ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Morphometric And Morphological Variations Of Jugular Foramen And Its Clinical Significance In Adult Dry Human Skull In Tertiary Care Hospital.

Gnanavel A[1], Karthick S[2], Lalitha R[3], Saravana Kumar S[4], Thamarai Selvi A[5]*, and Sarath Kumar S[6].

[1]Professor, Department Of Anatomy, Faculty Of Medicine, Meenakshi Medical College Hospital & Research Institute, Meenakshi Academy Of Higher Education And Research, Tamil Nadu, India.
[2]Professor& HOD, Department Of Anatomy, Faculty Of Medicine, Meenakshi Medical College Hospital & Research Institute, Meenakshi Academy Of Higher Education And Research, Tamil Nadu, India.
[3]Associate Professor, Department Of Anatomy, Faculty Of Medicine, Meenakshi Medical College Hospital & Research Institute, Meenakshi Academy Of Higher Education And Research, Tamil Nadu, India.
[4]Associate Professor, Department Of Anatomy, Faculty Of Medicine, Meenakshi Medical College Hospital & Research Institute, Meenakshi Academy Of Higher Education And Research, Tamil Nadu, India.
[5]Associate Professor, Department Of Anatomy, Faculty Of Medicine, Meenakshi Medical College Hospital & Research Institute, Meenakshi Academy Of Higher Education And Research, Tamil Nadu, India.
[6]Post Graduate, Department Of Anatomy, Faculty Of Medicine, Meenakshi Medical College Hospital & Research Institute, Meenakshi Academy Of Higher Education And Research, Tamil Nadu, India.

ABSTRACT

The jugular foramen remains one of the most complex regions of the human body. Approaching lesions in this area requires extensive anatomical knowledge and experience, due to the many critical neurovascular structures passing through or around the jugular foramen. The present study was performed to analyze the length, width, area, and depth of right and left jugular foramen, Presence or absence of doom of jugular fossae, number of septa in right and left jugular foramina, Type of septa (complete or incomplete) in right and left jugular foramina. The study was conducted in the year 2021 with 50 dried human skulls (100 foramina were studied) at Meenakshi Medical College & Research Institute, Kancheepuram parameters measurements were made with the use of digital Vernier caliper1.Maximum anteroposterior and mediolateral diameter of Jugular Foramen2.Width and Depth of Jugular Fossa 3. Area of Jugular Foramen4. Presence of septum in the Jugular Foramen 5. The presence or absence of a dome of the jugular fossa. The findings of a jugular foramen in the present study bring to give a wide variety of important facts as follows; the dimensions of the jugular foramen were considerably larger on the right side than compared on the left. The mean mediolateral diameter of JF on right was 12.78 ± 1.8 mm and left 11.88 ±1.68 mm. The width measured on the right side is 12.95±2.01 mm and 16.97 ± 1.7 mm on the left side. The mean area of jugular foramen on the right side was 167.68 ±46.4mm and on the left 147.44 ±34.75mm. The mean depth of the jugular foramen on right was 11.9± 1.9mm and on the left 11.38 ±1.8mm. The mean length of the apex of the mastoid process to JF on the right side was 18.58 ±2.5 mm and on the left was17.87± 2.6 mm. In the present study the jugular foramen shows various variability in terms of shape, size, area, septations, the position of the carotid canal, and the average mediolateral and anteroposterior measurements of the jugular foramen dimensions were more towards the right side when compared to the left side. The knowledge about the morphometric and morphological variations of JF helps the neurosurgeons to understand the progression of diseases and also helps in a better approach during the base of skull surgeries.
Keywords: Jugular foramen, morphology, Neurosurgery, compression of nerves.

https://doi.org/10.33887/rjpbcs/2023.14.4.32

Corresponding author

ISSN: 0975-8585

INTRODUCTION

The jugular foramen is one of the largest irregular opening presents in the base of the skull, this foramen acts as a passage for the exit of various neuronal structures which emerges from the skull base [1]. It is located anterior to the lower opening of the carotid canal and posterior to the petrous part of the occipital bone, on the lateral side of the jugular foramen itis related to the styloid process and medially to the occipital condyle and hypoglossal canal. Since the jugular foramen is considerably larger on the right side than compare to the left side due to various contributing factors such as race and sex [2]. The jugular foramen is divided into three compartments. The vagus nerve, accessory, and glossopharyngeal nerve pass through the middle compartment of JF [3]. Various pathological conditions such as intracranial meningiomas, schwannoma, and neurofibroma occur in the posterior cranial fossa, the surgical exploration is the only treatment of choice which once considered impossible [4]. Hence the present study was carried out to analyze various parameters such as length, width area, number of septations, and position of the carotid canal which will be helpful from the neurosurgical point of view which was once considered terminal.

METHODS

The study was conducted on 100 jugular foramina from 50 dry human skulls. The skulls were obtained from the Department of Anatomy, Meenakshi Medical College and Research Institute. All the skulls belong to an adult human type of unknown sex with erupted third molar, without any signs of erosion, and well-defined suture lines are included. Skulls with damaged jugular foramen and eroded are excluded from the study. The following parameters were measured in this study [5]. Maximum mediolateral & anteroposterior diameter of Jugular Foramen, Area, depth of right and left jugular foramen, Number of septa in right and left jugular foramen, Position of the carotid canal about jugular foramen, To measure the distance of jugular foramen to the apex of mastoid process measurements were taken using digital vernier caliper with a precision of 0.1mm, data analysis includes calculation of mean, range, the standard deviation of each dimension separately and the comparison was made by student's t-test the association between variables was investigated using Pearson's coefficient[6].

Maximum mediolateral diameter of Jugular Foramen: The distance between the medial most and lateral most points of the Jugular Foramen. This corresponds to the length of the Jugular Foramen.

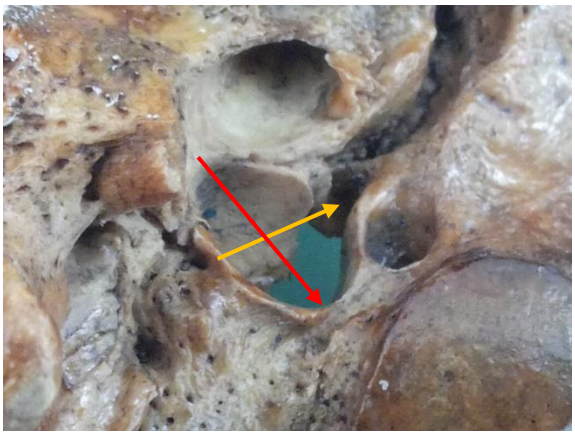


Figure 1: Showing maximum mediolateral diameter and anteroposterior diameter of the jugular foramen

Maximum anteroposterior diameter of Jugular Foramen: The distance between the anterior-most and posterior-most points of the Jugular Foramen. This corresponds to the breadth of the Jugular Foramen.

Area of Jugular Foramen: Derived as the length of the Jugular foramen multiplied by the breadth of the Jugular Foramen.

ISSN: 0975-8585

Depth of Jugular Fossa: Measured as the distance between the deepest point in the Jugular Fossa/summit of the dome, if the domed roof is present (point A) and a vertically corresponding point on the inferior border of the jugular fossa (point B) using a metallic probe and the reading was taken on a digital Vernier calliper.

The following morphological parameters were observed by the naked eye

Presence or absence of dome of the jugular fossa

Number of septa in right and left jugular foramen and type of septum (complete or incomplete) noted.

Figure 2: Shows septa present

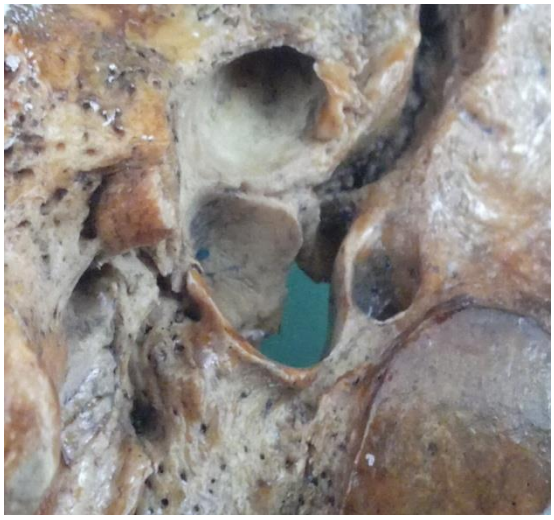


Figure 3: Shows septa Absent

Position of the carotid canal about jugular foramen

Figure 4: Antero medial to JF

Figure 5: Anterior to JF

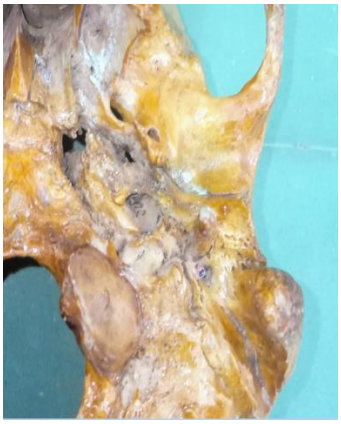


Figure 6: Anterolateral to JF

RESULTS

The average length of jugular foramen was found to be 12.78 mm on the right and 11.88 mm on the left side respectively. The width of the jugular foramen was 12.95mm on right and left side16.97mm (Table 1). The mean area of jugular foramen on the right was 167.68mm and on the left was 147.44mm. the average length of the apex of the mastoid process to the jugular foramen was 18.58 mm on the right side and 17.87 mm on the left side. There was statistical significance between the two sides in the length and apex of the mastoid process to the jugular foramen but there was a less statistically significant difference between the two sides in the width, area, and in-depth. There was a positive correlation

between the length and apex of the mastoid process on each side. Statistical analysis did show a significant positive correlation between the apex of the mastoid process and the length of the jugular foramen on both sides. The dome of jugular foramen was larger on the right side in 90% of skulls and on the left side in 74% of cases [Table 2]. The bilateral presence of the dome of the jugular fossa presents in 64%. The incidence of bridging of bone concerning jugular foramen revealed the presence of complete septation in 8% of skulls on the right side and 28% of skulls on the left side [Table 2]. The unilateral presence of a septum on the right side of the skull is 32% on the right side and 48% on the left side Incomplete septation and bilateral complete absence of septations are not seen in this study. The position of the carotid canal about jugular foramen in anterior relation is dominant on the right side 84% and on the left side, 52% of the skull the anteromedial relation of jugular foramen to the carotid canal is 8%on the right side, and 44% on the left side and the anterolateral relation to jugular foramen to the carotid canal is 8% on the right side and 4%. the bilateral presence of jugular foramen concerning the carotid canal is seen at 22% in the anterior, and 2% on the anteromedial side anterolateral relation of the carotid canal to jugular foramen is not observed in this present study.

Table 1: Morphometric Parameters Of Jugular Foramen

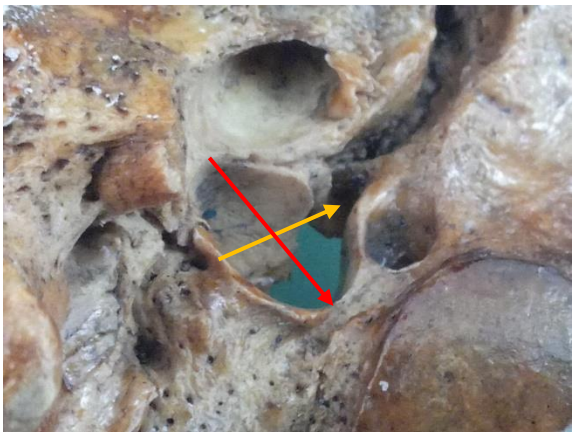
Morphometric measurements of JF	Right (mm)		Left (mm)		p-value
	Range	Mean ± SD	Range	Mean ± SD	
Length of JF	9.85– 17.05	12.78 ± 1.8	7.78 – 15.54	11.88 ±1.68	<0.01
Width of JF	9.43 – 16.97	12.95±2.01	7.94 – 16.2	16.97 ± 1.7	<0.05
Area of JF	104-293	167.68 ±46.4	79 – 238	147.44 ±34.75	<0.05
Depth of JF	8-15	11.9± 1.9	7-16	11.38 ±1.8	<0.05
Apex MP to JF	13.56-25.85	18.58 ±2.5	12.21-22.91	17.87± 2.6	<0.001

Table 2: Morphological Parameters Of Jugular Fossa

Sl. NO:	Morphological Parameters	features	Bilateral		Unilateral			
					right		left	
			Num.	%	Num.	%	Num.	%
1.	Dome of the jugular fossa	Present	32	64	45	90	37	74
		Absent	1	2	5	10	13	26
2.	Type of septa in jugular foramen (In some cases, incomplete and complete septa was seen in same skull)	Complete	6	12	4	8	14	28
		Incomplete	5	10	16	32	24	48
		Absent	-	-	30	60	12	24
3.	Position of carotid canal in relation to jugular foramen	Anterior	11	22	42	84	26	52
		Anteromedial	1	2	4	8	22	44
		Anterolateral	-	-	4	8	2	4

ISSN: 0975-8585

Figure 1: Showing maximum mediolateral diameter and anteroposterior diameter of the jugular foramen



Maximum mediolateral diameter of Jugular Foramen: The distance between the medial most and lateral most points of the Jugular Foramen. This corresponds to the length of the Jugular Foramen

Figure 2: Shows septa present **Figure 3: Shows septa Absent**

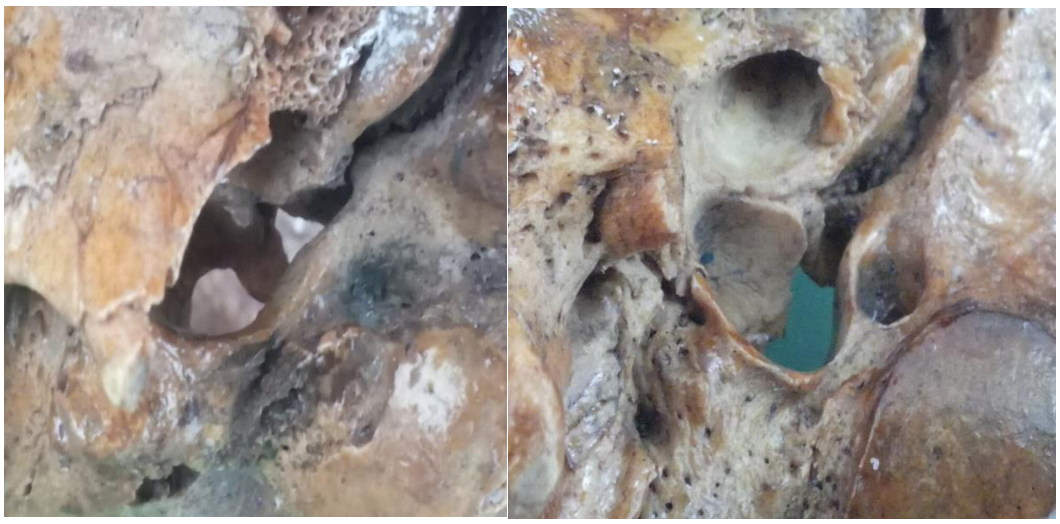


FIGURE :4 Position Of The Carotid Canal About Jugular Foramen

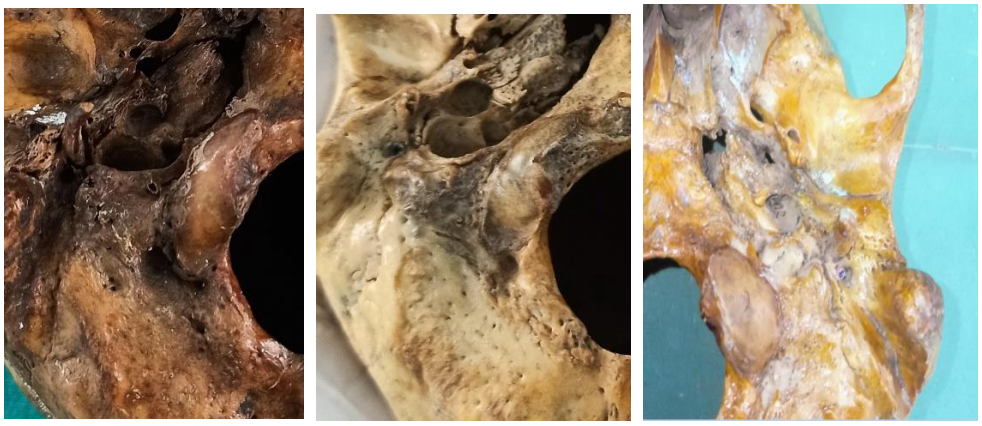


Figure 4: Antero medial to JF **Figure 5: Anterior to JF** **Figure 6: Anterolateral to JF**

ISSN: 0975-8585

DISCUSSION

The jugular foramen is one of the largest irregular hiatus presents in between the petrous part of the temporal bone and occipital bone. This jugular foramen has got both endocranial and exocranial opening this may be varied in size because of various races and ethnic groups. In the present study, the exocranial opening of jugular foramen has been measured morphometrically and morphologically for an easy approach to jugular foramen for neurosurgeons for exocranial operative procedures. N. Himabindu et al [7] studied the JF of 110 adult dry skulls and reported that mean RMLD was 14.6mm and mean L MLD was 12.69mm. Shifan Khanday et al [8] studied 648 JF of 324 skulls and found that mean R MLD was 14.6 mm and mean L MLD was 13.9 mm. In the present study, the mediolateral diameter of the jugular foramen ranged between 9.85mm to 17.05mm with a mean of 12.78 ± 1.8mm on the right side. The mediolateral diameter of the jugular foramen ranged from 7.78mm to 15.54mm with a mean of 11.88 ±1.68mm on the left side. The actual size of the jugular foramen varied on two sides in a skull however the right mediolateral diameter is larger than compared to the left mediolateral diameter in jugular foramen this could be the dominance and racial difference in the skulls. Chandni Gupta et al [9] studied 50 adult skulls and reported the R and L APD were 11.22 mm and 9.52 mm. Avanish Kumar et al [10] in their study of Jugular Foramen total of 68 skulls included with the mean of R APD was 10.6mm and L APD was 9.2 mm respectively. In the present study the R APD ranged between 3.43-16.97 with a mean of 12.95±2.01mm and the L APD ranged between 7.94 – 16.2 with an average mean of 16.97 ± 1.7 mm the difference in the mean value of R and L APD is due to the variations in the races and sex of induvial skull. The size and shape of JF are directly proportional to the internal jugular vein and the pattern of development of right and left brachiocephalic veins [10]. Vijisha P et al[11] conducted a study on 30 adult dry skulls and reported that the mean R area was 210.87mm and the mean L area was 141.93 mm. Chandni Gupta et al[9] studied 50 adult dry skulls and observed that the mean R area and mean L area were to be 187.34 mm and 153.2 mm respectively. In the present study the area of the Jugular Foramen on the right side ranged between 104-293 with an average mean of 167.68 ±46.4mm and on the left side ranged between 79 – 238 with an average mean of 147.44 ±34.75 mm the mean area is more on the right side than that of the left side this shows the venous drainage is more towards right side this is due to the presence of internal jugular vein on the dominant side of the individual [12]. Chandni Gupta et al [9] studied 50 adult dry skulls and reported that the mean R and L depth of jugular foramen were 11.58 and 11.13mm. The present study shows the average depth of jugular foramen on the right side ranged between 8-15 mm with an average of 11.9± 1.9 mm and on the left side ranged between 7-16 with an average of 11.38 ±1.8 mm the values of the present study coincide with the above study this parameter will be very much useful in assessing the growth of tumor such as paragangliomas for both radiologist and neurosurgeons[13]Nivethitha et al [14] studied 50 adult dry skull and reported the mean range of mastoid process to jugular foramen on right side 21.5mm and towards left 19.6mm. The Present study shows the average range of apex of the mastoid process to jugular foramen R side was 13.56-25.85mm with a mean of 18.58 ±2.5mm and towards L side were 12.21-22.91mm with a mean of 17.87± 2.6mm the accurate landmark of the jugular foramen is very essential for neurosurgeons to perform skull base surgeries.

Morphological parameters of the jugular foramen

Vijisha P et al [11] studied 30 adult dry skulls, the bilateral presence of dome is 70%, the right side was 26.6%, and the left side is 3.33% respectively. Avanish Kumar et al [15] studied the jugular foramen of 68 adult dry skulls, with the bilateral presence of JF at 57.35%, on the right side is 29.4%, and on the left side at 8.82% and was absent bilaterally at 4.41%.In the present study, the doom of the JF was present bilaterally at 64%, on the right side is 90%, and on the left side was observed at 74% [Table 2] bilateral absence of jugular foramen was noted at 2% unilateral presence of JF is 10% on the R side and 26% on L side. Peiris HRD et al [16] studied 75 dry skulls and reported that one complete septum was observed in 14.7% of L side and 10.6% of R side JF and an incomplete septum was noticed bilaterally in 70% of skulls. Roma Patel et al [17] studied 100 dry skulls and stated that the complete septum was present in 16% on the R side and 14% on the L side. the incomplete septum of JF was present in 29% of skulls on the R side and in 25% on the L side. In the present study bilateral complete septations were observed at 12%, unilateral presence of septations is present at 8% on the R side and 28% on the L side Bilateral incomplete septations were observed at 10%, unilateral incomplete septations were noted at 32% on the R side and 48% on L side. Complete absence of septations in JF was observed on 60% R side and 24% on the L side bilateral absence of septation was not observed. The incomplete septations of JF were more dominant on the L side than on the R, since the evolutionary process of development of JF and

the presence of septa can avoid the tumor invasion inside the JF and the data will be useful for radiologists & neurosurgeons. Bilateral presence of Position of the carotid canal about JF was observed anteriorly at 22%, unilateral presence of carotid canal about JF towards R side is 84% and 52% on L side. The anteromedial relation of the carotid canal to JF is 2% bilaterally, towards the R side is 8%, and 44% L side. Anterolateral relation of the carotid canal to JF on R side 8% and L side 4% bilateral anterolateral position of the carotid canal to JF was not observed in the presents study.

CONCLUSION

In the present study, the jugular foramen shows various variability in terms of shape, size, area, septations, the position of the carotid canal, and the average mediolateral and anteroposterior measurements of the jugular foramen dimensions were more towards the right side compared to the left side. The knowledge about the morphometric and morphological variations of JF helps the neurosurgeons to understand the progression of diseases and also helps in a better approach during the base of skull surgeries.

REFERENCES

[1] Vijisha p et al. Morphometric study of a jugular foramen in Tamil Nadu region. National Journal of Clinical Anatomy 2013;2(2):71-74.

[2] Sheetal Kotgirwar et al. Morphometric study of a jugular foramen in adult South Indian skulls. J Anat Soc India 2013;166-169.

[3] Govindarajan Amudha et al. Morphometric Study of Jugular Foramen and Jugular Fossa of Dried Adult Human Skulls and Its Clinical Significance. National Journal of Clinical Anatomy 2019;8(4):161-63.

[4] Vaibhav Prakash Anjankar et al. Morphometric Aspects of the Jugular Foramen and Jugular Fossa in Dry Skulls of Central India. J Evolution Med Dent Sci 2020; 38:2805-809.

[5] Patel MM, Singel TC. Variations in the structure of jugular foramen of the human skulls in the Saurashtra region. J Anat Soc India 2007;56(2):34-7.

[6] Khanday S, et al. Morphological and morphometric study of jugular Foramen in South Indian population. Int J Anat Res 2013;1,122–7.

[7] N Himabindu, G Supriya. Morphological and morphometric study of a jugular foramen in Telangana population. International Journal Of Medical Science And Clinical Inventions 2015;2(8):1212-1219.

[8] Shifan Khanday, Ramesh Kumar Subramanian, Melani Rajendran, Ashfaq Ul Hassan, Sajad Hamid Khan. Morphological And Morphometric Study Of Jugular Foramen In South Indian Population, International Journal of Anatomy and Research 2013; 1(3):122-27.

[9] Chandni Gupta, Punnose Kurian, Kantharaj Naik Seva, Sneha Guruprasad Kalthur, and Antony Sylvan D'Souza. morphological And Morphometric Study Of Jugular Foramen In Dry Skulls With Its Clinical Implications. J Craniovertebr Junction Spine 2014;5(3): 118–121.

[10] Padget DH. The development of cranial venous systems in man from the viewpoint of comparative anatomy. Contributions to embryology, 1957; 36:79 – 140.

[11] Vijisha P, Arun Kumar Billodi, Lokeshmaran. Morphometric study of Jugular Foramen in Tamil Nadu region, National Journal of Clinical Anatomy 2013; 2(2):71-74.

[12] SA Adejuwon, OT Salawu, CC Eke, RS Ajani. The Jugular Foramen and the Intracranial Volume; Are they Related?, Asian Journal of Medical Sciences 2011; 3(8): 143-145.

[13] G Coniglio, ML Lanza, A Uccello, M Coppolino, A Montana, GC Ettorre, Catania IT. Preoperative study of the petrous bone with Multi-Detector CT(MDCT): identification of anatomical risky conditions in otologic surgery ECR-2014/C-1031

[14] Nivethitha et all. Determining the position of jugular foramen concerning the mastoid process. Drug Invention Today 2018;10(12):2453-55.

[15] Avanish Kumar, Ritu, Md. Jawed Akhtar, Avanindra Kumar. Variations in the jugular foramen of a human skul. Asian Journal Of Medical Sciences 2015;6(2):95-98.

[16] HRD Peiris, et al. Morphological Variations in the Jugular Foramen and Hypoglossal Canal of Human Skulls in a Sri Lankan Population, Proceedings of the Peradeniya Univ. International Research Sessions, Sri Lanka 2014;18: 535:299.

[17] Roma Patel, CD Mehta. Morphometric study of Jugular Foramen at base of the skull in South Gujarat region. IOSR Journal of Dental and Medical Sciences 2014;13(9):58-61.