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Morphological variation of the Jugular foramen of the human skulls in south Bihar population

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Abstract
Jugular foramen is a large opening in the base of the skull. It is formed by the two bones (petrous part of thetemporal bone and by the occipital bone). it is located behind the carotid canal. The jugular foramen varies in shape and size in different crania and even in same cranium from side to side. The jugular foramen also varies in different racial groups and sexes. It is generally said that although the Jugular foramen is larger on the right side compared to the left. The jugular foramen is the main route of venous outflow from the skull. Sigmoid sinus continues as internal jugular vein in posterior part of jugular foramen. The foramen's irregular shape, its formation by two bones and the numerous nerves and venous channels that pass through it further compound its anatomy. The shape and size of the foramen is related to the size of sigmoid sinus and the presence or absence of prominent jugular fossa. The present study was undertaken in 100 (250 sides) human adult dry skulls from Department of Anatomy J.L.N. Medical Col lege Bhagalpur, Bihar, India and also from the MBBS students of J.L.N. Medical College Bhagalpur, Bihar, India. Out of 100 skulls in 82% of cases the right foramina were larger than the left, in 5% of cases the left foramina were larger than the right and in 13% cases were equal on both sides. The jugular fossa present bilaterally in 52%, on the right only in 23% cases, on the left only in20 % cases and was absent in 5% cases.

Keywords: Jugular fossa, jugular foramen, compartments, separation

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 transmits the sigmoid sinus, inferior petrosal sinus, meningeal branch of ascending pharyngeal artery, glossopharyngeal, vagus, and spinal accessory nerves. The contents of the jugular foramen are conventionally divided into the smaller pars nervosa, situated anteromedially, and the larger pars vascularis that is posterolateral. The jugular foramen is divided by a fibrous or bony septum in to three compartments-two venous and a neural or intrajugular 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. The jugular foramen is difficult to understand and to access surgically; the difficulties in exposing this foramen are due to its deep location and the surrounding structures, such as the carotid artery anteriorly, the facial nerve laterally, the hypoglossal nerve medially and the vertebral artery inferiorly, all of which block access to the foramen and require careful management. It varies in size and shape in different crania and two sides of the same cranium. It also varries from its intracranial to extracranial end in the same foramen .Due to 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 very difficult to conceptualise. The jugular foramen can be regarded as a hiatus between the temporal bone and the occipital bone. The right foramen is usually larger than the left. The present work was carried out to study normal range of variations in relation to size, shape and compartments of jugular foramen.

Methodology
One hundred normal human adult skulls were procured from of the Department of Anatomy J.L.N. Medical Col lege Bhagalpur, Bihar, India and also from the MBBS students of J.L.N. Medical Col lege Bhagalpur, Bihar, 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 five times and the mean figure recorded. Differences in the sides were analysed. The presence of jugular fossa and septation were also oberved.

Fig 1: Measurements of size of jugular foramen By Vernier caliper

Fig 2: Picture showing relative size of jugular foramina (Right = Left)

Fig 3: Picture showing relative size of jugular foramina (Right > Left)

Fig 4: Picture showing Bilateral jugular bulb dome

Results

The size of the jugular foramen varied on the two sides. In the present study of 100 skulls R>L were 82(82%), R<L were 05(05%), R=L were 13(13%). The jugular bulb dome was present bilaterally in 52 (52%), on the right side only in 23 (23%), on the left side only in20 (20%), and absent in 05 (05%) (Table 1).

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

	Relative size of Jugular foramen			**Jugular bulb dome**			
	R > L	R < L	R = L	BL	R.O	L.O	AB
Number	82	05	13	52	23	20	05
percentage	82%	05%	13%	52%	23%	20%	05%

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

Complete or partial separation or non separation of compartments of jugular foramina were observed as follows:

Complete separation was present in 25 (25%) on the right side and 20 (20%) on the left side.

Partial separation was present in 42 (42%) on the right side and in 64 (64%) on the left side.

Non separation was present in 36 (36%) on the right side and in 22(22%) on the left side (Table 2).

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

	Seperation of compartments					
	Complete		**Partial**		**Non-seperation**	
	R	L	R	L	R	L
Number	25	20	42	64	36	22
Percentage	25%	20%	42%	64%	36%	22%

Discussion

The size and shape 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 the right foramen is usually larger than the left .Standard text books says, superior sagittal sinus as draining into the right

transverse sinus but 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 foramina. 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 brachio-cephalic veins. 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 [3]. Hatiboglu and Anil [4] studied 300 Anatolian skulls from the 17thand 18thcenturies 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 reminder 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..

Patel and Singel [5] 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. (*Hussain /Mavishetter/ Thomas/Prasanna/Muralidhar).* In the present 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%. The jugular fossa was present bilaterally in 49.6% cases, on the right only in 27.2% cases, on the left only in 8.8% cases and absent on both sides in 14.4%.

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%.

Conclusion

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

Clinical significance

The compartmentalization of the jugular foramen is an oversimplification and 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.s

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