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 venier 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 Malawians 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’ètre venier.
Résultats: Dans la majorité des cas, la forme du foramen mental était ovale, orientée postérosupérieure, et bilatéralement symétrique. La position modale du foramen par rapport aux dents des mâchoires inférieures était inférieur par rapport à la deuxième dent prémolaire. 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 indiqués dans notre étude est a 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 mandible 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. There is also similar disagreement among authors of various published investigations.

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. 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.

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. 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.

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 - 7 mm. 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 crest 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.

Identification of the exact position of the mental foramen,
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 apicoectomy 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 authors19
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
disturbance of the radiographic image.23

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 venier caliper (Helios
digits, Caliper gauge DIN 861 - 1AZ - 0.01 - 150n rsts) with a
measuring accuracy of 0.01 mm. 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 Telford (Figure 1).

The digital venier 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 venier 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 (Stata v1.2).

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
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

diameter of the foramen 3.74 mm on the right and 3.86 mm 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.
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 Americans 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 Mbajorgu et al.25 in Zimbabweans and Gershenson et al.26 among Israelites. Singh et al.27 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.28 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 Mbajorgu 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 Turkish26 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, 11.45% in Indians, 2 but 9.40% in Zimbabweans. 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. 26 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 Zimbabwean 26 previously reported (Table 3). This finding, apart from the differences in percentage of occurrence, differed significantly from the findings of Gershenson et al. 3 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 Nigerians 18 and East Africans 26 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 anesthetic 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. Mbajorgu et al. 26 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 Telford 19 Singh et al., Mbajorgu et al. 25 and Mwaniki and Hassanali 26 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 via a vis distal foramen drift that has been reported among British and Chinese mandibles. 28 The comparison of our study to those of Mbajorgu et al. 25 and Mwaniki and Hassanali 26 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 posteroinferiorly, 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 Hassanali 26 in Kenyan subjects.

References
ERRATA


Please note that the name was misspelt. It should read B. O. Adegbiehingbe.


and


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