

A Morphological Study of Jugular Foramen

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Abstract

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. 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. The present study was undertaken in 263(526 sides) different medical and dental institutions in Karnataka, India. Out of 263 skulls in 61.21% of cases the right foramina were larger than the left, in 13.68% of cases the left foramina were larger than the right and in 25.09% cases were equal on both sides. The jugular fossa present bilaterally in 30.79%, on the right only in 36.50% cases, on the left only in 27.37% cases and was absent in 53.23% cases.

INTRODUCTION

Jugular foramen lesions are among the major complications of skull base surgery. Morphological variations in the structure are pertinent during interpretation of skull base radiographs and in surgical procedures within the foramen. Jugular foramen of human skull is one of the most fascinating foramina. The jugular foramen, sometimes referred to as the posterior foramen lacerum, is situated in the floor of the posterior fossa posterolateral to the carotid canal, between the petrous temporal bone and the occipital bone. The term foramen is not strictly accurate because the jugular foramen resembles a canal with endocranial and exocranial openings. This canal is triangular in shape with its apex pointing anteromedially. The jugular foramen is a complex crossroad of neurovascular structures in the skull base. Anatomical variation in the course of the nerves and vessels adds to the complexity of this area. The contents of the jugular foramen are conventionally divided into the smaller pars nervosa, situated anteromedially, and the larger pars vascularis that is posterolateral, although this terminology is misleading as both contain vascular and neural structures. The jugular foramen transmits the internal jugular vein, inferior petrosal sinus, meningeal branch of ascending pharyngeal artery, glossopharyngeal, vagus and spinal accessory nerves. Lesions including paragangliomas, schwannomas, meningiomas, high Jugular bulb and trauma may occur in the foramen, constituting one of the major challenges experienced in skull base surgery [1,2,3,4].

The jugular foramen is difficult to understand and to access surgically; It is difficult to conceptualize because it varies in size and shape in different crania, from side to side in the same cranium, from its intracranial to extracranial end in the same foramen, because of its complex irregular shape, its curved course, its formation by two bones, and the numerous nerves and venous channels that pass through it. 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 [5]. 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 [6]. Ligation of the internal jugular vein 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. The jugular foramen is divided by a fibrous or bony septum into an anteromedial compartment and posterolateral compartment. The smaller pars nervosa is relatively more consistent in size compared with the larger and more variable pars vascularis [7]. Not all the cranial nerves pass through the pars nervosa as the name suggest. Only the glossopharyngeal nerve goes through the pars nervosa together with the inferior petrosal sinus. The vagus and accessory nerves travel with the jugular vein in the pars vascularis. Within the jugular foramen the glossopharyngeal nerve gives off the glomus bearing tympanic branch called the nerve of Jacobson. Intracranial and extracranial lesions may affect the jugular foramen in addition to intrinsic abnormalities. Pathological processes affecting the jugular foramen include intracranial meningiomas, paragangliomas, schwannomas, metastatic lesions and infiltrative inflammatory processes from surrounding structures such as the middle ear [8]. 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 [9]. As neurosurgeons become bolder in approaching this region, the need for familiarity with the detailed anatomy of this region becomes greater. Morphological studies provide useful information for anatomists, anthropologists, forensic and radiological practice [10,11,12,13,14]. The present study was concentrated to study morphological variations.

Table 1. Relative size of jugular foramina and the jugular bulb dome.

	Relative Size of foramen			Dome			
	R>L	R<L	R=L	BL	RO	LO	AB
Number	161	36	66	81	96	72	14
Percentage	61.21	13.68	25.09	30.79	36.50	27.37	53.13

R = Right L= left BL= Bilateral R.O = Right only L.O = Left only AB =Absent.

Table 2. Complete or partial separation or non-separation of compartments of jugular foramina.

	Separation of compartments					
	Complete		Partial		Non-separation	
	R>L	R<L	R=L	BL	RO	LO
Number	161	36	66	81	96	72
Percentage	61.21	13.68	25.09	30.79	36.50	27.37

MATERIALS AND METHODS

The present study was undertaken in 263(526 sides) different medical and dental institutions in Karnataka, India. The length, width and area of the jugular foramina were measured. Sagittal and transverse diameters were taken using vernier callipers. Each dimension was measured thrice and the mean figure recorded. Differences in the sides were analysed. The presence of jugular fossa and separation were also observed.

RESULTS

The size of the jugular foramen varied on the two sides. In the present study of 263 skulls R>L were 161(61.21%), R<L were 36(13.68%), R=L were 66(25.09%). The jugular bulb dome was present bilaterally in 81(30.79%), on the right side only in 96(36.50%), on the left side only in 72(27.37%), and absent in 14(53.13%) (Table 1). Complete or partial separation or non-separation of compartments of jugular foramina were observed as follows: Complete separation was present in 47(17.87%) on the right side and 56(21.29%) on the left side. Partial separation was present in 92(34.98%) on the right side and in 101(38.40%) on the left side. Non separation was present in 124(47.14%) on the right side and in 106(40.30%) on the left side (Table 2).

DISCUSSION

The size of the internal jugular vein directly influence on the size of jugular foramen and the presence or absence of a prominent superior bulb the right foramen is usually larger than the left. The variation in the anatomy of the intra cranial venous sinuses which accounts for variation in size and shape of jugular foramina but usually superior sagittal sinus as draining into the right transverse sinus. 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[12]. In the present study of 263 skulls right jugular foramen greater than left were 161(61.21%), right jugular foramen lesser than left were 36(13.68%), right jugular foramen equal to left were 66(25.09%). The jugular bulb dome was

present bilaterally in 81(30.79%), on the right side only in 96(36.50%), on the left side only in 72(27.37%), and absent in 14(53.13%) (Table 1).

Our results are in agreement with 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 [15]. Our results were correlated with study of Hatiboglu and Anil [16]. 300 Anatolian skulls from the 17th 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[16]. In same subcontinent of present study the earlier studies also giving similar results as present study, Patel and Singel [17] studied 91 Indian skulls 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. Hussain Saheb et al[12] study was given similar results from same region, in their study of 125 skulls R>L were 81(64.8%), R<L were 31(24.8%), R=L were 13(10.4%). The jugular bulb dome was present bilaterally in 62(49.6%), on the right side only in 34(27.2%), on the left side only in 11(8.8%), and absent in 18(14.4%).

In present study complete separation in jugular foramen was present in 47(17.87%) on the right side and 56(21.29%) on the left side. Partial separation was present in 92(34.98%) on the right side and in 101(38.40%) on the left side. Non separation was present in 124(47.14%) on the right side and in 106(40.30%) on the left side (Table 2). 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%. 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%. 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%. Hussain sahib et al[12] study of 125 skull jugular foramina were larger on the right side in 64.8%, larger on left side in 24.8% and equal in size in 10.4%.

CONCLUSION

In present study observed that right jugular foramen was larger than left and in majority skulls the jugular dome was present bilaterally. We also observed variations in jugular foramen morphology when compared the present study results with previous studies it may be because of geographical differences.

CLINICAL SIGNIFICANCE

The compartmentalization of the jugular foramen is an oversimplification and has no surgical significance. Instead, it is more useful to describe the petrosal, sigmoid and intrajugular portions of the jugular foramen. The petrosal portion contains the inferior petrosal sinus. The sigmoid portion receives the sigmoid sinus. The intrajugular portion contains cranial nerves IX, X, and XI.

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