

## Morphometric study of Jugular Foramen at base of the skull in South Gujarat region

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**Abstract:** The jugular foramen is the main route of venous outflow from the skull and is characterised by laterality based on the predominance of one of the sides. Intracranial meningiomas, paragangliomas (glomus jugulare, from the jugular ganglion of the vagus nerve), schwannomas, metastatic lesions and infiltrative inflammatory processes from surrounding structures such as the middle ear may affect the structures passing through this foramen. We studied one hundred dry, adult human skull of unknown sex and measured sagittal and transverse diameter of Jugular foramen. Jugular foramen were also observed for the presence of dome, septation and right or left dominance. **Mean transverse diameter of jugular foramen was 11.61mm and mean sagittal diameter was 7.12mm.** The size of the jugular foramen varied on the two sides. R>L were 75%, R<L were 31%, R=L were 2%. The jugular bulb dome was present bilaterally in 23%, on the right side only in 30%, on the left side only in 11%, and absent in 36%. Complete septation was present in 16% on the right side and 14% on the left side. Partial separation was present in 29% on the right side and in 25% on the left side. Knowledge of morphology, compartments and morphometry is important for neurosurgeons dealing with space occupying lesions in jugular foramen.

**Key words:** jugular foramen, jugular bulb, internal jugular vein

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### I. Introduction:

Jugular foramen is a large aperture in the base of the skull. It is located behind the carotid canal and is formed by the petrous part of the temporal bone and behind by the occipital bone. The jugular foramen is the main route of venous outflow from the skull and is characterised by laterality based on the predominance of one of the sides. Sigmoid sinus continues as internal jugular vein in posterior part of jugular foramen. Ligation of the internal jugular is sometimes performed during radical neck dissection with the risk of venous infarction, which some adduce to be due to ligation of the dominant internal jugular vein<sup>[1]</sup>.

It is generally said that although the Jugular foramen is larger on the right side compared to the left, its size as well as its height and volume vary in different racial groups and sexes. The foramen's complex shape, its formation by two bones, and the numerous nerves and venous channels that pass through it further compound its anatomy<sup>[2]</sup>.

Hovelacque (1967) was the first to propose the subdivision of jugular foramen. The foramen is divided by a fibrous or bony septum that joins the jugular spine of the petrous bone to the jugular process of occipital bone, the anteromedial compartment (pars nervosa) and a posterolateral compartment (pars vascularis). The pars nervosa receives the 9<sup>th</sup> cranial nerve, inferior petrosal sinus and the meningeal branch of the ascending pharyngeal artery, while the remaining structures pass through the pars vascularis<sup>[3]</sup>. A dome is a bony roof present in the Jugular foramen.

Intracranial and extracranial lesions may affect the jugular foramen in addition to intrinsic abnormalities. Pathological processes affecting JF include intracranial meningiomas, paragangliomas (glomus jugulare, from the jugular ganglion of the vagus nerve), schwannomas, metastatic lesions and infiltrative inflammatory processes from surrounding structures such as the middle ear<sup>[4]</sup>. Surgical resection is the treatment of choice in the majority of these cases. Advances in microsurgical techniques have made possible the removal of advanced Jugular foramen lesions, which were once assumed to be inoperable<sup>[5]</sup>. As neurosurgeons become bolder in approaching this region, so the need for familiarity with the detailed anatomy of this region becomes greater. The present study was undertaken to examine size and presence or absence of dome; presence of septation; side dominance in jugular foramen.

### II. Material and Method:

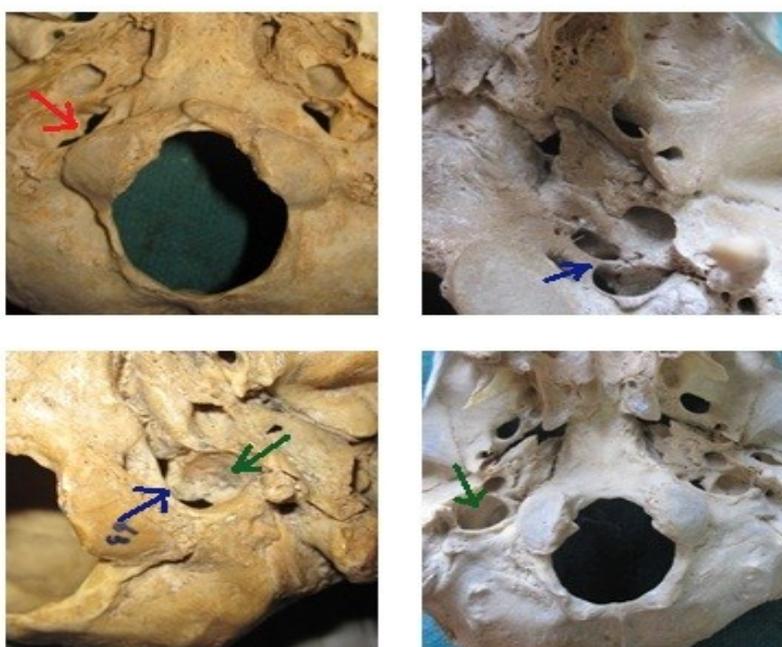
- The present study was undertaken on 100 dry, adult human skull obtained from department of Anatomy, Government medical college, Surat. With the help of simple vernier caliper sagittal and transverse diameter of Jugular foramen. Jugular foramen were also observed for the presence of dome, septation and right or left dominance.

**III. Result:**

The dimensions of jugular foramen are shown in Table/fig-1. Complete or partial separation or non separation of compartments of jugular foramina and presence of dome are shown in Table/fig-2,3& 4. Complete or partial separation or non separation of compartments of jugular foramina were observed as follows: Complete septation was present in 16 skulls on the right side and 14 skulls on the left side. Partial septation was present in 29 on the right side and in 25 on the left side.

Values	Length(right)	Length(left)	Width(Right)	Width(Left)
Maximum	16.5	16	12.5	12.5
Minimum	4.5	5	3	3
Mean	12.17	11	7.9	6.2

Table/fig-1: Dimensions (in mm) of jugular foramen on right and left side



Table/fig-2: showing septation & presence of dome in jugular foramen, Red arrow: partial septation; green arrow: presence of dome, Blue arrow: complete septation

	RELATIVE SIZE OF THE FORAMINA			DOME			
	R>L	L>R	R=L	Bilaterally present	Rt side only	Lt side only	Absent bilaterally
Percentage	75%	23%	2%	23%	30%	11%	36%

Table/fig-3: Relative size of jugular foramina and the jugular bulb dome

	Septation			
	Complete		Partial	
	Rt side	Lt side	Rt side	Lt side
Percentage	16%	14%	29%	25%

Table/fig-4: Complete or partial septation or non septation of compartments of jugular foramina

**IV. Discussion:**

The shape and size of the jugular foramen is obviously related to the size of the internal jugular vein and the presence or absence of a prominent superior bulb. It might be expected that the right foramen would usually be larger than the left, since the textbooks classically describe the superior sagittal sinus as draining into the right transverse sinus, but there is a very wide variation in the anatomy of the intracranial venous sinuses<sup>[6,7]</sup>, which accounts for variation in size and shape of jugular foramina.

The difference in size of the two internal jugular veins, when present, is already visible in the human embryo at the 23 mm stage (8 weeks post-conception) and probably results from differences in the pattern of development of the right and left brachiocephalic veins<sup>[8]</sup>.

In our study mean transverse diameter of jugular foramen on the right and left were 12.17mm (range: 4.5–16.5 mm and 11mm (range: 5-16mm) respectively, while their sagittal diameter measured 7.9mm (range:3–12.5 mm) and 6.2 mm (range:3–12.5mm) on the right and left respectively. The statistically significant difference was observed between the two sides in transverse and sagittal diameter ( $p < 0.01$ ). Both diameters are more on right side.

In the study done by Edowu on Nigerian skull, he found mean transverse diameter of jugular foramen on the right and left were 13.90 mm (11.6–17.0 mm) and 14.11 mm (9.2–20.2 mm), while their sagittal diameter measured 10.22 mm (6.8–14.4 mm) and 9.57 mm (7.4–12.8 mm) on the right and left respectively. Although the Jugular Foramen was larger on the right, it was not statistically significant<sup>[9]</sup>. There is statistically significant difference between our study and Edowu's study ( $p < 0.01$ ). According to study done on turks skull by Ekinci and Unur, the sagittal and transverse diameters of the left jugular foramen were 7.6 and 15.5 mm, respectively, and on the right 8.4 and 16 mm, respectively<sup>[10]</sup>. Pereira, GAM. studied total 111 skulls (of southern Brazil) and it was noticed that mean transverse diameter was 15.82mm on right side and 15.86mm on left side; mean sagittal diameter was 9.21mm on right side and 8.65mm on left side<sup>[11]</sup>.

In this study the size of the jugular foramen varied on the two sides. In the present study of 100 skulls R>L were 75%, R<L were 23%, R=L were 2%. In our study the jugular bulb dome was present bilaterally in 23%, on the right side only in 30%, on the left side only in 11%, and absent in 36%.

In Sturrock's investigation of 156 skulls the right foramen was larger in 68.6%, the left larger in 23.1% and equal on both side in 8.3%. The jugular fossa was present in 30.1% cases on the right side, 6.4% cases on the left side, 53.9% cases bilaterally and absent bilaterally in 9.6% of cases<sup>[12]</sup>.

Hatiboglu and Anil studied 300 Anatolian skulls from the 17<sup>th</sup> and 18<sup>th</sup> centuries and observed that in 61.6% the foramen was larger on the right side and in 26% it was larger on the left side and in the remainder of equal size. Presence of jugular fossa was observed bilaterally in 49%, on the right only in 36%, on the left only in 4.7% and absent bilaterally in 10.3% of skulls<sup>[13]</sup>.

Patel and Singel studied 91 Indian skulls (Saurashtra region) and observed in 60.4% cases larger right foramen, in 15.4% larger left foramen and in 24.2% equal on both sides. The jugular fossa was observed in 38.5% cases on the right side, 14.3% cases on the left side, 21% cases bilaterally and absent in 25.3% of skulls<sup>[14]</sup>. Thus there is marked difference between our study and the studies by Sturrock and Anil & Hatiboglu in respect to presence or absence of dome. But the findings are somewhat near to Patel and Singel study.

Hussain Saheb S. studied 125 skulls (south india) and observed that in 64.8% the foramen was larger on the right side and in 24.8% it was larger on the left side and of equal size in 10.4%. The jugular bulb dome was present bilaterally in 49.6%, on the right side only in 27.2%, on the left side only in 8.8%, and absent in 14.4% of skulls<sup>[15]</sup>. It is well known that the jugular bulb forms the floor of middle ear cavity<sup>[14]</sup>. The cases of glomus tumors in jugular foramen eroding this floor and encroaching the middle ear cavity have been reported<sup>[15]</sup>. The absence of roof of jugular fossa indicates that the jugular bulb is absent or poorly developed in such cases and may not form floor of middle ear cavity.

In our study complete or partial separation or non separation of compartments of jugular foramina were observed as follows: Complete septation was present in 16% on the right side and 14% on the left side. Partial septation was present in 29% on the right side and in 25% on the left side.

Regarding the separation of compartments Sturrock R.R observed complete separation on right side in 3.2%, left side in 3.2% and partial separation on the right side in 1.3%, on left side in 10.9%<sup>[12]</sup>. Hatiboglu and Anil observed complete separation on the right side in 5.6%, on the left side in 4.3% and partial separation on the right side in 2.6%, on the left side in 19.6%<sup>[13]</sup>. Patel and Singel observed complete separation on the right side in 23.1%, on the left side in 17.6% and partial separation on the right side in 49.5%, on the left side in 59.3%<sup>[14]</sup>. The present study differs a lot from the study by Sturrock, Anil & Hatiboglu and Patel and Singel.

Hussain Saheb S. observed complete separation was present in 20.8% on the right side and 16.8% on the left side. Partial septation was present in 45.6% on the right side and in 58.4% on the left side. Non separation was present in 33.6% on the right side and in 24.8% on the left side<sup>[15]</sup>. These findings are close to our study. Pereira, GAM. noticed in their study that in 0.9% of them (one skull) there was a completed bone septum on both sides; 0.9% (one skull) showed uncompleted bone septum on both sides, and 83.8% (93 skulls) did not show bone septum on both sides at all<sup>[11]</sup>.

Ekinci and Unur found that in 61.4% of cases the right jugular foramen was larger than the left. In 24.3% the left was larger and in 14.3% they were equal in size. Bony bridging was observed in 20% of cases and was not in 80%. In addition to, one tripartite jugular foramen was observed<sup>[10]</sup>. Hussain Saheb S. studied 125 skulls (south india) and observed that in 64.8% the foramen was larger on the right side and in 24.8% it was

larger on the left side and of equal size in 10.4%<sup>[15]</sup>. The jugular bulb dome was present bilaterally in 49.6%, on the right side only in 27.2%, on the left side only in 8.8%, and absent in 14.4% of skulls.

#### **V. Conclusion:**

Variations in the size, shapes and compartments of jugular foramen might be a part of the ongoing evolutionary process. It may be also due to racial and genetic factors. This study provides detailed anatomy of jugular foramen. Knowledge of morphology, compartments and morphometry is important for neurosurgeons dealing with space occupying lesions in jugular foramen.

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