

Anthropometric parameters of the mandibular foramen: A CT-Scan study in a sample of Cameroonian population; involvement in anesthesia

Edouma Jacques¹, Messina Ebogo^{1*}, Ngaba Olive², Abessolo Ondoa¹, Ongolo Zogo³

Jacques E, Ebogo M, Olive N, et al. Anthropometric parameters of the mandibular foramen: A CT-Scan study in a sample of Cameroonian population; involvement in anesthesia. *Anesthesiol Case Rep*. 2021;4(1):1-3.

Background: The Mandibular Foramen (MF) is an important anatomical structure during procedures such as anesthesia of the inferior alveolar nerve during dental and maxillofacial surgery. Many authors have shown that it is essential to know the morphometric characteristics of MF because the inferior alveolar nerve which passes through it could be damaged in dental practice or explain an anesthesia failure during dental treatment. Our objective is to determine the morphometric characteristics of the mandibular foramen and to determine their implications in anesthesia in a sample of the Cameroonian population.

Materials and methods: We conducted a cross-sectional study of craniofacial scans of a sample of individuals from the Cameroonian population. The CT-scans were obtained from the database of the radiology and medical imaging

Departments of the Yaoundé Central Hospital and the Cathedral medical center. We collected socio-demographic data and 05 dependent variables on 210 hemi mandibles (distance from the MF to the anterior edge, to the posterior edge, to the mandibular notch, to the basilar rim and to the molar occlusal plane). Student's t test was used for data analysis with a significance level $P < 0.05$.

Results: In total, it was 105 CT of the craniofacial mass of Cameroonian subjects, i.e., 74.2% of men and 25.8% of women. The MF was bilateral in all of our participants in our survey and positioned 19.4 mm from the anterior edge of the mandible in men and 19.2 mm in women. In our sample, 25.8% of subjects presented a left accessory mandibular foramen.

Conclusion: The MF delivers passage to the inferior alveolar nerve which is called upon during anesthesia by trunk block. This study showed differences in the location of the mandibular foramen with measurements taken in Caucasian individuals.

Key Words: Anatomy; Morphometry; Mandibular foramen; CT scan.

INTRODUCTION

Anaphylaxis is the Mandibular Foramen (MF) is an essential anatomical structure for anesthesia by trunk of the mandible during acts in current dental practice such as dental extractions of the lower molars, conservative endodontic care and maxillofacial surgeries or orthognathic surgeries such as sagittal osteotomy of the ramus. It is located just above the center of the inner surface of the ramus of the mandible [1].

The MF is a useful anatomic structure for positioning the needle in inferior alveolar nerve anesthesia. Infiltrating anesthetic solution in the perigomandibular space is an anesthetic technique frequently used in the dental practice. The failure indices of this technique range from 29% to 35% because of the lack of precision and information in locating of the mandibular foramen [2].

Mandible is frequently used in gender determination, among which mandible bones are preferred as they are compact, least destructible. It shows sexual dimorphism because size, and shape on the mandible are different in males and females subjects [3,4]. Humphrey et al. [5] considered that all the parts of the mandible make it possible to determine the gender. It is possible to consider the measurements of the ramus, the corpus or even the mandibular notch. Hence, mandibular condyle and ramus, in particular, are generally the most sexually dimorphic as they are the sites associated with the greatest morphological changes in size and remodeling during growth.

Therefore, morphometric analyses by CT-Scan images with the purpose of determining the anatomy of the MF in relation to the gender, are important for planning the anesthetic procedures during dental care. The aim of this study was to perform a morphometric analysis of the mandibular foramen and its relationship to the surrounding anatomical structures and to determine the implications for anesthesia.

MATERIALS AND METHODS

A Dexamethasone A cross-sectional study of facial CT scans was carried out over a period of 7 months at the Yaoundé Central Hospital and the Yaoundé Cathedral Medical Center.

Population

A total of 105 cerebral CT-Scans performed by helical acquisition including 78 men (74.2%) were retained for our study. We analyzed 105 CT images; therefore 210 hemimandibles were taken into account. The measurements were first carried out by the various authors and the average measurements were retained. Secondly, the measurements were carried out by the principal investigator and then validated by experienced radiologists.

We measured the distance from the MF to the anterior edge, posterior edge, mandibular notch, basilar rim and from the molar occlusal plane; all of these distances were measured in relation to gender. The morphometry of the MF was assessed using Radiant DICOM Viewer software on the mandibles on each side of our patients.

Data collection

Our data was collected on a database concurrently with the conduct of the investigation. We used facial CT-Scan images from the radiology and medical imaging departments of the hospitals selected for this research. The information was recorded on a technical sheet with strict respect for anonymity.

Was included in our study:

- Facial CT-Scan images of Cameroonian patients
- Image clearly showing the MF

¹Department of Oral and Maxillofacial Surgery, Cheikh Anta Diop University, Dakar, Senegal; ²Department of ENT/Ophthalmology and Stomatology, University of Yaounde I, Yaounde, Cameroon; ³Department of Medical Imaging and Radiotherapy, University of Yaounde I, Yaounde, Cameroon

Correspondence: Messina Ebogo, Department of Oral and Maxillofacial Surgery, Cheikh Anta Diop University, Dakar, Senegal, E mail: wilfriedebogo@gmail

Received: June 10, 2021, **Accepted:** June 24, 2021, **Published:** July 01, 2021



This open-access article is distributed under the terms of the Creative Commons Attribution Non-Commercial License (CC BY-NC) (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits reuse, distribution and reproduction of the article, provided that the original work is properly cited and the reuse is restricted to noncommercial purposes. For commercial reuse, contact reprints@pulsus.com

- Patient of any age

We then performed a visual analysis of the sagittal, coronal and axial slices of the craniofacial mass in order to clearly bring out the mandible and objectify the MF. For each MF identified, linear plots were carried out according to the variables we set for ourselves, using the measurement module present in our imaging analysis software. These distances, evaluated in millimeters, appeared automatically once the line was drawn and then were manually reported on our technical sheet. To ensure the reliability of our values, we compared our interpretations with those of an independent radiologist by reviewing 30 CT-Scans of the craniofacial mass before the start of collection. The intra- and inter-examiner agreement of our results was assessed by Cohen's kappa test [5]. The scanner used was TOSHIBA Aquilion GX 128-strip brand capable of making thin sections up to 0.5 mm thick and 3D reconstructions in different planes (transverse, sagittal, coronal). Measurements were made from the center of the foramen.

Ethics

The study was approved by the Ethics and Clearance Committee of the Faculty of Medicine and Biomedical Sciences of the University of Yaounde I, Cameroon. The authorizations of the Directors of the Yaoundé Central Hospital and of the Yaoundé Cathedral Clinic were obtained before the start of data collection.

Statistical analysis

Data from this study were analyzed and coded using SPSS version 24 software. Graphs were constructed using Microsoft Office Excel 2013 and SPSS software. To test the association between a binary qualitative variable and a quantitative variable, we used Student's T test or the Mann-Whitney test according to the distribution law.

The significance level of 5% was used to evoke the significance of the differences observed. We also have the p-value with a 95% confidence interval. The calculation of Cohen's kappa coefficient was used to measure the agreement between our results and those obtained by a radiologist [6]. Results were presented in the form of tables using Microsoft Excel 2016 software.

RESULTS

The incidence of perioperative Cohen's kappa test was performed to ensure the reliability of the data obtained. The intra-examiner agreement of our results was 0.905. For inter-rater agreement, we obtained the value of 0.788. By relying on the interpretation table of Landis and Koch [7], these results showed us that there was a strong agreement between our values and those obtained by an experienced radiologist.

We retained a total of 105 CT images, including 78 men (74.2%) and 27 women (25.8%). The average age of our population was 34 years old, split between 13 and 69 years old. The results of our research showed that the distance MF- anterior border of the mandible is 19.2 mm on the left and 19.5 mm on the right (Table 1). The distance MF- posterior edge of the mandible is 15 mm to the left and to the right. The distance MF- mandibular notch is 20.7 mm on the left and on the right. The distance MF -basilar rim is 29 mm on the left and 29.3 mm on the right.

TABLE 1

Comparison of anatomical distances of MF according to the side of the mandible

Variables (mm)	Left [CI 95%]	Right [CI 95%]	P-Value
Distance MF- anterior edge of ramus	19.2 [19-19.5]	19.5 [19-19.5]	0.42
Distance MF- posterior edge of ramus	15 [15-15.5]	15 [15-15.5]	0.99
Distance MF- mandibular notch	20.7 [20.5-21]	20.7 [20.5-21]	0.97
Distance MF- basilar rim	29 [28.5-29.5]	29.3 [29-30]	0.35

Occlusal plane in relation to M1 cusp	4,5 [4.5-5]	4,6 [4,5-5]	0.79
---------------------------------------	-------------	-------------	------

Note: M1: first Molar MF: Mandibular foramen

In this research, the FM- anterior border of the mandible distance was 19.4 mm in men and 19.2 mm in women (Table 2). The distance MF- posterior edge of the mandible is 15.2 mm in men and 14.5 mm in female. The MF- mandibular Notch distance is 20.9 mm in men and 20.4 mm in women. The MF - basilar rim distance is 29.2 mm in men and 28.1 mm in women with a P value = 0.04 in Student's T test. The distance of the MF from the molar occlusal plane is 4.6 mm in men and 4.5 mm in female.

TABLE 2

Comparison of anatomical distances of MF according to gender

Variables (mm)	Male [CI 95%]	Female [CI 95%]	P Value
Distance MF- anterior edge of ramus	19.4 [19-20]	19.2 [19-19.5]	0.63
Distance MF- posterior edge of ramus	15.2 [15-15.5]	14.5 [14.5-15]	0.051
Distance MF- mandibular notch	20.9 [20.5-21.5]	20.4 [20-21]	0.20
Distance MF- basilar rim	29.2 [29-30]	28.1 [27.5-28.5]	0,004
Occlusal plane in relation to M1 cusp	4.6 [4.5-5]	4.5 [4-4.5]	0.76

Note: M1: first Molar MF: Mandibular foramen

DISCUSSION

Cornerstones of anaphylaxis the location of the MF is an essential element in the planning of surgical and odontological procedures, as the vascular-nervous elements in transit through this orifice may be injured. Studies have shown that poor needle handling during truncal anaesthesia can account for nerve block failures. This structure is essential for block anaesthesia of the mandibular trunk, thus improving patient management [8]. The MF can be studied by various means, including anatomical subjects, dry skull or by using radiographic techniques such as panoramic radiography, CT scan of the face [9]. With advances in digital imaging and the introduction of CBCT, the study of the position of the MF using a three-dimensional plane and measurement points has become easier [10]. In the present study, the position of the 3D MF was measured in relation to the anatomical landmarks of the mandible in a sample of Cameroonian subjects.

In this series, the mean distance MF- anterior border of the mandible was 19.4 mm in men and 19.2 mm in women. The mean distance MF- posterior edge of the mandible is 15.2 mm in men and 14.5 mm in women. These distances remain lower than those found by Ennes et al. [11] who found the distance from the anterior border to the midpoint of the MF to be 16.2 mm; the ideal location for infiltration of the anaesthetic solution. Our results are similar to those found by Thangavelu et al. [12] in a study conducted in India who showed that the position of the MF is not central in the anteroposterior dimension of the ramus but is approximately 5mm posterior to the midpoint of the ramus width. This could have implications when infiltrating the anaesthetic solution in black patients.

Although it was impossible to establish absolute values to describe the permanent location of MF, its most frequent position was in the third quadrant in both anteroposterior and superoinferior sides, in accordance with previously described results [13,14]. Our results are similar to those found by Thangavelu et al. [12] in a study carried out in India which showed that the position of the mandibular foramen is not at the center in the anteroposterior dimension of the ramus but that it is around 5 mm posterior to the middle of the width of the ramus.

There was no statistical relation between the position of the MF and the height of the mandible body at middle line level. Satyapal et al. [15] in a

study conducted in India determined that the mandibular foramen is located posterior to the midpoint of the ramus of the mandible horizontally and above the midpoint of the ramus of the mandible vertically. Oguz et al. located the mandibular foramen in Turkish mandibles [13] while Shalini et al. [16] did so in Indian mandibles.

The MF- basilar rim distance is 29.2 mm in Male and 28.1 mm in Female with a P-value = 0.04 on Student's T- test. Many authors who have described the morphometry of the MF, have reported distances foramen-basilar rim of 19 mm in the study conducted by Ennes et al. [11]. However, the results of our research and those found in the literature are different from those reported by Ennes et al. in a study conducted in Turkey, found similar results (33 mm) and Oguz et al. [13] in India (30.7 mm).

The MF - mandibular Notch distance is 20.9 mm in Male and 20.4 mm in Female. Our results are similar to those found by Mustapha et al. who reported 23.2 mm in female subjects and 24.4 mm in men. Let us note all the same that the subjects of his study were aged 18 years or less; young population. These results are difficult to compare in our sample because many authors have shown that the measurements of the mandibular ramus change with age and sex [14].

The molar occlusal plane can also help locate the mandibular foramen. In the present study, the result showed that the location of the mandibular foramen was 4.5 mm $\pm$ 0.5 above the occlusal plane. The distance of the MF from the molar occlusal plane is 4.6 mm in men and 4.5 mm in women. In a study by Satyapal et al. [12] on CBCT the location of the MF was approximately 3.2 mm $\pm$ 2 above the occlusal plane; in contrast, Altunsoy et al. [17] in Turkey found this mandibular foramen at 2.5 mm in Male and 3.6 mm in Female above the occlusal plane of the molars. These variations could be explained by the fact that Cameroonians and Caucasians come from different races. In our study we did not find a statistically significant difference between distances for men and women; our results agree with those of Altunsoy et al. [17] who in 2014 did not find any differences in the distances between men and women. In contrast, Satyapal et al. in 2019 [15] showed that anteroposterior distances from MF depended on sex in the sample of its population. In some anesthetic techniques, molar occlusal plane can help to know the localization of MF. It shows that the infiltration of the needle should be 1cm above the molar occlusal plane. This practice is justified when the results of Hwang et al. [14] in a chinese sample are considered, in which MF was found even 4.2 mm above the occlusal plane, in adults. But not in close with those found by Nicholson [18], who presented MF below the occlusal plane in 75% of the exemplars and 22% at the same level, similar to the findings of Afsar et al. In children, Marzola et al. suggested that the needle set should be inclined in such a way to establish an angle of approximately 5°, in anteroposterior direction with the occlusal plane of molars. This is compliant with the results obtained by Hwang et al. [15], who found MF, on average, 4.1 mm below the occlusal plane in three-year-old children, moving towards this plane as age increased, reaching this level at the age of nine.

Seema et al. [19] in a study conducted in 2013 in Japan on CT scans of 300 subjects found 200 subjects (66.7%), who presented 432 accessory foramina. Another study conducted by Iwanaga et al. [20] in the United States on dry mandibles in 2020 showed a unilateral foramen, bilateral foramina and an absence of foramen respectively at 45.4%, 18.2% and 36.4%. The previous results seem lower than those obtained in our study, which showed the absence of an accessory foramen on the left at 74.2% against 70.5% on the right. Shalini et al. [16] obtained similar results in a study of 204 dry mandibles in India and found 66 (32.3%) mandibles on which a foramen could be seen. The differences obtained could be explained by the fact that our sample size was smaller, and the visualization methods were less precise.

In practice, the dentist or the maxillofacial surgeon will have to perform anesthesia by inferior alveolar block, position the needle 4.5 mm above the occlusal plane of the mandibular molars [21]. Also, they will have to palpate the mucosa covering the anterior border of the ramus and introduce the needle to a depth of about 19.2 mm and infiltrate the anesthetic solution to have more success in the trunk anesthesia.

CONCLUSION

The mandibular foramen was bilateral in all our participants in our survey and positioned 19.4mm from the anterior edge of the mandible in men and 19.2mm in women. The distance of the MF from the molar occlusal plane is 4.6 mm in men and 4.5 mm in women. We found an accessory mandibular

foramen was present in low proportion in the left and right hemi mandible.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

FINANCIAL DISCLOSURE

This article has no funding source.

REFERENCES

1. Samantha PP, Kharb P. Morphometric analysis of mandibular foramen and incidence of accessory mandibular foramina in adult human mandibles of an Indian population. *Rev Arg de Anat Clin.* 2013; 5 (2): 60-66.
2. Afsar A, Haas DA, Rossouw PE, et al. Radiographic localization of mandibular anesthesia landmarks. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 1998; 86 (2): 234-241.
3. Indira AP, Markande A, David MP. Mandibular ramus: An indicator for sex determination – A digital radiographic study. *J Forensic Dent Sci.* 2012; 4 (2): 58-62.
4. Kumar MP, Lokanadham S. Sex determination and morphometric parameters of human mandible. *Int J Res Med Sci.* 2013; 1 (2): 93-96.
5. Humphrey LT, Dean MC, Stringer CB. Morphological variation in great ape and modern human mandibles. *J Anat.* 1999; 195 (Pt 4): 491-513.
6. Sim J, Wright CC. The kappa statistic in reliability studies: use, interpretation, and sample size requirements. *Phys Ther.* 2005; 85 (3): 257-268.
7. Landis JR, Koch GG. The Measurement of Observer Agreement for Categorical Data. *Biometrics.* 1977; 33 (1): 159-174.
8. Kang S, Byun I, Kim J, et al. Three-dimensional anatomic analysis of mandibular foramen with mandibular anatomic landmarks for inferior alveolar nerve block anesthesia. *Oral Surg Oral Med Oral Pathol Oral Radiol.* 2013; 115 (6): 17-23.
9. Russa AD, Fabian FM. Position of the mandibular foramen in adult male Tanzania mandibles. *Ital J Anat Embryol.* 2014; 119 (3): 163-168.
10. Jr-Howerton WB, Mora MA. Advancements in digital imaging: what is new and on the horizon? *J Am Dent Assoc.* 2008; 139: 20S-24S.
11. Ennes JP, Medeiros RM. Localization of mandibular foramen and clinical implications. *Int J Morphol.* 2009; (27): 1305-1311.
12. Thangavelu K, Kannan R., Kumar N, et al. Significance of localization of mandibular foramen in an inferior alveolar nerve block. *J Nat Sci Biol and Med.* 2012; 3 (2): 156-160.
13. Oguz O, Bozkir MG. Evolution of location of mandibular and mental foramina in dry, young, adult human male, dentulous mandibles. *West Indian Med J.* 2002; 51 (1): 14-16.
14. Hwang TJ, Hsu SC, Huang QF, et al. Age changes in location of mandibular foramen. *Zhonghua Ya Yi Xue Hui Za Zhi.* 1990; 9 (3): 98-103.
15. Johaley S, Karjodkar FR, Sansare KP, et al. Determination of Three-Dimensional position of Mandibular Foramen Using CBCT. *J Forensic Sci and Criminal inves.* 2019; 12 (5) : 55-58.
16. Shalini R, Varman RC, Manoranjitham R, et al. 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.
17. Altunsoy M, Osman A, Evren Ok, et al. Localization of the mandibular foramen of 8-18 years old children and youths with cone-beam computed tomography. *J pediatr Dent.* 2014; (2): 44-48.
18. Nicholson ML. A study of the position of the mandibular foramen in adult human mandible. *Anat Rec.* 1985; 212 (1): 110-112.
19. Seema P, Yukiko M, Tomohiro O. Accessory mandibular foramen: a CT study of 300 cases. *Surg Radiol Anat.* 2013; 35 (4): 320-330.
20. Iwanaga J, Kikuta S, Ibaragi S, et al. Tubbs RS. Clinical anatomy of the accessory: application to mandibular ramus osteotomy. *Surg Radiol Anat.* 2019; 42 (1) :41-47.
21. Al-Shayyab MH. A simple method to locate mandibular foramen with cone-beam computed tomomography and its relevance to oral and maxillofacial surgery: a radio-anatomical study. *Surg Radiol Anat.* 2018; 40 (6): 625-634.