ACTA SCIENTIAE ANATOMICA

ISSN: **2595-7651**
Acta Sci Anat. 2020;1(4):198-205.

An osteometric study of the mandibular foramen and incidence of the accessory mandibular foramen in dry adult Nigerian mandibles

Efe Jennifer Jaiyeoba-Ojigho[1]

ABSTRACT

Introduction: The mandibular foramen has been a landmark for several orthognathic surgeries; hence its position is vital in preventing neurovascular complications and misinterpretations. This research was carried out to determine the location of the mandibular foramen and to investigate the incidence of this accessory foramen in a Nigerian population. Material and Methods: Sixty-five (65) dry adult human mandibles were investigated. Parameters were obtained with a digital vernier caliper calibrated to 0.1mm. T-test was used to compare means between sides while one-way Analysis of variance was used to compare means between and within groups of measured parameters. Chi-square was used to test for an association between the 2nd and 3rd anterior posterior and superior inferior localization of the foramen. Significance was accepted at $p< 0.05$ Results: The mean AB-MF and PB-MF distance was 20.95±3.10mm and 13.73±1.87mm respectively while that of MN-MF was 24.64 ±3.06mm and 27.60 ±3.72mm for MF-MB. The mean MF-G dimension was 24.20±3.46mm, AB-PB was 37.02±3.88mm, MF(Width) was 2.34 + 1.17 while the MN-MF was 52.35±4.83mm. Accessory mandibular foramen was observed in 20% of the accessed mandibles. Further findings revealed a significant difference in the MF-G distance at $p<0.05$ ($t=2.349$; $p=0.020$; $Ssq=63.714$; $p=0.020$). Conclusion: Findings from this study showed that the Nigerian mandibles are located in the posterior region and superior half of the ramus. They were also located in the 2nd and 3rd quadrant superior-inferiorly and anterior-posteriorly while the accessory foraminas' were positioned superior- posterior to the mandibular foramen.

Keywords: Mandible, Mandibular foramen, Accessory foramen, Nigeria

INTRODUCTION

The mandibular foramen has been described as an opening located on the medial side of the ramus [1]. Several authors had reported that the inferior alveoli vessels pass through this foramen, crosses and contributes to the evolution of the anterior loop of the mandibular canal and divides into branches that supplies the lower jaw [2-3].

Accessory foramen discovered in mandibles are referred to openings situated in mandibles other than the teeth sockets, mental, mandibular and lingual foramina' [4]. The accessory foramen was reported as a path for the proliferation of tumors and infections following radiotherapy, and its incidence found to be greater on the medial as compared to the lateral surface [5-6]. Inaccurate localization of the foramen, presence of accessory foramen and

[1]Delta State University
Corresponding author: Efe Jennifer Jaiyeoba-Ojigho - efemenadelsu@gmail.com

supplementary branches of the inferior alveolar nerve are some of the factors responsible for nerve block failure.

Understanding the location of the foramen is of great value for many techniques in Medicine. Its exact position could provide an effective anesthesia which may further lead to a tranquil patient control [7]. According to Daw et al. [8] an explicit awareness of the anatomy of the foramen would aid in conducting an actual sagittal split of the ramus. It has been documented that during pterygomandibular procedure of nerve blockage, using a long needle sized 33mm for small mandibles may perforate the capsule of the parotid gland while using a short needle sized 21.5mm for individuals with big mandibles may cause needle fractures when completely introduced in the oral region [9]. Hence, knowledge of the anatomy and position of the foramen is highly imperative.

Several studies have been carried out on the morphology of the mandible among several populations [3,5,10-11] but there are limited information in a Nigerian population, therefore this study was carried out to determine the anatomical position of the mandibular foramen and also to investigate the presence of accessory foramen in a Nigerian population.

MATERIAL AND METHODS

The study was carried out on 65 dry adult mandibles of unknown age and sex. The mandibles were obtained from the Anatomy museum of University of Port Harcourt, Rivers state and Delta State University, Abraka, Nigeria. Mandibles that were completely or moderately dentated with preserved features and sockets for the 3rd molar tooth on either side were included for the study while mandibles that were damaged or not having sockets for the 3rd molar tooth were excluded from the study.

Prior to the study, Ethical approval was obtained from the Research and Ethics Committee of the Faculty of Basic Medical Sciences, Delta State University on the 16th of November 2018 (DELSU/CHS/ANA/18/68). Parameters of the mandibular ramus were obtained with a digital viernier caliper calibrated to 0.1mm and the following were measured bilaterally inorder to describe the location of the mandibular foramen (fig 1): distance from the midpoint of the anterior and posterior margin of the mandibular foramen to the proximate point on the anterior and posterior boarders of the ramus (AB-MF)/(PB-MF). The distance from the anterior to the posterior boarder (AB-PB) of the mandibular ramus was calculated inorder to determine the width of the ramus. Also the sum distance obtained from (AB-MF) and (PB-MF) were subtracted from the distance (AB-PB) to ascertain the width of the foramen. However half the width of the foramen gave the midpoint of the foramen (MpF). Other parameters recorded were the distance from the lowest end of the mandibular notch to the inferior boarder of the foramen (MN-MF) and the distance from the foramen to the mandibular base (MF-MB). Further parameters obtained were MN-MB which was referred to the extent from the lowest point of the notch to the base of the foramen while MF-G was reported as the extent from the mandibular foramen to the gonion [12] .

Inorder to locate the quadrant which the foramen was localized, parameters such as anterior posterior distance of the mandibular foramen(APD) , localization of the anterior posterior (APL) and superior inferior axis (SIL) were calculated. The parameters are shown below [12].

Values that were obtained< 26% made up the 1st quadrant, < 51% constituted the 2nd quadrant, <76% the 3rd quadrant while values that were between 76 to 100% made up the 4th quadrant [12].

Data were represented in frequencies, mean and standard deviation. T-test was used to compare means between the left and right sides of parameters of the mandibles. One way analysis of variance compared means between and within groups of measured parameters. Chi-square test was performed to show an association between the 2nd and 3rd anterior posterior and superior inferior localization of the foramen. Significance was accepted at $p< 0.05$.

Figure 1. Measured parameters

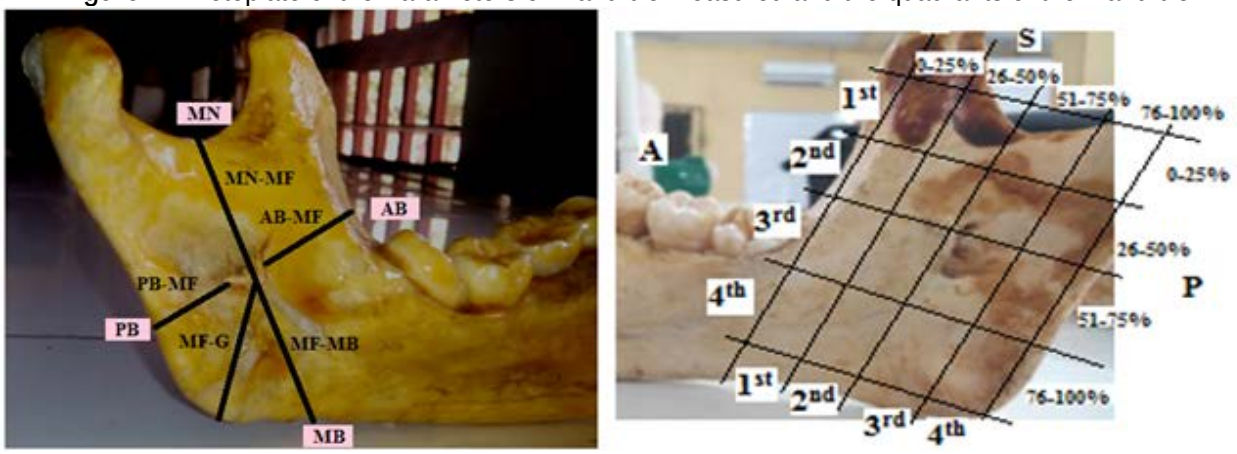
I. $(\mathrm{Ab} \rightarrow \mathrm{Pb}) - (\mathrm{Ab} \rightarrow \mathrm{Mf} + \mathrm{Pb} \rightarrow \mathrm{Mf}) = \text{width of foramen}(\mathrm{W_f})$

II. $\frac{\mathrm{W_f}}{2} = \text{midpoint of foramen}(\mathrm{MpF})$

III. $\mathrm{MpF} + \mathrm{Ab} \rightarrow \mathrm{Mf} = \text{anteriorposterior distance (APD) of Mf.}$

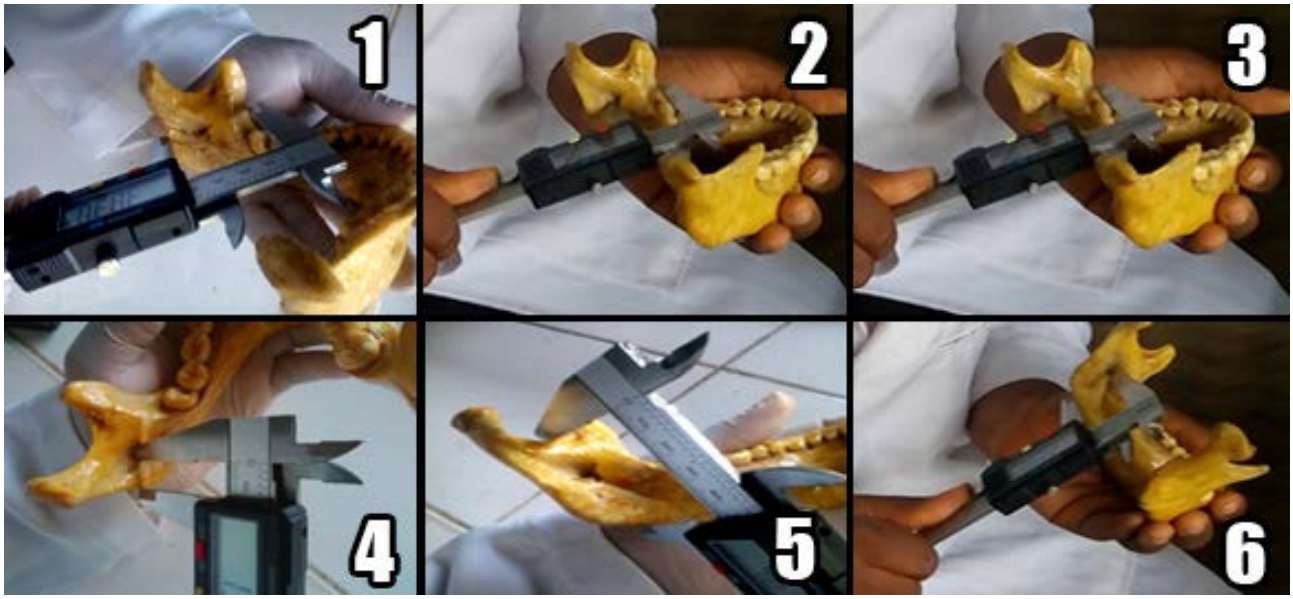
IV. $\frac{\mathrm{APD}}{\mathrm{Ab}\rightarrow\mathrm{Pb}} * 100 = \text{anterioposterior localization}(\mathrm{APL})$

Figure 2. Photoplate of the Parameters of mandible measured and the quadrants of the mandible.



*MN- mandibular notch, MF- mandibular foramen, MB- mandibular base of ramus , AB/PB- anterior and posterior boarder of mandibular ramus, G- gonion.

Figure 3. Measurements performed.*



*1: AP-PB; 2: AB-MF; 3: PB-MF; 4: MN-MB; 5: MF-MB; 6: MN-MF. MN- mandibular notch, MF- mandibular foramen, MB- mandibular base of ramus , AB/PB- anterior and posterior boarder of mandibular ramus, G- gonion,

RESULTS

The horizontal mean value from the anterior and posterior boarders of the foramen (AB-MF; PB-MF) for both sides were 20.95 ±3.10 and 13.73 ± 1.87 mm. The AB-PB diameter was obtained as 37.02 ± 3.88 mm (table 2). Further findings showed that the vertical dimension of the notch to the foramen (MN-MF) was seen as 24.64 ± 3.06 mm while from the foramen to the base of the ramus (MF-MB) was recorded as 27.90 ± 3.72 mm. The width of the mandible was reported as 2.34 ± 1.17 mm (Table 1).

Table 2 shows mean distances obtained for the right and left sides of the mandibles. Measurements were recorded to locate the position of the foramen as regards to the horizontal and vertical axis of the ramus. The study depicts that the average vertical distance from the notch to foramen (MN-MF) were recorded as 24.76 ± 3.05 and 24.52

± 3.08 mm while from the foramen to the base of the ramus (MF-MB) were obtained as 28.01 ± 3.58 and 27.79 ± 3.88 mm for the right and left side. The width of the foramen was 2.49±1.20 mm and 2.19 ±1.13mm for the left and right sides respectively.

In Table 3, the anterior posterior and superior inferior localization was reported. Findings showed that 50% each of the right and left sides of the mandibles were located on the 2nd and 3rd quadrant superior inferiorly and anterior posteriorly. Chi-square test revealed no significant association between the 2nd and 3rd quadrant, anterior posteriorly and superior inferiorly at $p < 0.05$

Accessory mandibular foramina were recorded in 13(20%) mandibles. Unilateral cases were observed in 10.77% as compared to 9.23% bilateral cases. Further findings showed that 6.15% each of AMF were found above the lingula and antilingula respectively; 4.62% was found anterior to the antilingula while 1.54% each were found posterior to the lingula and antilingula respectively (Tables 4 and 5).

One-way analysis of variance and the t-test revealed a significant difference in the MF-G distance.

Table 8 compared the result of the present study with previous studies of other populations carried out on the mandibular foramen.

Table 1. Parameters of the analyzed mandibles.

Parameters(mm)	No	Mean	Stand.dev	St.error	Minimum	Maximum
AB-MF	130	20.95	3.10	0.27	14.51	30.06
PB-MF	130	13.73	1.87	0.16	8.87	19.60
AB-PB	130	37.02	3.88	0.34	27.43	49.72
MN-MF	130	24.64	3.06	0.27	16.60	33.40
MF-MB	130	27.90	3.72	0.33	17.38	37.83
MN-MB	130	52.35	4.83	0.42	42.33	63.31
MF-G	130	24.20	3.46	0.30	16.66	31.91
MF WIDTH	130	2.34	1.17	0.10	0.07	5.79

*MN- mandibular notch, MF- mandibular foramen, MB- mandibular base of ramus, AB/PB- anterior and posterior boarder of mandibular ramus, G- gonion, AMF-accessory mandibular foramen.

DISCUSSION

Findings from the study showed that from a horizontal axis, the anterior posterior dimension was greater in the anterior than its posterior equivalent.

This indicates that the foramen of the Nigerian mandibles are located in the posterior region of the ramus. Findings were in accordance with previous studies by Oguz et al. study in Turkey [1] ; Ennes and Medeiros among the Brazilians [9]; Prajna et al. among Indians [13]; Afadhali and Fabian investigation in Tanzania[14]; Mbajiorgu on Zimbabweans [15]; Lavanya et al. and Padmavathi et al., studies in South India[16 ,17] . Further findings from this study showed that the left AB-MF dimensions were greater than the right side. This was similar to previous studies on different population [14-17].

However it was different from the Turkish and Brazilian population in which the right AB-MF length was greater than that of the left [1,9]. From this study, the anterior and posterior dimensions of the ramus to the foramen were different from those of the latter studies as shown in table 8. These variations could be as a result of age, ethnic differences and sex.

The study showed that from a vertical axis, the extent from the mandibular foramen to the mandibular notch was less than the distance to the mandibular base, entailing that the mandibular foramen was located in the superior half of the ramus. Findings were similar to Oguz et al. and Mbajiorgu studies among the Turkish and Zimbabweans mandibles [1,15].

Table 2. Parameters for the left and right sides of the mandibles.

		No.	Mean	Std. Deviation	Std. Error Mean	Maximum	Minimum
AB-MF	Right	65	20.708	3.159	0.392	30.06	10.13
	Left	65	21.188	3.052	0.379	28.86	15.48
MF-PB	Right	65	13.748	1.875	0.233	17.86	10.13
	Left	65	13.722	1.889	0.234	19.60	8.87
AB-PB	Right	65	36.943	3.861	0.479	49.65	27.43
	Left	65	37.098	3.927	0.487	49.72	27.77
MN-MF	Right	65	24.757	3.051	0.378	31.39	16.60
	Left	65	24.515	3.084	0.383	33.40	17.19
MF-MB	Right	65	28.006	3.580	0.444	37.83	17.38
	Left	65	27.787	3.883	0.482	36.51	18.56
MN-MB	Right	65	52.713	4.559	0.566	63.31	42.58
	Left	65	51.937	5.088	0.631	62.22	42.33
MF-G	Right	65	24.900	3.081	0.382	30.32	16.91
	Left	65	23.500	3.688	0.457	31.91	16.66
SIL(%)	Right	65	47.086	5.643	0.700	64.51	34.66
	Left	65	47.253	4.328	0.537	56.78	37.10
APL(%)	Right	65	59.014	5.180	0.642	69.28	37.81
	Left	65	60.170	3.835	0.476	69.03	51.64
SIZE	Right	65	2.488	1.197	0.149	5.79	0.33
	Left	65	2.188	1.133	0.141	5.25	0.07

*MN- mandibular notch, MF- mandibular foramen, MB- mandibular base of ramus, AB/PB- anterior and posterior boarder of mandibular ramus, G- gonion, AMF-accessory mandibular foramen.

Table 3. Superior-inferior and Anterior-posterior localization of the mandibular foramen.

Sides	Placed antero-posteriorly	Antero-posterior quadrant	Placed superior-inferiorly	Supero-inferior quadrant
Right	65(50%)	2nd & 3rd	65(50%)	2nd & 3rd
Left	65(50%)	2nd & 3rd	65(50%)	2nd & 3rd

*Antero-posteriorly (X2= 0.01; P value=1.00) Superior inferiorly (X2 = 2.031, P value=0.496)

Table 4. Incidence of Accessory Mandibular Foramen (AMF)

AMF	NUMBER	PERCENTAGE
Right side(unilateral)	5	7.69%
Left side (unilateral)	2	3.08%
Bilateral	6	9.23%
Absent	52	80%

Table 5. Location of the accessory mandibular foramen.

Location	Percentages
Above the Lingula	6.15%
Above the Anti-Lingula	6.15%
Anterior to the Anti-Lingula	4.62%
Posterior to the lingula	1.54%
Posterior to the Anti- lingula	1.54%

Table 6. Comparison of the different results regarding the accessory mandible foramen.

Authors and population	Side	AB-MF(mm)	PB-MF(mm)	AB-PB(mm)	MN-MF(mm)	MF-MB(mm)	MN-MB(mm)	MF-G(mm)
Oguz et al. [1] (Turkey)	R	16.90	14.09	-	22.37	30.97	-	-
	L	16.78	14.37	-	22.17	29.75	-	-
Ennes & Medeiros [9] (Brazilians)	R	9.40	8.60	-	18.30	-	-	-
	L	6.90	8.40	-	17.50	-	-	-
Lavanya et al. [16] (south Indians)	R	16.52	13.35	-	23.39	-	-	-
	L	16.94	13.46	-	24.41	-	-	-
Prajna et al. [13] (Indians)	R	15.72	13.29	-	22.70	-	-	21.54
	L	16.23	12.73	-	22.27	-	-	21.13
Padmavathi et al. [17] (South Indians)	R	16.80	11.7	31.6	22	-	47.0	22.2
	L	16.9	12.1	32.1	22.3	-	47.1	22.6
Afadhali & Fabian[14] (Tanzania)	R	19.88	12.69	-	21.54	-	-	26.23
	L	20.19	12.65	-	20.70	-	-	25.68
Present study Nigerian population	R	20.71	13.75	36.94	24.76	28.01	52.71	24.90
	L	21.19	13.72	37.10	24.52	27.79	51.94	23.50

*MN- mandibular notch, MF- mandibular foramen, MB- mandibular base of ramus, AB/PB- anterior and posterior boarder of mandibular ramus, G- gonion, AMF-accessory mandibular foramen.

The mandibular foramen from this study were located in the 2nd and 3rd quadrant superior-inferiorly and anterior-posteriorly. Findings were similar to a study carried out on the Brazilian mandibles which showed that the foramen was positioned at the 3rd quadrant anterior-posterioly and superior-inferiorly [9]. However studies among the Indians and South Indians [12,17] discovered the foramen at the junction of the 2nd and 3rd quadrant from a superior-inferior view, which was not in accordance with my study. Further findings showed that there was no significant association in the position of the foramen on either sides from an anterior-superior and a superior-inferior perspective. The result was similar to that of Shalini et al. study among the Indian mandibles.

The accessory mandibular foramen has been reported to transmit the branches of the inferior alveolar, mylohoid and facial vessels which makes it clinically significant [18]. It has also been documented that these branches are one of factors that may lead to an improper nerve block [12]. Findings from this study showed that bilateral were more than unilateral cases, which could be attributed to chance because informations on it are lacking. However, findings were different from studies by Shalini et al., Padmavathi et al. and Murlimanju et al. [12, 17-18]. Further findings showed that the accessory foraminas' were located

above the lingual and anti-lingula, anterior to the lingual and posterior to the lingula and antilingula respectively. It can therefore be ascertained that the commonest position of the accessory foramen of the Nigerian mandibles is superior posterior to the mandibular foramen.

The study also showed that the dimensions from the mandibular foramen to the gonion were higher for the right sides as compared to the left. The dimensions obtained for both right and left sides differed from that of the Tanzania mandibles [14], which showed that despite Negriods having similar skull pattern, they may be slight differences in component parts of the skull.

The study discovered a significant difference in the MF-G distance. This implies that the dimensions MF-G on either side of the mandible are asymmetrical.

CONCLUSIONS

Findings from this study showed that the Nigerian mandibles were located on the second and third quadrant superior-inferiorly and anterior-posteriorly. it can also be ascertained that the foramen was found more at the posterior and superior aspect of the mandibular ramus from the midline horizontally and vertically.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

ACKNOWLEDGMENTS

My appreciation goes to Dr Ezon- Ebidor Innocent Edibamode and Miss Mounagor Onyinyechi for their assistant towards this research work. I also want to appreciate Prof. Patrick Sunday Igbigbi, Professor of Human Anatomy, for reviewing the manuscript.

REFERENCES

1. Oguz O, Bozkir MG. Evaluation of location of mandibular and mental foramina in dry, young, adult human male, dentulous mandibles. West Indian Med J. 2002;51:14–16.

2. Bavitz JB, Harn SD, Hansen CA, Lang M. An anatomical study of mental neurovascular bundle-implant relationships. Int J Oral Maxillofac Implants. 1993;8:563–567

3. Yu SK, Kim S, Kang SG, Kim JH, Lim KO, Hwang SI, Kim HJ. Morphological assessment of the anterior loop of the mandibular canal in Koreans. Anat Cell Biol. 2015;48:75–80

4. Przystanska A, Bruska M. Accessory mandibular foramina: histological
and immunohistochemical studies of their contents. Arch Oral Biol.2010;
vol 55, pp. 77-80

5. Fanibunda K, Matthews JN. Relationship between accessory foramina and tumour spread in the lateral mandibular surface. J Anat. 1999;195(Pt 2):185–190.

6. Das S. Suri RK. An anatomico-radiological study of an accessory
mandibular foramen on the medial mandibular surface. Folia Morphol. 2004;
vol 63, Pp. 511-513.

7. Heasman PA. Variation in the position of the inferior dental canaland its significance to restorative dentistry. J Dent 1987;16:36-9

8. Daw JL, Jr, de la Paz MG, Han H, Aitken ME, Patel PK. The mandibular foramen: an anatomic study and its relevance to the sagittal ramus osteotomy. J Craniofac Surg. 1999;10:475–479

9. Ennes JP, Medeiros RM. Localization of mandibular foramen and clinical implications. Int J Morphol. 2009;27:1305–1311

10. Neiva RF, Gapski R, Wang HL. Morphometric analysis of implant-related anatomy in Caucasian skulls. J Periodontol. 2004;75:1061–1067.

11. Komar D, Lathrop S. Frequencies of morphological characteristics in two contemporary forensic collections: implications for identification. J Forensic Sci. 2006;51:974–978

12. Shalini R, Ravivarman C, Manoranjitham R, Veeramuthu M. Morphometric study on mandibular foramen and incidence of accessory mandibular foramen in mandibles of south Indian population and its clinical implications in inferior alveolar nerve block . Anat. Cell Biol.2016;49(4): 241-248

13. Prajna PS, Poonam K. Morphometric analysis of mandibular foramen and incidence of accessory mandibular foramina in adult human mandibles of an Indian population. Original communication. Rev Arg de Anat Clin. 2013; Vol 5(2), pp. 60-66.
14. Afadhali DR, Fabian MF. Position of the mandibular foramen in adult male Tanzania mandibles. Ita. J. of Anat. Embry. 2014; Vol. 119(3), pp. 163-168.
15. Mbajiorgu EF. Position of the mandibular foramen in adult black Zimbabwean mandibles. Cent Afr J Med. 2000;46:184–190
16. Lavanya CV, Imtiazul H, Rajeshwari T. Position of Mandibular Foramen in South Indian Mandibles. Anat. Karnat.,2011. Vol 5, Pp 53–6.
17. Padmavathi G, Suman T, Varalakshmi KL, Roopashree R. An anatomical study of the mandibular foramen and accessory mandibular foramen in Dry Adult Human Mandibles of South Indians Origin. J of Dent. Med. sc. 2014. Vol 13(4). pp 83-88.
18. Murlimanju BV, Latha VP, Prameela MD, Ashraf MC, Krishnamurthy A, Kumar C, Ganesh K. Accessory mandibular foramina: prevalence, embryological Basis and surgical Implications. J. Clin. Diag. Research. 2011; Vol. 5(5), pp. 1137-1139

RESUMO

Estudo osteométrico do forame mandibular e incidência do forame mandibular acessório em mandíbulas nigerianas adultas secas

Introdução: O forame mandibular tem sido um marco para várias cirurgias ortognáticas; portanto, sua posição é vital na prevenção de complicações neurovasculares e interpretações errôneas. Esta pesquisa foi realizada para determinar a localização do forame mandibular e investigar a incidência desse forame acessório em uma população nigeriana. Material e Métodos: Sessenta e cinco (65) mandíbulas humanas adultas secas foram investigadas. Os parâmetros foram obtidos com um paquímetro digital calibrado para 0,1 mm. O teste T foi usado para comparar médias entre os lados, enquanto a Análise de Variância unidirecional foi usada para comparar médias entre e dentro dos grupos de parâmetros medidos. O Qui-quadrado foi utilizado para testar a associação entre a 2ª e a 3ª localização anterior posterior e superior inferior do forame. A significância foi aceita em p <0,05. Resultados: A distância média entre AB-MF e PB-MF foi 20,95 ± 3,10mm e 13,73 ± 1,87mm, respectivamente, enquanto a MN-MF foi 24,64 ± 3,06mm e 27,60 ± 3,72mm para MF-MB . A dimensão média do MF-G foi de 24,20 ± 3,46 mm, o AB-PB foi de 37,02 ± 3,88 mm, o MF (Largura) foi de 2,34 + 1,17 enquanto o MN-MF foi de 52,35 ± 4,83 mm. Forame mandibular acessório foi observado em 20% das mandíbulas acessadas. Outros achados revelaram uma diferença significativa na distância MF-G em p <0,05 (t = 2,349; p = 0,020; Ssq = 63,714; p = 0,020). Conclusão: Os resultados deste estudo mostraram que as mandíbulas nigerianas estão localizadas na região posterior e na metade superior do ramo. Eles também estavam localizados no 2º e 3º quadrante superior-inferior e anterior-posterior, enquanto as foraminas acessórias foram posicionadas superior-posterior ao forame mandibular.

Palavras-chave: mandíbula, forame mandibular, forame acessório, Nigeria