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## Analysis of mental foramen in dry human mandibles of adult Nigerians

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### Abstract

**Objective:** This study was undertaken to investigate the dimensions number, shape and actual location of the mental foramen as well as to assess the occurrence of accessory mental foramen in dry human mandibles of adult Nigerians. It also considered the distances between the foramen and some anatomical landmarks.

**Method:** A total of 54 adult dry human mandibles obtained from bone collections in the department of Anatomy of selected Nigerian Universities were used for this study. The sliding digital caliper was used for taking measurements from mental foramen to symphysiamenti, posterior border of ramus, lower and superior borders of the mandible. The vertical and transverse diameters of the mental foramen were also measured.

**Results:** The most common location of the mental foramen was in line with the second premolar tooth (64.8%). The oval shape occurred more (63.6% on the left side and 56.6% on the right side) than the round shape. The dominant mental foramen was single mental foramen (76.9%) and there was no significant association between occurrence, location and shape of mental foramen and sides of the mandibles in this study ( $P>0.05$ ).

**Conclusion:** This study will be of clinicalrelevance to the dentists, oral and maxillofacial surgeons and anaesthetists. It will also be useful to the anthropologists and archeologists in identification and population studies.

**Keywords:** *Mental foramen, mental nerve, mandible, premolar tooth, morphology, morphometry, dental anaesthesia.*

### Résumé

**Objective :** Cette étude était entreprise pour investiguer les dimensions, nombre, forme et location actuelle du foramen mental aussi bien que d'évaluer l'occurrence de foramen mental

secondaire dans des mandibules humaine sèche des adultes nigériens. Elle considérait aussi les distances entre le foramen et certains points de repère anatomique. Méthode : Un total de 54 mandibules sèches d'adulte humaine obtenues des collections d'os dans le département d'Anatomie d'une sélection d'Universités nigériane étaient utilisées pour cette étude. L'instrument à calibre de mesure digital glissant était utilisé pour prendre les mesures du foramen mental à symphyse, bordure postérieure du ramus, bordures inférieure et supérieure de la mandibule. Les diamètres vertical et transverse du foramen mental étaient aussi mesurés.

**Résultats:** La location la plus commune du foramen mental était en ligne avec la deuxième dent prémoilaire (64,8%). La forme ovale se présentait plus (63,6% sur le flanc gauche et 56,6% sur le flanc droit) que la forme ronde. Le foramen mental dominant était le foramen mental simple (76,9%) et il n'y avait pas une association significative entre occurrence, location et forme du foramen mental et flancs des mandibules dans cette étude ( $P>0,05$ ).

**Conclusion :** Cette étude serra d'une relevance clinique aux dentistes, oral et maxillo-facial chirurgiens et anesthésistes. Elle serra aussi utile aux anthropologues et archéologues dans les études d'identification et de population.

**Mots clé:** Foramen mental, nerf mental, mandibule, dent prémoilaire, morphologie, morphométrie, anesthésie dentale.

### Introduction

The mental foramen (MF) transmits the mental nerve and accompanying vessels. It lies in the same vertical plane as the supraorbital and infraorbital foramina [1]. The variation of the position of the foramen with age influences the direction in which a needle is advanced for a mental nerve block [2]. Sinnatamby [2] reported that at first the mental foramen lies near the lower border of the mandible. He further stated that after eruption of the permanent teeth, the foramen lies higher, and is halfway between the upper and lower borders of the mandible in adults; in line with the interval between the two premolar teeth. In the edentulous elderly subject, absorption of the alveolar margin makes the mental foramen closer to the upper border of the mandible [2]. Forward growth of the mandible changes the direction of the mental foramen [2]. At birth the mental neurovascular bundle emerges through the



foramen in a forward direction; but it is directed backwards in the adults [2].

Accessory foramina of the mandible are common, usually unnamed and infrequently described, yet they are numerous. They may transmit auxiliary nerves to the teeth [1]. Accessory mental foramen transmits the accessory branch of mental nerve. The knowledge of the occurrence, position and incidence is significant in dental anaesthetic blocking techniques [1], as well as to prevent accessory nerve injury during periapical surgery [3].

Studies on mental foramen and accessory mental foramen have been carried out in some populations across the globe including Nigeria, with different but related foci [4-8]. This study was undertaken to investigate the dimensions, number, shape and actual location of the mental foramen as well as to assess the occurrence of accessory mental foramen in dry human skulls from some Nigerian Universities. The study was carried out to also examine the linear distances of the foramen to some anatomical landmarks.

The outcome of this research will be useful in dental practice like localization of important maxillofacial neurological structures in many interventions. It will also be of importance in anthropology and archeology with regard to population study and identification.

### Materials and method

This descriptive anthropometric study utilized 54 dry adult human mandibles obtained from the bone collections of the department of Anatomy in Anambra State University, Uli; NnamdiAzikiwe University, Nnewi; University of Benin, Benin City; Ambrose Ali University, Ekpoma; Niger Delta University, Wilberforce Island and Delta State University, Abraka. The mandibles were of unknown sex and age. Prior to data collection, the Research Ethics Committee of the College of Health Sciences, Delta State University, approved the research protocol.

### Method of data collection

This study was done by assessing both sides of the mandible and the number of foramina present were recorded as single, double, triple or multiple. Their presence was noted and recorded and the most prominent foramen was used as the primary structure for characterization.

The shape and location of MF were also recorded by direct visual inspection. The location of MF was recorded as: in line with first premolar (PM1); between first premolar (PM1) and second premolar (PM2); in line with second premolar (PM2);

between second premolar (PM2) and first molar (M1); in line with first molar (M1) (Fig. 1). The shape of MF was recorded as either round or oval

### Anthropometry

The vertical and transverse dimensions of the MF were measured in millimeter. The linear distances of the mental foramen to symphysis menti, lower border of mandible, superior border of mandible and posterior border of ramus of mandible were also measured in millimeter (Figure 1). Measurements were repeated twice and the average taken to minimize errors of measurements. All measurements were taken using a digital vernier caliper (Mitutoyo, Japan).

In order to assess error of measurements and to obtain comparability of anthropometric measurement error, ten mandibles were selected and the various dimensions were measured two times on different occasions [9-10]. Intra-observer error was obtained by calculating the technical error of measurement (TEM), using the formula  $TEM = \frac{D^2}{N}$  [9-10]. Where D is the difference between two measurements and N is the number of mandibles measured. It was observed that TEM for vertical dimension, transverse dimension of the MF, the linear distances of the mental foramen to symphysis menti, lower border of mandible, superior border of mandible and posterior border of ramus of mandible was 0.077, 0.074, 0.074, 0.077, 0.059 and 0.077 respectively. These values are very small and therefore will not bias the results of the study

The coefficient of reliability (R) was calculated using the equation:  $R = 1 - \frac{(Total\ TEM)^2}{SD^2}$  [9-10]. Where TEM is as calculated and  $SD^2$  is standard deviation squared. It was observed that the coefficient of reliability (R) was 0.95 (95%) for vertical dimension, transverse dimension of the MF, the linear distances of the MF to the symphysis menti, lower border of mandible and posterior border of ramus of mandible. The coefficient of reliability (R) for superior border of mandible was 0.96 (96%). This indicates that 95% and 96% of the variance was due to factors other than measurement error.

### Exclusion criterion

Deformed mandibles were excluded from the study.

### Data analysis

The data obtained were subjected to statistical analysis using descriptive statistics, paired samples *t*-tests and Chi-square contingency table with the aid of the statistical package for Social Sciences (SPSS) version 16. *P*-values less than 0.05 were considered statistically significant.



## Results

The occurrence of mental foramen was recorded as single, double, triple and multiple on both sides of the mandible. The single type was highest (76.00% on the left side and 78.00% on the right side). The double MF was 20.00% on both sides. This was followed by the multiple MF which was 2.00% on both sides and the least was triple MF (left=2.00%; right=0.00%). Pearson Chi square test for degree of association between occurrence of mental foramen and side of mandible was statistically not significant ( $P>0.05$ ). Therefore, there was no significant association between the occurrences of mental foramen with the side of the mandible.

The locations of the mental foramen are also presented as frequency distribution on both sides of the mandibles. The location in line with the second premolar was highest 65.00% on both sides. The location between the first and second premolar was 18.00% on both sides. This was followed by the MF lying between the second premolar and first molar 11.00% on both sides. Next is the MF in line with first premolar (4.00% on both sides), and the least was in line with first molar (2.00% on both sides). Pearson Chi square test for degree of association between location of mental foramen and side of mandible was statistically not significant ( $P>0.05$ ). Consequently, there was no significant association between the locations of mental foramen with the side of the mandible.

The percentage distribution of the shape of mental foramen revealed that the oval shape are commoner (left=63.00%; right=57.40%) than the round shape (left=37.00%; right=42.60%). Pearson Chi-square test showed no significant association between the shapes of mental foramen with the side of the mandibles ( $P>0.05$ ).

Considering the dimensions, the mean vertical dimension of the mental foramen was  $2.38 \pm 0.63$ mm (left= $2.44 \pm 0.68$ mm; right= $2.32 \pm 0.57$ ) with range 1.16 - 4.46mm (left= $1.39 - 4.01$ mm; right= $1.16 - 4.46$ ). The mean transverse dimension of the mental foramen was  $3.08 \pm 1.71$ mm (left= $3.32 \pm 2.29$ mm; right= $2.82 \pm 0.74$ ) with range 1.66 -

19.02mm (left= $1.80 - 19.02$ mm; right= $1.66 - 5.56$ mm).

Figure 1 is mandible showing mental foramen (MF or B), accessory mental foramen (AMF), and measurements between MF and: symphysis menti (AB), posterior border of ramus of mandible (BC), superior border of mandible (BD), lower border of mandible (BE). Figure 1 also shows the location of the mental foramen in relation to the mandibular teeth. In this figure, the MF is located between PM1 and PM2.

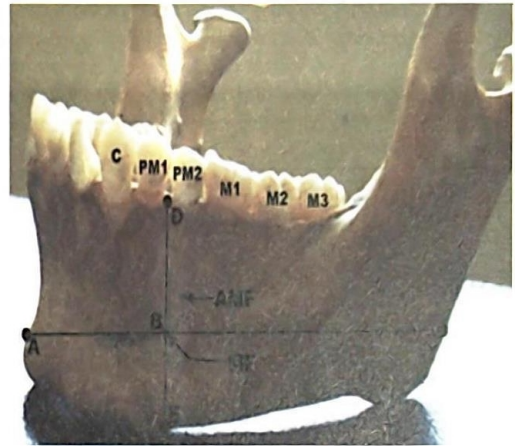


Fig. 1: MF, AMF and measurements between MF and some structures.

MF=lower border of mandible, C=posterior border of mandible, D=superior border of mandible, C=canine, PM1=first premolar, PM2=second premolar, M1=first molar, M2=second molar, M3=third molar

Table 1a shows the descriptive statistics (left and right combined) of the linear lengths between the mental foramen and the symphysis menti, lower and superior borders of the mandible and the posterior border of mandible. Table 1b shows the descriptive statistics of the linear lengths between the mental foramen and the symphysis menti, lower and superior borders of the mandible and the posterior border of mandible on both sides.

Table 1a: Dimensions measured between the MF and some structures (N=108).

Distance (mm)	Minimum	Maximum	Mean	SD
MF-symphysis menti	22.46	34.44	26.83	2.37
MF-lower border of Mandible	9.33	63.83	14.27	5.17
MF-superior border of mandible	5.91	22.91	14.90	3.19
MF- posterior border of mandible	47.66	77.64	67.33	5.65



Paired (left and right) samples correlations showed significant correlations ( $P < 0.05$ ):  $r = 0.85$  at  $P = 0.001$ ;  $r = 0.28$  at  $P = 0.04$ ;  $r = 0.89$  at  $P = 0.001$  and  $r = 0.92$  at  $P = 0.001$ , between MF and symphysis menti; between MF and inferior border of the mandible; between MF and superior border of the mandible and between MF and posterior border of mandible respectively. Paired samples  $t$ -test revealed that the differences observed between left and right measurements (Table 1b) were statistically not significant except in the case of the length between MF and symphysis menti which was statistically significant ( $P < 0.05$ ) ( $t = 3.50$ ,  $df = 53$  and  $P = 0.001$ ).

The present study revealed that the location of metal foramen occurred in the following order: in line with the second premolar (65.00%); between the first and second premolars (18.00%); between the second premolar and first molar (11.00%); in line with the first premolar (4.00%) and the least was in line with first molar (2.00%). This corresponds with the study carried out by Aspinhasmit *et al.* [10], in which the most common location of the MF was bilaterally symmetrical and located on the same vertical line with the long axis of the lower second premolar. Our finding is similar to Yesilyurt *et al.* [12] who carried out a study on the local differences in the position of the mental foramen in Turkey and

**Table 1b:** Dimensions measured between the MF and some structures (N=54).

Side	Distance (mm)	Minimum	Maximum	Mean	SD
Left	MF-symphysis menti	22.53	34.07	27.13	2.35
	MF- lower border of mandible	9.42	18.01	13.80	1.90
	MF- superior border of mandible	5.91	22.91	14.73	3.21
	MF- posterior border of mandible	48.67	77.64	67.09	5.59
Right	MF-symphysis menti	22.46	34.44	26.52	2.37
	MF- lower border of mandible	9.33	63.83	14.73	7.07
	MF- superior border of mandible	6.94	22.43	15.07	3.18
	MF- posterior border of mandible	47.66	76.84	67.56	5.74

MF=Mental Foramen; SD=Standard Deviation

## Discussion

In the present study, the dominant mental foramen was single, followed in descending order by double, multiple and triple. This finding is in agreement with a Thai study that reported single mental foramen to be the most dominant (88.9%), followed in order by double (2.8%), multiple (3.3%) and triple (0.5%) [10]. It is also in agreement with a study of the mental foramen using 80 mandibles from colleges in the State of Alagoas that reported 95% and 5% of the mental foramen to be single and double respectively on both sides [8]. It is in line with Agarwal and Gupta [6], who reported 97.4% and 2.6% of cases of mental foramen, was single and double respectively in South Gujarat. In a related study, Prabodha and Nanayakkara [11] reported presence of accessory mental foramen in 8.23% a sample of 24 hemi-mandibles studied in Sri Lankan. In a Nigerian study, Osunwoke *et al.* [4] reported that of the 59 mandibles studied; only one accessory mental foramen was observed. The observations reported in these studies are lower than in the present study. The variations observed in the number of accessory mental foramina may be attributed to population differences due to genetic or environmental factors.

reported that the common position of the mental foramen relative to mandibular teeth was in line with the longitudinal axis of the second premolar tooth having 55.7% on the right side and 61.4% on the left side. It is also in agreement with Ilayperuma *et al.* [13], who carried out morphometric analysis of the mental foramen in adult Sri Lankan mandibles and reported that the most common position of the mental foramen relative to the lower teeth was in line with the second lower premolar for both right (58.82%) and left (47.06%) sides and the second most common location was in line with first premolar (23.53% on the right side and 29.41% on the left side); between the first and second premolar (right side = 11.76%; left side = 11.76%); in line with the first molar (5.88% on the right side and 11.76% on the left side) and none (0%) was found between second premolar and first molar, which is at variance with the present study. The present study agrees with Sankar *et al.* [14], who reported that the most common position of the mental foramen in relation to the mandibular teeth of south Andhra population of India was below the apex of the second premolar teeth (73.2%). This is also similar to the findings of



Agarwal and Gupta [6] that the most common position of the mental foramen in relation to the teeth was in line with the longitudinal axis of the second premolar for both right (81.55%) and left (81.50%) sides. Our study is also in line with Singh and Srivastav [12] who reported that mental foramen was situated below the apex of second premolar tooth in 86.8% of the 100 dry human mandibles. This is also in agreement with Siddiqui *et al.* [15], who reported that the most common position of mental foramen as related to lower set of teeth was in line with the second premolar (44.08% on the right and 46.23% on the left side) next common position was between the first and second premolar (41.93% on the right side and 35.48% on the left sides). The result of the present study is in conformity with Gupta and Soni [3] who carried out a study of anatomical variation and incidence of mental mandibles in India and reported that mental foramen was situated below the apex of second premolar tooth in 75.80% of the mandibles studied; 12.20% was located between the premolars; 8.30% was situated below the apex of first premolar tooth and 3.33% below the first molar tooth. The present study is also in line with Hasan [5], who carried out a study on the characteristics of the mental foramen in different populations and reported that the mental foramen was frequently located in line with the longitudinal axis of the lower second premolar in Tanzanians, mongoloids, Zimbabweans, Turkish and Africans in general. The author also reported that in Caucasoid, Israelis and Jordanians, it was located between the premolars. The result of this study also corresponds with a Nigerian study carried out by Osunwoke *et al.* [4], in which the most common position of mental foramen in relation to the mandibular teeth was in line with the long axis of the second premolar with a percentage of 54.24%. The same observation was noted by Adejuwon *et al.* [16] in South-Western Nigerian study.

Our finding is at variance with a Northern Nigerian study in which Olosoji *et al* [17] observed that the most common location of the MF was the interdental space between the first and second mandibular premolars (radiographs=34%, dry mandibles=32.8%), closely followed by the position apical to the second premolars (radiographs=25.5%, dry mandibles=35.9%). They noted that there was almost an equal chance of locating the mental foramen between the mandibular premolars and apical to the mandibular second premolar. Our study is not in agreement with Oliveira *et al* [8], who reported a tie between the location of mental foramen in line with second premolar (45.17% on the right

side and 43.64% on the left side) and the location between the first and second premolars (45.17% on the right side and 43.64% on the left side).

In the present study, the oval shape was more predominant than the round shape with 63.6% on the left side and 56.6% on the right side and the round shape was 36.4% on the left side and 43.4%. This is in line with a study carried out by Ilayperuma *et al.* [13], who reported that in the majority of cases, the mental foramen was oval in shape (59.00%) while circular shape was 41.00% in adult Sri-lankan mandibles. This is also in agreement with Agarwal and Gupta [6] who reported that the shape of foramen was oval in 92.00% cases and rounded in 8.00% cases. Our study is also in line with Siddiqui *et al.* [15], who reported that the shape of mental foramen was oval in 70.00% of the 93 mandibles studied and rounded in 30.00%. Fabian [18] studied the positioning, shape and direction of opening of mental foramen in Tanzanian adult black males and reported that the oval shape was more predominant (54%) than the round shape (46%). Igbigbi *et al.* [19] also studied the position and dimension of the mental foramen in 70 adult Malawian mandibles and reported that the oval shape was more predominant than the round shape. The same observation was made by Mbajjorgu *et al.* [20]. The present study is at variance with Sankar *et al.* [14], Singh and Srivastav [21] and a South-Western Nigerian study [16] that reported the shape of metal foramen was more predominantly rounded than the oval shape.

In the present study, the mean vertical diameter of the mental foramen was  $2.38 \pm 0.63$ mm ( $2.44 \pm 0.67$ mm on the left side and  $2.31 \pm 0.57$ mm on the right side). The transverse diameter of the mental foramen was  $3.07 \pm 1.71$ mm ( $3.32 \pm 2.27$ mm on the left side and  $2.82 \pm 0.74$ mm on the right side). This is in line with Ilayperuma *et al.* [13], who reported the mean vertical and transverse diameter of the mental foramen to be  $2.50 \pm 0.61$ mm and  $3.31 \pm 0.76$ mm respectively. The maximum transverse vertical diameter of MF on the right side was  $2.45 \pm 0.71$ mm and  $2.60 \pm 0.63$ mm on the left side was  $2.45 \pm 0.71$ mm and  $2.60 \pm 0.61$ mm on the left side and the mean transverse diameters of metal foramen on the right side was  $3.26 \pm 0.90$  and  $3.41 \pm 0.82$ mm on the left side. This is also in line with Oliveira *et al.* [8] who reported that the mean vertical diameter of mental foramen was  $2.38 \pm 0.63$ mm on the right and  $2.39 \pm 0.58$  on the left and the mean horizontal diameter on the right was  $3.32 \pm 0.91$ mm and  $3.25 \pm 0.86$ mm on the left side.

In the present study, the mean distance from mental foramen to: symphysis menti, lower border, superior border and posterior border of mandible was



26.83 ± 2.37mm, 14.26 ± 5.17mm, 14.90 ± 3.19mm and 67.33 ± 5.64mm respectively. This is very close to the findings of Aspinhasmit *et al.* [10], who reported the distance between mental foramen and symphysismenti to be 28.52 ± 2.15mm. In a study in Sri Lanka, Prabodha and Nanayakkara [11] reported 26.52mm and 12.25mm as the mean distance of the symphysismenti and the inferior border of the mandible from mental foramen respectively. Apinhasmit *et al* [10] reported 28.83 mm and 14.88 mm respectively. Agarwal and Gupta [6] reported the mean distance between the mental foramen to: symphysismenti, inferior border of the mandible and superior border of the mandible as 25.55±5.07 mm (right), 25.05±5.07mm (left); 12.16±3.04mm (right), 12.11±3.11mm (left) and 14.05±3.05mm (right), 13.82±3.06mm (left) respectively. A study carried out by Ilayperuma *et al* [13], in Sri-Lankan reported that the distance between symphysismenti and mental foramen was 24.87 ± 6.07mm on the right side and 24.77±6.07mm on the left side. The distance between mental foramen and lower border of mandible was reported by Siddiqui *et al* [15] reported the mean distance between alveolar crest and superior margin of MF was 10.20 mm (SD= 5.40) on right side and 10.00 mm (SD=5.20) on the left side. Mean distance between inferior margin of MF and lower border of the body of mandible was 9.90 mm (SD= 5.12) on the right side and 10.10 mm (SD= 5.20) on the left side. Regarding the mean distance from mental foramen to posterior border of mandible, Prabodha and Nanayakkara [11] reported 65.38 mm; Apinhasmit *et al* [10] observed 68.85 mm while Gupta and Soni [3] reported 76.16 mm as compared to the present study. Singh and Srivastav [21] reported 71.8 mm and 84.7 mm on the right and left side respectively as against 67.56 mm and 67.09 mm respectively in the present study.

### Conclusion

In the present study, the dominant type of mental foramen is single while the dominant location is in line with the second premolar tooth. There is no significant association between location of the mental foramen and side of the mandible ( $p>0.05$ ). The dominant shape of the mental foramen is oval. The transverse dimension of the mental foramen is greater than the vertical dimension.

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