital bones, (b) A dural septum which connects these two bony structures. More often there is no septation and the JF exists as one compartment [6].

JF is difficult to conceptualize and assess surgically because it varies:- (a) In size and shape in different crania, (b) from side to side in the same cranium, (c) from its intracranial to extracranial end in the same foramen and also because of: (d) Its complex irregular shape and its curved course, (e) Its formation by two bones and (f) The numerous nerves and venous channels that pass through it [2,7].

Variety of lesion may occur in the JF, arising from the structures normally found within the JF or from contiguous structures [8]. The most common tumours or lesions include glomus jugulare tumours, neuroma, meningomas, metastatic carcinoma, chondroma, nasopharynx carcinoma & carcinoma of tympanic cavity [9]. Schwannoma (neuroma) represents approximately 7-10%

of all primary intracranial tumours [10].

Surgical resection is the treatment of choice in the majority of these cases. As neurosurgeons become bolder in approaching this region, the need for familiarity with the detailed anatomy of this region becomes greater. The present study was embarked on to examine the anatomy of the jugular foramen including its dimensions, and to discover the degree of predominance, if any, of this opening in adult human skulls in north india.

Material and methods

A total of 200 jugular foramina were examined from 100 adult dry skulls. The skulls were obtained from the Department of Anatomy, Teerthanker Mahaveer Medical College and Research Center, Moradabad, India. The length and width of the jugular foramina were determined. Metric measurements (sagittal and transverse diameters) were taken using Vernier calliper. The foramina were also studied for the presence of complete or partial septation, presence of dome and size predominance. Data analysis was done with SPSS version 16. A comparison of the dimensions was made using Student's t-test. The association between continuous variables was investigated by Pearson's correlation coefficient.

Results

The mean length of jugular foramen on the right and left were 23.62mm and 22.86mm, while their widths measured 7.83mm and 6.83mm respectively (Table - 1). Predominance of one of the two foramina appeared in 93% of cases. Predominance on the right (R) was 74% and 19% on the left (L). 7% cases showed equal on both sides (Table 2). Complete septation was present on 68% cases on the right side and on 21% of cases on the left side whereas 32% had partial septation on the right side and 79% on the left side. Dome was present bilaterally, on right side, on left side and absent on 48%, 30%, 10%, 12% of the cases respectively.

There was statistical significance between the foramina of two sides in terms of width but no significant difference in case of length (Table 2 and 3). The APD of jugular foramen on right side showed significant positive correlation with that on the left side. Similar was the case with TVD on right and left side ($p < 0.05$, table 3).

Table 1. (Minimum & maximum values with $\mu \pm sd$)

Diameter	Min (mm)	Max (mm)	Mean \pm SD ($\mu \pm sd$)
APDR	4.5	10.7	6.92 \pm 1.53

Diameter	Min (mm)	Max (mm)	Mean ±SD (μ±sd)
APDL	4.2	10.5	8.1 ± 1.49
TVDR	5.3	19.8	12.9 ± 3.37
TVDL	5.1	19.9	13.0 ± 3.53

SD→standard deviation

Table 2. Comparison of APD of Right and Left side

Side	Mean (μ)	SD	p
APDR	8.096 mm	1.478	<0.0001*
APDL	6.917 mm	1.519	

*→statistically significant (p<0.05)

Table 3. Comparison of TVD of Right and Left side

Side	Mean (μ)	SD	p
TVDR	12.921 mm	3.257	0.9661
TVDL	13.01 mm	3.508	

Table 4. Pearson correlation coefficient (r) and p value

SN	variable		APD right	APD left	TVD right	TVD left
1	APD right	r	-	0.228	0.102	-0.014
		p		0.022*	0.313	0.917
2	APD left	r	0.228	-	-0.006	0.042
		p	0.022*		0.98	0.967
3	TVD right	r	0.102	-0.006	-	0.589
		p	0.313	0.98		0.001*
4	TVD left	r	-0.014	0.042	0.589	-
		p	0.917	0.967	0.001*	

*→statistically significant (p<0.05)

Table 5. Presence of dome in jugular

Dome	Bilateral	Right	Left	Absent
Percentage	48%	30%	10%	12%

Table 6. Size of the jugular foramen

Size	percentage
Right>Left	74%
Left>Right	19%
Right=Left	7%

Table 7. Septation of jugular foramen

Side	Complete (%)	Partial (%)
Right	68%	32%
Left	21%	79%

Discussion

The JF is one of the most complicated anatomic structures of the skull base. It is bounded by the temporal and occipital bones. It is an aperture between the medial and lateral portions of the

occipito-temporal suture. The temporal side of the foramen is the jugular fossa (bulb), bounded superiorly by the bony floor of the middle ear. The glomus jugulare lies in the fossa or middle ear near the fossa and the glomus tumor arises in this area [11].

In this study, 100 skulls were analysed for their size, length, width, presence of dome and septation. Predominance of JF was on the right side (74%) with maximum cases of complete septation (68%). Most of the skulls showed to have dome bilaterally (48%).

R. R. Sturrock found that in 69% of cases the right JF was larger than the left and in 23% the left JF was larger, with the remainder being of equal size. A dome caused by a superior jugular bulb was present bilaterally in 54%, on the right only in 30%, on the left only in 6% and was absent bilaterally in 10% of the cases. Incomplete septation was present on the right in 1.3% and on the left in 10.9% of cases. A complete division was found in 3.2% of cases for both the right and left sides [12].

In a study of M. Tahir. Hatiboglu et al 61.6% cases had larger foramen the right side and 26% on the left side with the remainder being of almost equal size in both the sides. Dome was present bilaterally in 49%, on the right only in 36%, on the left only in 4.6%, it was absent bilaterally in 10.3%. Complete bony septation occurred in 5.6% on the right and in 4.3% on the left, partial septation was observed in 2.6% on the right and in 19.6% on the left. Another foramen which was completely separated by a spicule of bone and which transmits the inferior petrosal sinus was present in 5.6% of skulls on the right and in 4.6% on the left [13]. Patel MM et al observed the presence of gutter on the lateral side of jugular foramen. This study postulates the hypothesis that the presence of size of gutter is inversely proportional with the size of dome and helps in accommodating the superior jugular bulb of internal jugular vein [14].

The size and shape of the jugular foramen is related to the size of the internal jugular vein and the presence or absence of a prominent superior bulb. The right foramen is usually larger than the left. There is a very wide variation in the anatomy of the intra cranial venous sinuses which accounts for variation in size and shape of jugular foramen. The difference in size of the two internal jugular veins is already visible in the human embryo at the 23mm stage and probably results from differences in the pattern of development of the right and left brachiocephalic veins [2]. The larger superior sagittal sinus continues in succession as right transverse sinus, right sigmoid sinus and right internal jugular vein whereas the smaller inferior sagittal sinus continues in succession as straight sinus, left transverse sinus, left sigmoid sinus and into left internal jugular vein [15].

The bony growth reduces the size of JF and jugular fossa. It might cause the neurovascular symptoms which can mimic the symptoms caused by jugular meningiomas, glomus jugulare tumors of choleastatoma. The bony growth in the jugular fossa region might compress the superior bulb of internal jugular vein which in turn might result in venous congestion in the cranial cavity. The compression of 9th 10th and 11th nerves might result in paralysis of pharynx, larynx and palate [16].

Conclusion

The surgical anatomy of the JF and its contents is complex. Therefore, an excellent knowledge of its variations and the relationships between its neurovascular structures is critical when surgically approaching this complex area, in order to maximize the surgical outcome and decrease postoperative complications when treating the pathology of this region.

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