

Morphometric aspects of the jugular foramen in dry skulls of adult individuals in Southern Brazil

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Abstract

The jugular foramen (JF) lies between the occipital bone and the petrosal portion of the temporal bone, and it allows for the passage of important nervous and vascular elements, such as the glossopharyngeal vagus and accessory nerves, and the internal jugular vein. Glomtic tumors, schwannomas, metastatic lesions and infiltrating inflammatory processes are associated with this foramen, which can account for injuries of related structures. Variations of the JF were already reported regarding shape, size and laterality in one only skull, besides differences related to sex, race and laterality domain, which makes the study of these parameters in the population of southern Brazil significant. Objective: this paper wants to conduct the morphometric analysis of the JF of 111 dry skulls belonging to males and females. Results: the latero-medial the anteroposterior measurements showed significant differences when genera were compared and side was compared, respectively. Of the total amount of the investigated skulls, 0.9% showed a complete septum on both sides; 0.9% showed incomplete septum, and 83.8% lacked the septum. The presence of a domed bony roof was noticed in 68.5% of skulls on both sides. Conclusion: the obtained results presented variations regarding some parameters when compared to previous studies, thus making it evident the significance of race in the morphometric measurements and characteristics of the JF, besides the relevance of studying the kind of impairment which can jeopardize important functions, as the cardiac innervation of the vagus nerve.

Keywords: jugular foramen, gender, laterality, Brazilian population, osteology.

1 Introduction

The jugular foramen (JF) lies between the occipital bone and the petrosal portion of the temporal bone in the posterior end of the petrosal-occipital structure, and it is long and irregularly shaped. It is anteriorly separated from the inferior carotid opening by a crest; it is laterally related to the medial face of the styloid process covering, and separated from the hypoglossal channel through a thin bone bar. Its axis is projected antero-medially, with the right foramen being often bigger. Its anterior portion has the lower petrosal sinus; the intermediate portion or neural compartment involves the glossopharyngeal, the vagus and the accessory nerves; and its posterior portion or vascular compartment includes the internal jugular vein and the meningeal branches of the ascending pharyngeal and occipital arteries. The neural and vascular compartments are usually divided by a bone projection called the intrajugular process (HATIBOGLU and ANIL, 1992; PRADES, MARTIN, VEYRETSCH et al., 1994; WILLIAMS, WARWICK, DYSON et al., 1995).

The foramen presents variations regarding shape, size and laterality for the same skull, besides differences related to sex and race. Laterality dominance was also reported (WYSOCKI, CHMIELIK and GACEK, 1999; BERGE and BERGMAN, 2001; IDOWU, 2004).

The so-called anomalies of the jugular bulb are associated with the JF, as the glomtic tumors, which are often in direct contact with structures that cross it, as the internal jugular vein, the internal carotid artery, and the cranial nerves. Besides, schwannomas, metastatic lesions and infiltrating inflammatory processes can also occur. Microsurgical

techniques improvement, such as the lateral suboccipital access, have allowed for the removal of these lesions, previously regarded as not possible to undergo surgery (GUIDO and ZORZETTO, 1997; IDOWU, 2004). Therefore, the detailed study and the acknowledgement of the characteristics related to this foramen are indispensable.

This study wants to analyse the shape, size, presence of septa, presence of a domed bony roof and bilateral symmetry of the JF in dry adult skulls of males and females in the South of Brazil.

2 Material and methods

It was carried out the analysis of 111 dry skulls of adult individuals in southern Brazil, with 31 female skulls, and 80 male skulls, belonging to the of the Human Anatomy Laboratory of the Lutheran University of Brazil. The measurements were made by two researchers, separately. Comparison and mean of the collected data were provided right after. The research project was approved by Lutheran University of Brazil Ethical Committee.

As to size, the latero-medial and the anteroposterior measurements of the foramen were analysed and compared between males and females, between genera regardless of side, and between sides regardless of genus. The Mitutoyo calliper was used for the measurements.

Incidence of bone septum, intrajugular process, either on the right side and the left side regardless of genus, was also recorded, being either uncompleted (Figure 1) or completed (Figure 2) when present.

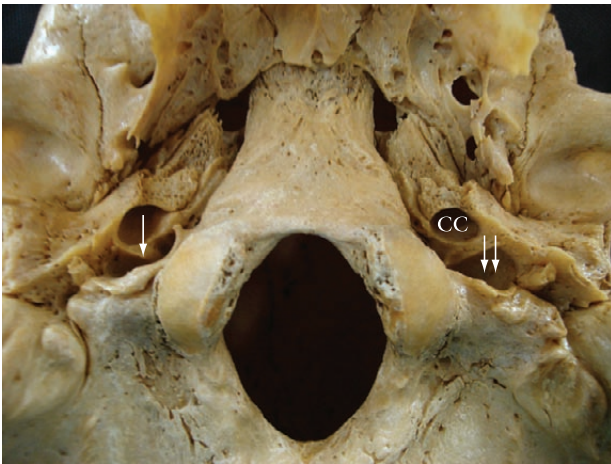


Figure 1. Right jugular foramen with uncompleted septum (single arrow); left jugular foramen with septum lack (double arrow); CC, carotid canal.



Figure 2. Larger right jugular foramen without septum and with domed bone roof (single arrow); left jugular foramen with completed septum (double arrow); CC, carotid canal.

The foramen opening was analysed according to the presence or absence of a domed bony roof, both on the right side and the left side regardless of genus.

Statistical analysis was conducted through Student's *t*-test for paired or independent samples, making it evident a significant difference when $p < 0.05$.

3 Results

Length-latero-medial measurement: Either in male skulls ($p = 0.910 > 0.05$) and female skulls ($p = 0.631 > 0.05$) there was no significant difference between the right and the left side (Table 1, A1, A2, B1, B2). As to genera comparison regardless of side, this measurement was significantly larger in male skulls ($p = 0.002 < 0.05$) (Table 1, C1, C2). When comparing the right side and the left side regardless of genus, there was no significant difference ($p = 0.902 > 0.05$) (Table 1, D1, D2).

Width-anteroposterior measurement: Comparison between the right side and the left side of male skulls showed a significant difference, seeing that the largest measurements were found for the right side ($p = 0.021 < 0.05$) (Table 2, E1,

Table 1. Lateral-medial measurement of the jugular foramen (mm; mean \pm standard deviation). A1, right side in male skulls; A2, left side in male skulls; B1, right side in female skulls; B2, left side in female skulls; C1, male skulls regardless of side; C2, female skulls regardless of side; D1, right side in male and female skulls; D2, left side in male and female skulls.

A1 (80)	16.18 \pm 2.72
A2 (80)	16.14 \pm 2.77
B1 (31)	14.89 \pm 2.34
B2 (31)	15.13 \pm 2.16
C1 (160)	16.16 \pm 2.73
C2 (62)	15.00 \pm 2.23
D1 (111)	15.82 \pm 2.67
D2 (111)	15.86 \pm 2.64

Table 2. Anteroposterior measurement of the jugular foramen (mm; mean \pm standard deviation). E1, right side in male skulls; E2, left side in male skulls; F1, right side in female skulls; F2, left side in female skulls; G1, male skulls regardless of side; G2, female skulls regardless of side; H1, right side in male and female skulls; H2, left side in male and female skulls.

E1 (80)	9.33 \pm 2.03
E2 (80)	8.65 \pm 1.70
F1 (31)	8.92 \pm 1.72
F2 (31)	8.65 \pm 1.19
G1 (160)	8.99 \pm 1.90
G2 (62)	8.78 \pm 1.48
H1 (111)	9.21 \pm 1.95
H2 (111)	8.65 \pm 1.57

E2); as to female skulls, there was no significant difference ($p = 0.435 > 0.05$) (Table 2, F1, F2). When comparing genera regardless of side, there was also no significant difference ($p = 0.389 > 0.05$) (Table 2, G1, G2). As to the right side and the left side a significant difference was found, with the right side showing a larger measurement ($p = 0.018 < 0.05$) (Table 2, H1, H2).

Presence of septa: Of the total 111 analysed skulls it was noticed 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.

Opening: Of the total amount of analysed skulls, 68.5% (76 skulls) showed a covered opening on both sides, and 4.5% (5 skulls) showed an uncovered opening on both sides.

4 Discussion

The found length measurements (latero-medial) and width measurements (anteroposterior) are near to the figures reported by Idowu, who found the mean length of 13.9 mm on the right side, and 14.11 mm on the left side, and the mean width of 10.2 mm on the right side, and 9.57 mm on the left side in Nigerian skulls. When width was analysed regarding genus data showed themselves apart from Idowu's, because a significant difference was found in this

measurement for the male skulls, which presented a wider right side. Hatiboglu and Anil in Turkish subjects' skulls, and Sturrock (1988), in a sampling of Roman-British skulls, have also found a larger area on the right side, although with a genus-independent analysis. According to Wysocki, Reymond and Skarzyński (2006), results variation can be explained by racial and individual factors. As to the individual factors, these authors mention the significant correlation between the size of the JF and also the hypoglossal channel with skull volume, thus pointing to the significance of cranial capacity for brain venous drainage.

As to completed or uncompleted septum, the obtained results are far from Sturrock's, who found completed septa on the right side in 3.2% of the foramina, and the same figure in foramina of the left side, besides uncompleted septa in 1.3 and 10.9% on the right side and the left side, respectively.

As to domed bony roof presence in the jugular foramen the results are similar to the ones by Sturrock, who reported 30% on the right side, and 6% on the left side, and results are also similar to the ones by Hatiboglu and Anil, with 36.6 and 4.6% on the right side and the left side, respectively.

Navsa and Kramer (1998) found a larger volume for the jugular foramen on the right side of female skulls both for the white and the black race. Schelling (1978) reported a significantly larger volume of the jugular foramen on the right side of female skulls. Findings do not make it evident a difference between the right side and the left side regarding width and length measurements; although the analysis of the latero-medial measurement for genus regardless of laterality showed the largest measurement in male skulls.

5 Conclusion

The large variation of the JF equally reported in previous studies is possibly due to constitutional, racial and/or genus factors. Comparison of some parameters was impaired by the scarce data regarding genus and the different approaches to measure this foramen as well. This study supports reported morphometric variations of the JF, besides adding data on the population of the Brazilian Southern region.

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