

The position and dimensions of the mental foramen in adult Malawian mandibles

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Summary

Background: The mental foramen is found on the anterolateral aspect of the mandible and transmits the mental nerve and vessels. The identification and actual location of this foramen is very important in clinical dentistry as well as in the microscopic and macroscopic evaluation of the morphology and maturity of the human mandible.

Methodology: We determined the position and dimensions of this foramen from seventy adult indigenous Malawian mandibles of both sexes. The shape, number and orientation of the mental foramen were determined by visual examination and its transverse and vertical diameters measured using a digital vernier caliper.

Results: In the majority of cases, the mental foramen was oval in shape, oriented posterosuperiorly, and bilaterally symmetrical. The modal position of the foramen with respect to the mandibular teeth was inferior to the second premolar tooth. Its vertical position was slightly below the midpoint of the distance between the lower border of the mandible and the alveolar margin.

Conclusion: The shape and orientation of the mental foramen shown in our study correspond to what have been documented in most previous studies. However, variations do exist in the modal position of this foramen in different population groups. We therefore stress the importance of palpation of the foramen during administration of local anaesthesia and in the interpretation of radiographs prior to surgery.

Key-words: Mandible, Mental foramen, Mental nerve, Anatomy, Malawians

Résumé

Introduction: Le foramen mental se trouve sur l'aspect anterolatéral de la mâchoire inférieure et il transmet le nerf mental et les vaisseaux. L'identification et localisation de ce foramen est très nécessaire dans la dentisterie clinique de même que dans l'évaluation microscopique et macroscopique de la morphologie et la maturité de la mâchoire inférieure de l'homme.

Méthodologie: Nous avons étudié la position et les dimensions de ce foramen chez soixante dix adultes indigènes Malawian de sexe masculin et féminin les deux de mâchoires inférieures. La forme, nombre et l'orientation du foramen mental ont été étudiés à travers un examen visuel et ses diamètres transversal et vertical ont été mesurés avec, l'utilisation d'étier vernier.

Résultats: Dans la majorité des cas, la forme du foramen mental était ovale, orientée postérosupérieur, et bilatéralement symétrique. La position modale du foramen par rapport aux dents des mâchoires inférieures était inférieur par rapport à la deuxième dent pré-molaire. Sa position verticale était

légèrement au dessous du mi-point d'une distance entre la frontière inférieure de la mâchoire inférieure et la marge alvéolaire.

Conclusion: La forme et l'orientation du foramen mental indiqué dans notre étude est à peu près l'équivalent de ce qui a été documenté dans des études précédentes. Toutefois, on remarque des variations dans la position modale de ce foramen dans les groupes de la population diverses.

Donc, nous tenons à insister sur l'importance de la palpation du foramen pendant l'administration d'anesthésie locale et dans l'interprétation de la radiographie avant l'intervention chirurgicale.

Introduction

The mental foramen is found on the anterolateral aspect of the mandible (lower jaw) and transmits the mental nerve and vessels. The innervation and vascularisation of the mandibles and surrounding tissue is done by the mandibular nerve and artery. These structures enter the mandible through the mandibular foramen and leave it through the mental foramen. Standard anatomy and radiology textbooks contain conflicting statements regarding the position of the mental foramen.¹⁻⁵ There is also similar disagreement among authors of various published investigations.⁶⁻⁸

The position of the mental foramen between the lower border of the body of the mandible and the alveolar margin along a vertical line that passes through the supraorbital notch is influenced by race, age, tooth loss and alveolar bone resorption.⁹ Before tooth eruption takes place in children, the mental foramen is closer to the alveolar margin. During the tooth eruption period, it descends to half way between the alveolar margin and the lower border of the mandible. In adults with intact teeth and alveolar bone resorption, it ascends towards the alveolar margin.⁹

The mental foramen may be round or oval in shape, it may be absent, unilateral, or bilateral and in some cases may be multiple on one or both sides of the mandible. It is also often reported to open with a posterosuperior orientation.² In most cases, however, there is one mental foramen in each side of the mandible, but the number differs in different races and generally varies from one to three.¹⁰⁻¹¹ In 82% of the cases the shape of the mental foramen is oval and in the rest it has a rounded form, its diameter is 3 - 7mm. Also in most cases of normal adult mandibles with teeth, the mental foramen is located halfway between the lower margins of the mandible and the alveolar crest⁹ in a vertical line with the supraorbital notch; in 50% of cases it is located at the edge of the second premolar root; in 20 - 25% it is between the first and second premolars, and in 24%, it is behind the second premolar.^{6, 9, 11, 13, 16}

Identification of the exact position of the mental foramen,

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from where the mental nerve emerges is very important for dental surgeons as damage to this nerve will lead to anaesthesia of the region supplied by it. This is necessary in surgical procedures like apicocurretage of mandibular premolars, retrograde amalgam filling, periodontal surgery, flap operation of the lower teeth and the other lower lip surgical procedures where block anaesthesia of the mental nerve is preferred to local infiltrations.¹⁷ Furthermore the identification and actual location of the mental foramen are quite important in clinical dentistry as well as in microscopic and macroscopic evaluation of the morphology and maturity of the human mandible.¹⁸ Similarly knowledge of the variations in the position of the mental foramen is necessary for differential diagnosis of small radiolucencies in the premolar and molar regions of the mandible. Although racial variation in the position of the foramen has been noted by a few authors,¹⁹ this phenomenon appears to have escaped the attention of the authors of more recent studies.¹⁹

Although a reliable and successful anaesthesia in mandibular arch surgery is essential, it is more difficult to accomplish.²⁰ The reason is that the position of anatomic structures, such as the mandibular nerve, mental and mandibular foramina vary. The development of the mandibular implant technique and the increasing frequency of maxillofacial surgery and oral procedures are adding to the importance of the accurate evaluation of anatomic landmarks.²⁰⁻²¹ To this end, numerous findings regarding locations of the mandibular and mental foramina were obtained from dry mandibles and panoramic radiographs.²² However, accurate estimation regarding location of these foramina may still be insufficient because such factors as variations in normal anatomy and distortion of the radiographic image.²²

There are disagreements on the precise location of these foramina and the surrounding anatomic landmarks.²³⁻²⁴ Therefore, accurately estimating the location of the mandibular and mental foramina is very important.²² The racial differences in the position of the mental foramen, the variations in the reports by different authors on its position, and the clinical relevance of this position as outlined above, emphasize the need for its accurate localization in different population groups.²⁵ Thus dimensions of the body of the mandible and position, size and number of mental foramina vary with the population.¹⁷

The purpose of this study therefore was to determine the most common modal position of the mental foramen in adult Malawians.

Materials and methods

The mandibles for this study were selected from the skeletal collection of the Department of Anatomy, College of Medicine, University of Malawi, Blantyre, Malawi. Seventy normal adult indigenous Malawian mandibles of both sexes with all the teeth in situ or with preserved alveolar margins in those cases where some teeth had been lost post mortem were used. The shape of the mental foramen was determined by visual examination and its transverse and vertical diameters were measured with the aid of a digital vernier caliper (Hellow-digits, Caliper gauge DIN 861 - 1AZ - 0.01 - 150nrst) with a measuring accuracy of 0.01mm. A note was also made of the

number of mental foramina present and their orientation.

The position of the mental foramen in relation to the lower teeth was determined by visual examination²⁵ and was expressed as a percentage for each of the six positions classified by Tebo and Telford⁶ (Figure 1).

The digital vernier caliper was also used to measure the distances shown in Figure 2a and indicated below:

- From the lower border of the mandible to the alveolar margin across the mental foramen (AD).
- From the lower border of the mandible to the inferior border of the mental foramen (AB).
- From the superior border of the mental foramen to the alveolar margin (CD).
- The vertical diameter of the mental foramen (BC).

The distance CD from the superior border of the mental foramen to the alveolar margin was determined by subtraction of AB from the vertical diameter AD.

In order to determine the position of the mental foramen in relation to the anterior and posterior borders of the mandible (Figure 2b), the mandible was placed on the osteometric table according to the method of Morant.²⁴ A horizontal line was drawn from the most prominent point of the mandible symphysis (P) backward across the mental foramen to the posterior border of the ramus of the mandible (Z). A fine flexible wire was stretched on the body of the mandible between the two points to be measured. These points and those of the most anterior and posterior borders of the mental foramen (L and R respectively) were marked on the wire using a pointed permanent marker. The wire was then transferred to a tabletop and the digital vernier Caliper was used to measure the distances between the marked points. In this way, the following distances were measured:

- PZ - from the most prominent part of the mandibular symphysis to the posterior border of the ramus
- PL - from the most prominent part of the mandibular symphysis to the anterior border of the mental foramen.
- RZ - from the posterior border of the mental foramen to the posterior border of the ramus.

The horizontal diameter of the mental foramen was determined by subtracting PL and RZ from PZ.

All measurements were carried out by one of the authors in order to minimize bias and error of identification of the parts of the mandible involved in the measurements. To test the reliability of the measurements, a sample of ten mandibles were randomly drawn after recording details for the first twenty mandibles and the measurements repeated. There was over 95% agreement between the initial and the second set of measurements in all the parameters described above.

Simple percentage evaluation was used to determine the frequency of the mental foramen in relation to the lower teeth. Descriptive statistics, the Student's t-test, and correlation coefficients were used to analyze the data collected using statistical software (stat work 1.2).

Result

Table 1 shows the mean dimensions of the mental foramen. The majority of the foramina studied were oval in shape (74.3%) while the rest were round with the mean

Table 1 Average dimensions of the mental foramen

Parameter	Side	
	Right	Left
Mean vertical diameter (mm)	2.43	2.71
SE vertical diameter	0.15	0.18
Mean horizontal diameter (mm)	5.05	5.00
SE horizontal diameter	0.27	0.34

SE = standard error; mm = millimeters

had one foramen on the right, and an accessory one on the left, located posterosuperior to the main foramen. The incidence of one foramen is 4.3% of the cases.

Tables 2a and b show the vertical and horizontal parameters to locate the position of the mental foramen in relation to the border of the mandible and the mandibular symphysis and the posterior border of the ramus of the mandible respectively. The modal position of the mental

Table 2a Summary of the vertical parameters to locate the position of the mental foramen in relation to the border of the mandible

Parameter	AD		AB		CD		AB/AD		CD/AD	
	Rt	Lt	Rt	Lt	Rt	Lt	Rt	Lt	Rt	Lt
Mean (mm)	29.44	29.16	13.24	13.49	13.77	12.96	0.451	0.464	0.468	0.444
SE	0.466	0.476	0.283	0.355	0.355	0.343	0.0084	0.0083	0.0092	0.0091
Overall mean (mm)	29.3		13.36		13.37		0.46		0.46	
95% CI of overall mean	28.38	30.22	12.81	13.91	12.68	14.06	-	-	-	-

Rt = Right; Lt = Left; mm = millimeters; SE = standard error. See text for abbreviations AD, AB and CD

Table 2b Summary of the horizontal parameters to locate the position of mental foramen in relation to the mandibular symphysis and the posterior border of the ramus of the mandible

Parameter	PL		LZ		RZ		PI/PZ		PI/RZ	
	Rt	Lt	Rt	Lt	Rt	Lt	Rt	Lt	Rt	Lt
Mean (mm)	26.49	26.31	78.17	79.06	73.11	74.06	0.253	0.250	0.364	0.358
SE	0.431	0.463	0.859	0.979	0.818	0.934	0.0040	0.0047	0.0074	0.0092
Overall mean (mm)	26.40		78.62		73.58		0.50		0.36	
95% CI of overall mean	25.53	27.27	76.82	80.42	71.86	75.30	-	-	-	-

Rt = Right; Lt = Left; mm = millimeters; SE = standard error. See text for abbreviations PL, LZ and RZ

Table 3 Comparison of the percentage position of the mental foramen indifferent population group

Population groups	Sample Size (n)	% Distribution per position					Authors
		1	2	3	4	5	
North Americans	100	0	3.5	23	49.4	24.1	Tebo & Telford (1950) ⁶
Hong Kong							
Chinese	87	0	21	51	24	4	Green (1987) ¹⁹
Chinese	100	0	21	59	19	1	Wang et al. (1986) ¹⁸ *
British	44	0	9.1	59.1	31.8	0	Santini & Land (1990) ²⁷
North Indians	96	0	2.08	17.71	68.75	11.46	Singh et al. (1992) ¹⁷
Asian Indians	138	0	5.80	75.36	18.84	0	Shankland (1994) ¹⁸
Turks	44	0	0	44.1	55.9	0	Oguz & Bozkir (2002) ²²
East Africans	165	0.30	7.57	57.88	31.52	0	Zivanovic (1970) ¹⁸ *
Kenyans	79	0	31.9	56.1	12.1	0	Mwaniki and Hassanali (1992) ¹⁸
Nigerians	302	1.82	26.99	55.63	12.25	3.31	Kekere-Ekun (1989) ¹⁸ *
Zimbabweans	32	0	0	12.4	56.3	31.3	Mbajirgu et al. (1998) ²⁵
Malawians	70	0	2.8	10.0	62.9	24.3	Present study

* Cited from Shankland (1994)

diameter of the foramen 3.74mm on the right and 3.86mm on the left respectively. Most of the foramina were oriented posterosuperiorly with only 2.3% of them oriented superiorly. All the mandibles measured had one or two mental foramina and there was no incidence of absence of mental foramina. Furthermore, all the mandibles were bilaterally symmetrical in the number of foramina on each side, except one (2.9%), which

foramen was below the second premolar tooth (position 4), which occurred in 62.9% of the mandibles. Position 5 (between the second premolar and the first molar) occurred in 24.3% of the mandibles while 10% of the foramina were between the two premolar teeth (position 3). Only 2.8% were at the apex of the 2nd premolar tooth (position 2). There was complete absence of the mental foramen in positions 1 and 6.

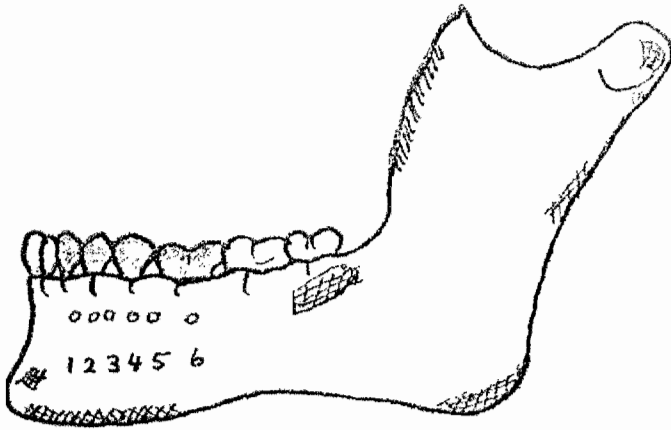


Fig. 1 Illustrates the position of the mental foramen in relation to the lower teeth
Position 1: Anterior to the 1st premolar tooth; Position 2: Below the apex of the 1st premolar tooth; Position 3: Between the two premolar teeth; Position 4: Below the apex of the 2nd premolar tooth; Position 5: Between the 2nd premolar and the 1st molar teeth; Position 6: Below the apices of the 1st molar tooth. (adapted from Tebo and Telford⁶).

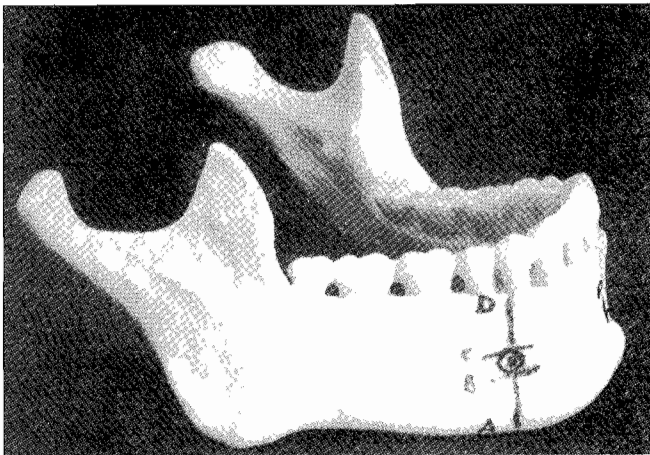


Fig. 2a Illustrates the parameters measured to determine the vertical position of the mental foramen on the body of the mandible.

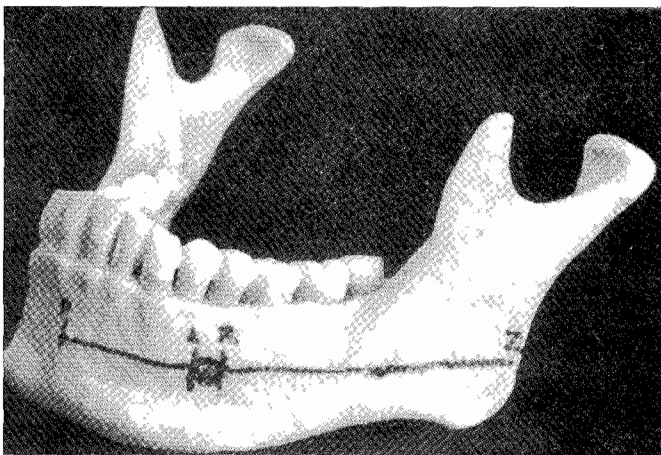


Fig. 2b Illustrates the parameters measured to determine the horizontal (antero-posterior)

Furthermore, chi-square test did not show significant differences in the position of the mandibular foramina relative to the occlusal plane and location of the mental foramina for the right and left side data ($P > 0.87$) hence both data were pooled.

The position of the mental foramen in relation to the alveolar margin and the lower border of the body of the mandible (Fig. 2a, Table 2a): The vertical position of the mental foramen as determined by the distance AB was 13.36mm (95% CI 12.81; 13.91). The distance AD between the lower border of the mandible and the alveolar margin was 29.30mm (95% CI 28.38; 30.22). On the average the mental foramen was located slightly inferior to the midpoint (45.8% of the distance) between the inferior border of the mandible and the alveolar margin. The coefficient of variation was slightly higher on the right side for AD and the left side for AB. There were positive correlations between both sides with respect to AD and AB and the differences were not statistically significant (AD: $P=0.24$; AB: $P=0.20$).

The mean distance PZ from the mandibular symphysis to the posterior border of the ramus of the mandible was 105.01mm (95% CI 103.22; 106.80) while the mean distance PL from the mandibular symphysis to the anterior border of the mental foramen was 26.40mm (95% CI 25.53; 27.27). On the average the mental foramen was 25.10% of the distance between the symphysis menti and the posterior border of the ramus. The mean distances PL, LZ and RZ had similar coefficient of variations between the right and left sides. There was also positive correlations between both sides with respect to PL and LZ but the differences were not statistically significant (PL: $P=0.68$; LZ: $P=0.18$; RZ: $P=0.16$ for each comparison.)

Table 3 compares the position of the mental foramen in relation to the mandibular teeth among various population groups. Majority of the groups had their mental foramina between the two premolars (position 3) and below the second premolar tooth (position 4). Where position 3 was the most common position of the mental foramen, position 4 was the next common and vice-versa except with the North Americans⁶ where the next common position is position 5 and in Nigerians and Kenyans where the next common position was position 2. For Zimbabweans and Malawians, however, the most common position of the mental foramen was position 4 while the next common position was position 5.

Discussion

We have demonstrated in this study that the majority (74.3%) of the mental foramina were oval in shape. This finding is supported by studies done by Mbajiorgu et al.²⁵ in Zimbabweans and Gershenson et al.⁹ among Israelites. Singh et al.¹⁷ however, found that in Indians, majority (73.4%) of the foramina were round. Furthermore the mean size of the long and short axes of the oval shaped foramina was slightly larger than those earlier reported for other populations.²⁵ This information is more of functional than clinical significance. The direction of opening of the mental foramen in our study is posterosuperior similar to what was reported by Mbajiorgu et al.²⁵ in Zimbabweans, Kenyans and also claimed by McMinn.² Previously, lateral, posterior and horizontal directions have been reported.⁹

The present study also found that the overall mean diameter of the mental foramina was 3.79mm, while it was 3.18mm and 2.77mm in the Zimbabweans²⁵ and Turkish²² populations respectively. Tebo and Telford⁶ in Texas, found

a high degree of bilateral symmetry of the mental foramen on each side of the mandible, as were also shown in this study. We found multiple foramina in 4.30% of cases, while multiple foramina was found in 5.33% of cases in Israelites,⁹ 11.45% in Indians,¹⁷ but 9.40% in Zimbabweans.²⁵ These findings show that in general, multiple foramina seem to occur in the minority of cases. Furthermore, we did not find any case of the absence of mental foramen in our study while de Freitas et al.¹⁰ found the incidence of absence of mental foramina in a Brazilian population to be 0.06% on the right side and 0.03% on the left side.

Evaluation of the relationship between the mental foramen and the lower teeth showed that the most common position of the foramen was position 4, followed by position 5 as indeed was the case with Zimbabweans²⁵ previously reported (Table 3). This finding, apart from the differences in percentage of occurrence, differed significantly from the findings of Gershenson et al.⁹ who reported high prevalence of the mental foramen in positions 1, 2 and 6 between the Indian and Sinai (Bedouin or Middle East) populations. Among Nigerians¹⁸ and East Africans¹⁸ previously reported, the most common position was 3 followed by position 2 in Nigerians and Kenyans but position 4 in East Africans (Table 3). In addition our findings were not in agreement with those of other investigators.^{17-19,22,27} Although our results showed differences in the position of the mental foramina, these were not clearly on distinct racial line as reported by Santini and Land.²⁷ Therefore the variability of the position of the mental foramen should always be considered when diagnosing radiographic periapical areas and when undertaking periodontal or endodontic surgery in the area from the canine to the mesial root of the first molar. Similarly, we recommend the importance of palpation of the foramen during administration of local anaesthetic fluid.

We have also shown that the vertical position of the mental foramen on the body of the mandible was slightly inferior to the midpoint of the distance between the inferior border of the mandible and the alveolar margin. Mbajjorgu et al.²⁵ also reported a similar finding among the Zimbabweans. Also the anteroposterior position of the mental foramen in this study was also a quarter of the distance from the symphysis menti to the posterior border of the ramus. Tebo and Telford⁶ Singh et al¹⁷, Mbajjorgu et al²⁵ and Mwaniki and Hassanali²⁸ also found similar results in Texans, Indians, Zimbabweans and Kenyans respectively.

While we cannot discount the possible contribution of anthropometric differences to the variations we have shown above, it is also probable that these differences could have resulted from the different methodologies employed. In relation to anthropometric differences, some of these studies lack details on age distribution and hence did not allow the age related mesial tooth drift vis a vis distal foramen drift that has been reported among British and Chinese mandibles.²⁸ The comparison of our study to those of Mbajjorgu et al²⁵ and Mwaniki and Hassanali²⁸ which used adult mandibles and whose methodologies were similar are therefore more appropriate.

In conclusion, we have found the majority of Malawian

mental foramina are oval in shape, single on each side of the mandible, and oriented posterosuperiorly, which seems to be the most common orientation of the mental foramina in most population groups. However, variations do exist in the modal position of the mental foramina in different population groups. Our findings are at variance with what obtains in anatomy textbooks. We therefore stress the importance of palpation of the foramen during administration of local anaesthetic fluid and interpretation of radiographs prior to surgery as was indeed advocated by Mwaniki and Hassanali²⁸ in Kenyan subjects.

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ERRATA

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Please note that the name was misspelt. It should read B. O. Adegbeingbe.
2. A. A. Sobande, **M. Eskander** and E. I. Archibong, "Complications of pregnancy and foetal outcomes in pregnant diabetic patients managed in a tertiary hospital" *WAJM*; April - June, 2005 Volume 24, No. 1 13 - 17.

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Please note that the name in bold should read M. Eskandar.