Morphometric study of the jugular foramen and sexual dimorphism using dried skull obtained in two Nigerian States

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Abstract

Objective: The objective of this study was to determine the morphometric variation between male and female jugular foramen using dried human skulls obtained in two Nigerian states.'

Methods: A total of ninety-three (93) dry human skulls were obtained from the osteology collection of the Department of Anatomy, University of Ilorin, Kwara state and Ladoke Akintola University Ogbomosho, Oyo state, Nigeria for this study. Using a digital Vernier caliper various morphometric features were measured.

Results: The mean right lateromedial distance was 14.69 (±2.31) mm and 13.78 (±1.95) mm for male and females respectively, the mean left lateromedial distance was 14.40 (±2.34) mm and 14.52 (±2.40) mm. Complete septa in males and females were 31.7% and 9.1% while incomplete septa in males and females 35.0% and 39.4% respectively.

Conclusion: There was no significant difference between the jugular foramen of both male and female skulls. The presence of complete septa is more in males while females has more of incomplete septa. The presence of dome, septa and dome height in both sexes were not sexually different from each other.

Keywords: Jugular foramen, morphometric, dome, septa, vernier caliper.

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Etude morphométrique du foramen jugulaire et du dimorphisme sexuel à l'aide de crânes séchés obtenus dans deux États nigérians

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Resume

Objectif: L'objectif de cette étude était de déterminer la variation morphométrique entre le foramen jugulaire masculin et féminin à l'aide de crânes humains séchés obtenus dans deux États nigérians. '

Méthodes: Quatre-vingt-treize (93) crânes humains secs ont été obtenus de la collection d'ostéologie du département d'anatomie de l'Université d'Ilorin, dans l'État de Kwara, et de l'Université Ladoke Akintola d'Ogbomosho, dans l'État d'Oyo, au Nigéria. En utilisant un pied à coulisse numérique, différentes caractéristiques morphométriques ont été mesurées.

Résultats: La distance moyenne latéro-latérale droite était de 14,69 (± 2,31) mm et 13,78 (± 1,95) mm respectivement chez les hommes et les femmes, la distance moyenne latéro-latérale gauche était de 14,40 (± 2,34) mm et 14,52 (± 2,40) mm. Les septa complets chez les hommes et les femmes étaient de 31,7% et 9,1%, tandis que les septa incomplets chez les hommes et les femmes étaient de 35,0% et 39,4% respectivement.

Conclusion: Il n'y avait pas de différence significative entre le foramen jugulaire des crânes masculin et féminin. La présence de septa complets est plus fréquente chez les hommes, tandis que les femmes ont davantage de septa incomplets. La présence du dôme, des septa et de la hauteur du dôme chez les deux sexes n'était pas sexuellement différente.

Mots clés: foramen jugulaire, morphométrique, dôme, septa, pied à coulisse.

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INTRODUCTION

The canal that lie between the occipital bone and the inferior and medial portion of the petrous pyramid of the temporal bone is known as Jugular foramen. It is an important route at the base of the skull for arterial, venous and nervous structures (1-4). The jugular foramen presents variations as regards shape, size and laterality for the same skull, besides changes related to sex and race (5, 6).

In other to measure these morphologic variations, the knowledge of morphometry has to be applied. Morphometry is defined as the quantitative analysis of *form,* this concept include size and shape. It can be used to quantify a trait of evolutionary significance, and detecting changes in shape of structures (12). Sexual dimorphism is a condition where two sexes of the same species exhibit different characteristics beyond the differences in their sexual organs. Morphometric study of jugular foramen was previously carried out by (6) on North western Indian population, a similar study was also done in southern India (7). In Nigeria, morphometric study of jugular foramen was done previously on adult male dry skull (8).

Since it has earlier been reported that variations exist in jugular foramen, the morphometric study of jugular foramen and its sexual dimorphism is unknown or scantly reported particularly in Nigeria. Hence this study was aimed at determining the morphometric variation which exists between the male and female jugular foramen in Nigeria using dried human skull.

MATERIALS AND METHOD

Approval for this study was obtained from the university ethical review committee (UERC) of university of Ilorin before the study began.

A total of ninety-three (93) dry human skulls; comprising of 60 males and 33 female were used. The skulls were obtained from the osteology collection of the Department of Anatomy, University of Ilorin, Kwara state and Ladoke Akintola University Ogbomosho, Oyo state, Nigeria. Skulls gender was determined using the description of Toledo Avelar et al., (14). The entire skulls were in good condition. A digital Vernier caliper (Qingdao Preco Imp. & Exp. Co., Ltd._Shandong, China) with an accuracy of 0.01mm was used for measurement (9). Antero-posterior (width) diameter of jugular foramen: this was done by measuring the maximum antero-posterior dimension of jugular foramen. **Presence or absence of dome shape roof of jugular foramen** was carried out by observation. Also, Septation in jugular foramen was done by observation. Lateromedial of jugular foramen (length) was carried out as maximum lateromedial measurement of jugular foramen. Depth: was measured between jugular fossa and dome.

Statistical Analysis

The data were analyzed using the Statistical Package for Social Sciences (IBM, version 23, Armonk, New York, USA). Statistical analysis employed include: Pearson's Chi-square trend analysis and t-test analysis of mean difference. $p<0.05$ was considered statistically significant.

RESULTS

Table 1 shows the descriptive characteristic and test of mean difference (T-test) between males and females. Sixty male skulls representing (64.5%) and thirty-three female skulls representing (35.5%) of the total population were analyzed. The mean of the right lateromedial width for male was 14.69mm±2.31 while the average size of the right lateromedial width for females was 13.78mm±1.95 there was no significant difference ($P > 0.057$). Similarly, there was no significant difference ($P > 0.815$) in left lateromedial width of male when compared to female (14.40±2.34 vs. 14.52±2.40). When the male and female right anterioposterior width were compared (8.87±1.62 vs. 9.02±1.98) there was no significant difference ($P > 0.683$). Similarly, there was no difference ($P > 0.596$) between male and female left anterioposterior width (9.65±1.58 vs. 9.84±1.80).

In table 2a, the distribution of right septa in males and females as well as their association was tested. The percentage of complete septa in male to female was 25 (41.7%) vs. 3 (9.1%), for incomplete 17 (28.3%) vs. 11 (33.3%) while that of none was 18 (30.0%) vs. 19 (57.6%). Generally, the males had higher ($p<0.003$) number of both complete and incomplete septa compared to the females. While the females had higher number ($p<0.003$) of none septa.

In table 2b, the distribution of left septa in males and females as well as their association was tested. The percentage of complete septa in male to female was 19 (31.7%) vs. 3 (9.1%), for incomplete 21 (35.0%) vs. 13 (39.4%) while that of none was 20 (33.3%) vs. 17 (51.5%). Generally, the males had higher ($p<0.039$) number of both complete and incomplete septa

compared to the females.

In table 3a, the distribution of right dome in males and females as well as their chi-square association was tested. The percentage of the presence (yes) of dome at the right in male to female was 35 vs. 21, for absence (No) 25 vs. 12. However, there was no significant difference between male and female ($P > 0.663$).

In table 3b, the distribution of left dome in males and females as well as their chi-square association was tested. The percentage of the presence (Yes) of dome at the right in male to female was 33 vs. 21, for absence (No) 27 vs. 12. However, there was no significant difference between male and female ($P > 0.419$).

In table 4, when the mean of right dome height in male and female (11.55±1.99 vs. 10.62±2.27) was compared, there was no significant difference ($P > 0.114$). Similarly, when the mean of left dome height in male and female (11.07±2.01 vs. 10.77±2.05) was compared, there was no significant difference ($P > 0.600$).

DISCUSSION

The jugular foramen presents variations as regards shape, size and laterality, besides changes related to sex and race (5, 6). Some of the morphometric features that are used in analyzing variations in jugular foramen are: anteromedial and posterolateral distance, lateromedial width, anterioposterior width, septa, dome and depth (10), (6).

In this study, there was no significant difference in right lateromedial width in both male and female neither was there significant difference in left lateromedial width in both male and female. Similar result was reported previously by (11), however their study was on 111 (31 females and 80 males) dry adult skull in southern Brazil.

Anteroposterior width is the maximum distance between anterior and posterior parts of the foramen (6). In this study, when the male and female right anterioposterior width were compared there was no significant difference. Similarly, there was no difference between male and female left anterioposterior width. Shruthi et al., (7) also reported the same result from southern India. On the contrary, (11) reported different outcome in male and female anterioposterior width. In their study, it was reported that the right and left side showed significant difference, with the right side showing a larger measurement. The observation presented in this result could arise as a result of racial differences. Bony septa that divide the foramen into compartments can either be complete or incomplete. Current result showed that right septa is more complete than the left while the left septa are more incomplete when compared to the right septa. Furthermore, males had more complete septa than the females while the number of incomplete septa is more in the females. This observation is different from the one reported by (10) but similar to the results of (3, 5).

The dome is one feature that can be used in jugular foramen morphometric analysis, it can be present or absent from jugular fossa. In the current study, the percentage of skulls that has dome present is more than those that has it absent. In terms of percentage sex variation of the dome, it is present more in females than in males for both right and left. (3), (10), (13), (6) all reported higher percentage for right dome than the left dome for unilateral parts. Their result is different from this current study probably because of racial difference.

The depth of jugular fossa is the measure of height from the summit of the dome to the inferior border of jugular fossa (6). In this study, when dome height in male and female for both right and left was compared, there was no significant difference. However those of males were slightly higher. It was reported previously that depth ranges from 5-15mm with mean depth at 11mm (6) in their work sex of the skulls used were no specified.

CONCLUSION

There was no difference between the jugular foramen of both male and female skulls. The presence of complete septa is more in males while females has more incomplete septa. The presence of dome, septa and dome height in both sexes were not sexually different from each other.

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Conflicts of interest: The authors declare no conflicts of interest.

REFERENCES:

1. Tubbs RS, Griessenauer CJ, Bilal M, Raborn J, Loukas M, Cohen-Gadol AA. Dural Septation on the Inner Surface of the Jugular Foramen: An Anatomical Study. Journal of Neurological Surgery Part B, Skull Base. 2015;76(3):214-7.
2. Moore KL, Dalley AF. Clinically Oriented

Anatomy: Lippincott Williams & Wilkins; 1999.
3. Gupta C, Kurian P, Seva KN, Kalthur SG, D'Souza AS. A morphological and morphometric study of jugular foramen in dry skulls with its clinical implications. Journal of Craniovertebral Junction & Spine. 2014;5(3):118-21.
4. Das SS, Saluja S, Vasudeva N. Complete morphometric analysis of jugular foramen and its clinical implications. Journal of Craniovertebral Junction & Spine. 2016;7(4):257-64.
5. Vlajkovic S, Vasovic L, Dakovic-Bjelakovic M, Stankovic S, Popovic J, Cukuranovic R. Human bony jugular foramen: some additional morphological and morphometric features. Medical science monitor : international medical journal of experimental and clinical research. 2010;16(5):Br140-6.
6. Singla A, Sahni D, Aggarwal A, Gupta T, Kaur H. Morphometric Study of the Jugular Foramen in Northwest Indian Population. J. Postgrad. Med. Edu. Res. 2012; 46 (4): 165-71.
7. Shruthi, B.N., Pavan, P., Havaldar, Shaik Hussain Saheb., Henjarappa K S. Morphometric Study of Jugular Foramen. Int J Intg Med Sci 2015, Vol 2(10):164-66.
8. Idowu OE. The jugular foramen—A morphometric study. Folia Morphol 2004; 63:419–22.
9. Kopecký M, Krejčovský L, Švarc M. Anthropometric Measuring Tools and Methodology for the Measurement of Anthropometric Parameters. 2014. 1st Edition. Pp 5-6.
10. Mahajan, A., Verma, R., Kumar, S., Mehra, R.D. Evaluation of osteologic parameters of jugular foramen and its significance with respect to expanded endoscopic endonasal approach. Eur. J. Anat. 2017. 21 (3): 225-233.
11. Pereira, G.A., Lopes, PT., Santos, A.M., Krebs, W.D. Morphometric aspects of the jugular foramen in dry skulls of adult individuals in Southern Brazil. Journal of morphology 2010; 27(1):3-5
12. Rao, T.C and Sreenivasulu, G. A Study of Status of Brain Morphometry Analysis in Neuroimaging. International Journal of Electronics and Communication Engineering. 2015 Vol (8) 1.51-64.
13. Vijisha, P., Bilodi, A.K., Lokeshmara, N. Morphometric study of jugular foramen in Tamil Nadu region. Nat J Clin Anat. 2013. 2(2): 71-74.
14. Toledo Avelar, L. E., Cardoso, M. A., Santos Bordoni, L., de Miranda Avelar, L., & de Miranda Avelar, J. V. Aging and Sexual Differences of the Human Skull. Plastic and Reconstructive Surgery - Global Open, 2017 5(4), e1297. doi:10.1097/gox.0000000000001297

Table 1: The descriptive characteristic and test of mean between males and females

SEX		N	Mean ±S.D	S.E	t-value	P-value	Inference
RIGHT L.M WIDTH	**Male**	60	14.69±2.31	0.3	1.930	0.057	NS
	Female	33	13.78±1.95	0.34			
RIGHT A.P WIDTH	**Male**	60	8.87±1.62	0.21	-.410	0.683	NS
	Female	33	9.02±1.98	0.34			
RIGHT JUG.WIDTH	**Male**	60	7.10±2.14	0.28	-.340	0.735	NS
	Female	33	7.26±2.14	0.37			
LEFT L.M WIDTH	**Male**	60	14.40±2.34	0.3	-.234	0.815	NS
	Female	33	14.52±2.40	0.42			
LEFT A.P WIDTH	**Male**	60	9.65±1.58	0.2	-.531	0.596	NS
	Female	33	9.84±1.80	0.31			

Table 2a: Distribution of the right septa in males and females and chi-square test of association

Sex	RIGHT SEPTA			Chi-square analysis		
	Complete	**Incomplete**	**None**	**df**	**?2-value**	**P-value**
Male (%)	25 (41.7)	17 (28.3)	18 (30.0)	2	11.75	0.003
Female (%)	3 (9.1)	11 (33.3)	19 (57.6)			
Total (%)	**28 (30.1)**	**28 (30.1)**	**37 (39.8)**			

Table 2b: Distribution of the left septa in males and females and chi-square test of association

Sex	LEFT SEPTA			Chi-square analysis		
	Complete	**Incomplete**	**None**	**df**	**?2-value**	**P-value**
Male (%)	19 (31.7)	21 (35.0)	20 (33.3)	2	6.468	0.039
Female (%)	3 (9.1)	13 (39.4)	17 (51.5)			
Total (%)	**22 (23.7)**	**34 (36.6)**	**37 (39.8)**			

Table 3a: Distribution of the right dome in males and females and chi-square test of association

Sex	RIGHT DOME		Chi-square analysis		
	Yes	No	df	-value	P-value
Male (%)	35 (58.3)	25 (41.7)	1	0.25	0.663
Female (%)	21 (63.6)	12 (36.4)			
Total (%)	**56 (60.2)**	**37 (39.8)**			

Table 3b: Distribution of the left dome in males and females and chi-square test of association

Sex	LEFT DOME		Chi-square analysis		
	Yes	No	df	$?^2$-value	P-value
Male (%)	33 (55.0)	27 (45.0)	1	0.652	0.419
Female (%)	21 (63.6)	12 (36.4)			
Total (%)	**54 (58.1)**	**39 (41.9)**			

Table 4: Mean dome height and test of mean differences between males and females

	Sex	N	Mean±S.D		t-value	P-value	Inference
R_DOME HEIGHT	**Male**	60	11.55±1.99	0.34	1.605	0.114	NS
	Female	33	10.62±2.27	0.49			
L_DOME HEIGHT	**Male**	60	11.07±2.01	0.35	0.527	0.600	NS
	Female	33	10.77±2.05	0.45			