Original Research Article

A cross sectional study of morphometric aspects of the jugular foramen and jugular fossa in dry skulls

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Received: 10-06-2021 / Revised: 02-08-2021 / Accepted: 25-09-2021

Abstract

Introduction: Jugular foramen is most complex irregular bony canal. Many important nerves and vessels are passing through it. The foramen presents variations regarding shape, size and laterality for the same skull besides differences related to sex and race. Vesalius studied variations in shape and compartmentations. Many osteological, radiological and micro dissections studies tried to solved the mystery of partitions and variations of the foramen. **Materials and Methods:** The present cross sectional observational study was carried out in the Department of Anatomy, RVM Institute of Medical Sciences and Research Center, Laxmakkapally, Mulugu, Siddipet from January 2020 to December 2020. A total of 60 dry human skulls were included in this study. The sample size was taken at conveniences. Only adult skulls (as identified by suture closure) were included in study. Broken or malformed skulls were excluded from study. Skulls with pathological or traumatic damage were also excluded. The measurements were made by two separate researchers to avoid observer error. The mean value of two researchers was considered finally. All the measurements were taken with the help of digital vernier caliper accurate to 0.01 mm. **Results:** Antero-posterior and transverse diameters of right jugular foramen were found to be more than left one. Complete septation of jugular foramen was observed in 1.67 % and 2.5 % skulls on right and left side respectively. Bony roof or dome of jugular fossa was observed in 30 %, 17.5 % and 16.67 % on the right side, the left side, and bilaterally respectively. In 10.83 % skulls, we found an accessory foramen connecting jugular foramen to anterior condylar canal. **Conclusion:** Detailed knowledge of various anomalies of jugular fossa and jugular foramen should be kept in mind while doing surgery by neurosurgeons and ENT surgeons. Radiologists also should keep these points in the mind while interpreting CT and MRI scans.

Keywords: jugular foramen, jugular fossa, dome, malformed skulls, ENT surgeons, CT, MRI

Introduction

Jugular foramen is most complex irregular bony canal. Many important nerves and vessels are passing through it. The foramen presents variations regarding shape, size and laterality for the same skull besides differences related to sex and race[1]. Vesalius studied variations in shape and compartmentations. Many osteological, radiological and micro dissections studies tried to solved the mystery of partitions and variations of the foramen[2].

Jugular foramen develops by the fusion and ossification of periotic capsule and ala temporalis with parachordal plate of chondrocranium. Foramen is a large opening at the posterior end of the petro-occipital suture between petrous temporal anterolaterally and occipital bone postero medially. Its inferior smooth part is formed by lateral part of occipital bone and superior sharp irregular border formed by petrous part of temporal bone having a notch (intra jugular process) which divides foramen into two compartments[3].

Anteromedial small compartment (petrosal part /pars nervosa) contains inferior petrosal sinus with a branch of the ascending pharyngeal artery and glossopharyngeal nerve[4]. Posterolateral large compartment (sigmoid part /pars vascularis) receives drainage of sigmoid sinus as internal jugular vein with meningeal branch of occipital artery, vagus and spinal accessory[5].

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The present study was carried out with the aim to analyze the shape, size, presence of septa, presence of a domed bony roof and bilateral symmetry of the Jugular foramen in dry adult skulls of males and females in the central Indian population.

Materials and methods

The present cross sectional observational study was carried out in the Department of Anatomy, RVM Institute of Medical Sciences and Research Center, Laxmakkapally, Mulugu, Siddipet from January 2020 to December 2020.

A total of 60 dry human skulls were included in this study. The sample size was taken at conveniences. Only adult skulls (as identified by suture closure) were included in study. Broken or malformed skulls were excluded from study. Skulls with pathological or traumatic damage were also excluded. The measurements were made by two separate researchers to avoid observer error. The mean value of two researchers was considered finally. All the measurements were taken with the help of digital vernier caliper accurate to 0.01 mm.

Parameters Studied

Jugular Foramen:

a) Maximum antero-posterior diameter
b) Maximum transverse diameter
c) Bony septum, if any, was noted

Jugular Fossa

a) Maximum width of Jugular fossa
b) Depth of jugular fossa
c) Presence or absence of bony roof (Dome)

Statistical Analysis

The collected data was entered in Microsoft excel sheet. The statistical analysis was performed using SPSS version 11. Mean and standard deviation (SD) was calculated.

Results

The jugular foramen was larger on right side in 35 (57.5 %) skulls and larger on left in 5 skulls. In 20 (34.17 %) skulls, both foramina were of same size (shown in Table 1). Figure 1 depicts large right jugular foramen as compared to left jugular foramen.

Table 1: Laterality of Size of Jugular Foramen (JF)

S.No	Size of Jugular Foramen	Number of Skulls	Percentage
1	Larger right JF	35	57.5 %
2	Larger Left JF	05	8.33 %
3	Equal on both sides	20	34.17 %

Table 2: Various Parameters of Jugular Foramen and Jugular Fossa

S.No	Various Parameters Studied (in mm)	Right Side	Left Side
1	Antero-Posterior Diameter of Jugular Foramen	9.8 ± 1.2	7.2 ± 1.3
2	Max. Transverse Diameter of Jugular Foramen	14.9 ± 1.4	12.7 ± 1.3
3	Maximum Width of Jugular Fossa	8.13 ± 1.9	7.98 ± 1.6

Table 3: Presence of Bony Roof (Dome) of Jugular Fossa

		Number of skulls	Percentage
Presence of Dome	Right Side	18	30 %
	Left Side	10	17.5 %
	Bilateral	10	16.67 %
	No Dome	22	35.83 %

Jugular Foramen

a) Antero-Posterior Diameter of Jugular Foramen

The mean AP diameter of jugular foramen (Table 2) was found to be 9.8 ± 1.2 mm on right side and 7.2 ± 1.3 mm on left side. The largest AP diameter observed on right side was 13.2 mm, and 11.4 mm on left side.

b) Maximum Transverse Diameter of Jugular Foramen

The mean transverse diameter of Jugular foramen also showed variation in measurements (on right side was 14.9 ± 1.4 mm and 12.7 ± 1.3 mm on left side; Table 2).

c) Presence of Bony Septum in Jugular Foramen

Most of the literature agrees that jugular foramen is divided into three compartments by two constrictions. We observed bilateral complete septation of jugular foramen in two compartments in 3 (2.5 %) skulls. Complete septation of right jugular foramen was observed in 2 (1.67 %) skulls and left jugular foramen only was found in 3 (2.5 %) skulls. Figure 2 shows complete septation of right jugular foramen. Figure 3 shows complete septation of left jugular foramen. Incomplete unilateral septation was observed in 29 skulls [9 skulls (7.5 %) on right and 20 skulls (16.67 %) on left side]. Figure 4 shows incomplete septation of left jugular foramen. Rest of the skulls no septation with single jugular foramen.

Jugular Fossa

a) Maximum Width of Jugular Fossa

The mean width of jugular fossa as observed on right side was 8.13 ± 1.9 mm and on left side 7.98 ± 1.6 mm (Table 2). Jugular fossae were much wider on right side than left side.

b) Bony Roof (Dome) of Jugular Fossa

The presence of bony roof or dome indicates the jugular bulb. Bony roof was observed in 18 (30 %) skulls on right side and 10 (17.5 %) skulls on left side. Bilateral dome (roof) was present in 10 (16.67 %) skulls. No dome was observed in 22 (35.83 %) skulls (Table 3).

c) Depth of Jugular Fossa: Depth was measured only when fossa has dome or bony roof. The mean depth of jugular fossa on right side was found to be 10.9 ± 1.2 mm and 10.5 ± 1.8 mm on left side (Table 2).

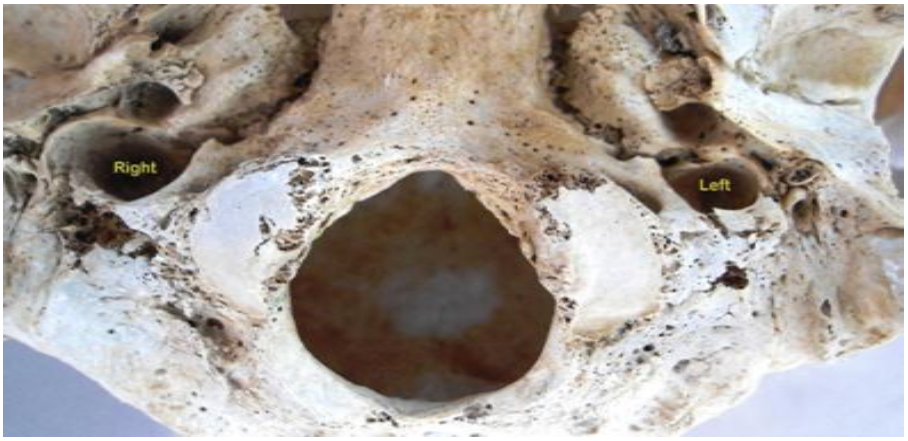

Fig 1: Large Right Jugular Foramen as Compared to Left Jugular Foramen

Fig 2: Complete Septation of Right Jugular Foramen. Arrow Showing Septum in Right Jugular Foramen

Fig 3: Complete Septation of Left Jugular Foramen. Arrow Showing Septum in Left Jugular Foramen Forming Round Foramen in Anterior Aspect

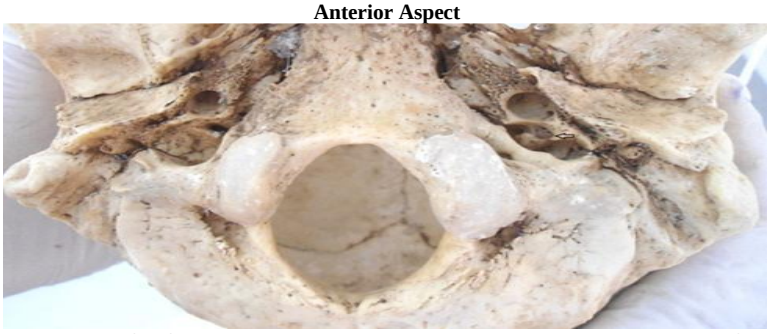

Fig 4: Incomplete Septation of Left Jugular Foramen. Arrow Showing Incomplete Septum in Left Jugular Foramen

Fig 5: Abnormal Communication between Jugular Foramen and Anterior Condylar Canal. Thread Passing Through the Abnormal Communication

Discussion

In the present study, we made a sincere attempt to study the normal anatomy of jugular foramen and jugular fossa. The shape and size of the jugular foramen is dependent on the size of the internal jugular vein and the presence or absence of a prominent superior bulb of the internal jugular vein. It is generally expected that the right jugular foramen is larger than the left, since superior sagittal sinus as draining into the right transverse sinus[6]. The variations in size and shape of

jugular foramen are also contributed to variations in the anatomy of intracranial venous sinuses[7]. The difference in the size of two internal jugular veins is visible during development at 23 weeks stage of embryo, which results from different developmental pattern of right and left brachiocephalic veins.

The various values of antero-posterior diameter of jugular foramen as observed by other researchers. Our values of AP diameter are very comparable to values observed by other authors like Pereira et al, Idowu and Singla et al. The values of transverse diameter of jugular foramen in the present study was found to be 14.9 ± 1.4 mm on right side and 12.7 ± 1.3 mm on left side. The values by Pereira et al and Singla et al are on higher side while values by Idowu are on lower side as compared to our study findings[7]. The difference in the values may be contributed to difference human races and geographical regions in which the study was carried out. Pereira1 studied south Brazilian population, Idowu studied Nigerian population, Hatiboglu & Anil examined Antolian skulls, Patel & Singel carried their study in Saurashtra region and Singla et al studied Northwest Indian population. Furthermore, Wysockiet al quoted in their study that variations in the size of foramina are due to racial and individual factors[8].

In this study, depth of jugular fossa was found to be 10.9 ± 1.2 mm and 10.5 ± 1.8 mm respectively on right and left side. Singla et al8 recorded same as 11.11 ± 2.96 and 11.04 ± 3.75 mm respectively (ranging between 5 and 11 mm). According to Anson, depth of jugular fossa ranges between 0 and 14 mm. Singla et al8 quoted that depth may be related to high jugular bulb causing conductive deafness because of its contact with tympanic membrane causing interference with ossicular chain and obstructing round window[9]. This high jugular bulb may also cause interference during cochlear implantation. High jugular bulb close to internal acoustic meatus may also impose some problems during surgical interventions for vestibular schwannomas. Accessory foramen connecting jugular foramen with anterior condylar canal can cause spread of infection[10].

The major limitation of our study was the small sample size. If large number of skulls would have been included, the results would change a bit. The present study put light on various aspects of jugular foramen and jugular fossa as well as added data in Indian population.

Conflict of Interest: Nil
Source of support: Nil

Conclusion

The observed variation of jugular foramen is possibly due to constitutional, racial or genetic factors. This study is expected to provide a clear understanding of the jugular foramen anatomy and supports reported morphometric variations. Anatomical variations especially slit like jugular foramen and jugular fossa with high depth may be the reason for unusual clinical diagnosis. Variations from normal may put the structures of jugular foramen and fossa at risk during microsurgical procedures in this region. So the knowledge of these variations may be important for neurosurgeons, radiologists as well as anthropologists

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