# Position of the mental foramen in a North American, white population

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Knowledge of the position of the mental foramen is important both when administering regional anesthesia and performing periapical surgery in the mandible. Although it is often possible to identify the mental foramen by palpation and radiographically, knowing the normal range of possible locations is essential. Standard anatomic texts have data collected from dried skulls, but often of unknown origin or from an ethnic group that does not represent the North American population.

**Objectives.** This study identified the position of the mental foramen in a more representative sample of the North American population. Ethnic and gender differences were also investigated and the symmetry of location within individuals analyzed.

**Study design.** Regional dissections of 105 human cadavers were carried out to identify the normal range of position of the mental foramen. The vertical and horizontal position was recorded with the two adjacent teeth used as references. If the two adjacent teeth were not present the foramen was not included in the study.

**Results.** The results indicated that the mental foramen was, on average, between the premolars, therefore not statistically different from previous studies. However, there appears to be a greater range than generally reported, which is of considerable clinical significance. Examples of dissections of unusually positioned mental foramina are given.

(Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1998;85:457-60)

One oral region that causes considerable concern during periapical surgery is the mandibular premolar region because of the proximity of the mental nerve.<sup>1</sup> The mental nerve is a terminal branch of the inferior alveolar nerve that passes through the mental foramen, supplying sensory innervation to the lower lip, buccal vestibule, and gingiva mesial to the first mandibular molar (Fig. 1). Obviously it is important to be able to localize the mental foramen when attempting to achieve regional anesthesia of the incisive nerve, (the other terminal branch of the inferior alveolar nerve), and to avoid it during periapical surgery involving the molars and premolars.

Many studies have investigated the position of this foramen by examining collections of dried skulls<sup>2-6</sup> and clinical radiographs.<sup>7</sup> However, a weakness common among most of these previous studies has been the lack of demographic records. One study with good documentation reported on a population comprised of 90% Bantu skulls.<sup>4</sup> This highlights another potential shortcoming—the position of the mental foramen in a population such as the Bantu of Africa may not relate to a North American clinical population. Examples of sexual and racial osteologic differences are fairly common.<sup>8</sup> Also, most dried skull collections are composed of material from the Indian Subcontinent. It remains unclear if these previous studies are relevant to the general North American clinical population. Although the

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Received for publication Aug. 4, 1997; returned for revision Oct. 13, 1997; accepted for publication Nov. 16, 1997. 1079-2104/98/\$5.00 + 0 7/15/87818

position of the mental foramen has been extensively studied, possibly this position varies according to gender or ethnic origin.

Previous studies (Table I) show the most common location for the mental foramen to be a position aligned with the second premolar  $(pm_2)$ , followed by between the first and second mandibular premolars  $(pm_1 \ ^{\wedge} pm_2)$ . Indeed, both positions are given as possibilities by standard textbooks of anatomy.<sup>8,9</sup>

The purpose of this study was to investigate the position of the mental foramen in a sample of cadavers for whom the demographics were available. Also assessed were any differences by gender and, through comparison with previous studies, by ethnic group.

### MATERIAL AND METHODS

One hundred five cadavers were made available over a 3-year period for regional dissection of the mental foramen after completion of gross anatomy dissection at the University of North Carolina at Chapel Hill, School of Medicine. These cadavers were donated to the school from the general population without bias for race or gender. Examination of the demographics revealed an even distribution between African-Americans and whites. Neither Native Americans nor Asians were present within the group. Hispanic whites could not be reliably differentiated from non-Hispanics, so no attempt was made to distinguish between these subgroups. There were 51 males and 54 females, 60 whites and 45 African-Americans in the sample, which is within the 95% confidence interval of the general population of North Carolina. In order to assess the



Fig. 1. Common position for mental foramen (*arrow*) through which mental nerve exits, is between premolar teeth. Note facial artery (*arrowhead*), which supplies major blood supply to area. (*C*, canine; *PM*, premolars; *M*, molar)

**Table I.** Previously reported position of mental foramina. Percentage at each position are reported. Phillips<sup>5</sup> reported only position relative to the  $pm_2$ . This is indicated by the number of foramina mesial or distal to this tooth being placed in parenthesis.

	$c^{pm_I}$	$pm_I$	$pm_1^{h}pm_2$	$pm_2$	$pm_2^M$	М
Matsuda <sup>2</sup>	0	3	16	69	6	6
Miller <sup>3</sup>	0	3	38	40	20	0
Mwaniki and Hassana	0 Ili <sup>4</sup>	0	12	56	32	0
Phillips et al. <sup>4</sup>	5		(18)	63	(19)	
Tebo and Telford <sup>6</sup>	0	2	23	50	24	1
Sweet*7	2.5	8	63	23	3	0.5

position of the mental foramen in relation to the dentition, it was decided that at least the two adjacent teeth had to be present for the measurements to be included in the study.

Dissections were carried out on every specimen that could have potentially met this criterion. Each mental foramen was then visualized, and a decision made at that time as to whether or not it should be included in the study. A total of 133 foramina from 70 cadavers were dissected over a 3-year period, of which 100 foramina met the criteria for further analysis.

Each mental foramen was assessed for its horizontal relationship to the facial cusp of the nearest teeth. A ruler was held along the long axis of the facial surface of the crown of the nearest tooth. If the ruler crossed the mental foramen it was said to be "In line" with that tooth. If it fell entirely between rulers positioned on two adjacent teeth, it was said to be "Between" those teeth.



Fig. 2. A, Mental foramen may be positioned as far mesially as first premolar or **B**, as distal as roots of first molar. Usually there is a single, circular foramen facing distally. C, Two openings are present 1% to 2% of the time.

**Table II.** Position of mental foramen in present study by gender. Total numbers are also percentages as the total number of mental foramen measured was 100.

	$c^{pm_{I}}$	$pm_1$	$pm_1^{h}pm_2$	$pm_2$	$pm_2^M$	М
Males	1	1	19	9	16	2
Females	0	4	22	9	15	2
Total	1	5	41	18	31	4

c, Canine; pm, premolar; M, molar; ^ between.

No significant gender-related differences.

**Table III.** Number of persons with mental foramina inthe same position on both sides (symmetric) versusthose in different positions (asymmetric)

 Symmetric	28	 
 Asymmetric	21	 

Thus the foramen could be at one of the following positions: (1) between the canine and  $pm_1$ , (2) in line with the crown of  $pm_1$ , (3) between  $pm_1$  and  $pm_2$ , (4) in line with the crown of  $pm_2$ , (5) between  $pm_2$  and  $M_1$ , or (6) in line with the crown of  $M_1$ . The vertical relationship of the mental foramen was measured in millimeters as the vertical distance from the superior border of the foramen to the cementoenamel junction (CEJ) of the nearest tooth.

The group of cadavers that had both left and right mental foramina included in the study were further investigated to determine whether or not the position was symmetrical.

All observations were carried out by J.R.D.M. The information was tabulated at the time of the dissections. The position of the right and left foramina and their respective vertical distances from the closest CEJs were noted separately. As the information was collected over a 3-year period, representative samples were photographed each year to ensure reproducibility.

Statistical analysis was carried out with the nonpara-



Fig. 3. A, Mental foramen is usually inferior to tooth apex, but (B) may be at the midroot level only 8 mm from the CEJ.

metric Wilcoxon rank sum test to assess possible ethnic differences. Gender and differences of symmetry were assessed using the  $\chi^2$  test for independence.

## RESULTS

Having completed 133 regional dissections it was found that 103 mental foramina, from a total of 55 cadavers, met the stated criteria for their measurements to be made and included in the study. However, this group contained foramina from only 2 African-American cadavers; the remainder were from 53 whites. Such a small number of African-Americans was deemed not to be representative of the general population: these data were omitted from the overall tabulation, although all three did, in fact, fall within the center of the larger distribution. The final distribution by gender was 27 female and 26 male cadavers for a total of 52 mental foramina from females and 48 from males. The uneven numbers were due to several of the cadavers having only one mental foramen that met the criteria for inclusion. There was no difference in the distribution of the position of the mental foramen by gender (Table II, p > 0.1).

Analysis of the symmetry of the mental foramina, when both sides fulfilled the criteria for inclusion, demonstrated that frequently the foramina would be in different positions (Table III, p < 0.05). Also shown was that it was unlikely to be different by more than one group, i.e., if a foramen was located in line with the crown of pm<sub>2</sub> on the left, there was 95% likelihood of the right being aligned either between the pm<sub>1</sub> and pm<sub>2</sub>, at the crown of pm<sub>2</sub> or between pm<sub>2</sub> and M<sub>1</sub>. However, this is confounded by the fact that 90% of the foramina appear between these limits whether or not they were the same on both sides.

Because the position on one side of the mandible was

independent of the position on the other side and because gender made no difference to the distribution, in order to provide a larger group for analysis, the positions of the mental foramina from all the individuals were combined and the sides considered as independent units thus making 100 mental foramina available for analysis.

The majority of mental foramina were located between the first and second premolars (Table II). The second most common location was between the second premolar and the first molar. Third most common was a position in line with the crown of the second premolar. These groups comprised over 90% of the total sample. This was not found to be statistically significantly different from the results of previous studies (p > 0.1).

The vertical position of the foramina, as measured from the CEJ of the nearest tooth, was 16 mm, with a range of 8 to 21 mm. This was the same as previously demonstrated,  $^{2,6}$  so statistical analysis was deemed unnecessary.

## DISCUSSION

It has been demonstrated that in this sample the mental foramen is most commonly located between the two premolars (Fig. 1), which is within the range of previous studies. Furthermore, 90% of foramina lie either at the second premolar or immediately mesial or distal to this position, also in agreement with previous information.<sup>2-7</sup> Thus, when administering anesthetic solution to provide regional mental and incisive anesthesia, if the needle is placed next to the pm<sub>2</sub> one could expect success 90% of the time. However, 10% of the foramina present in what might be considered unusual positions, either being aligned with the first premolar (Fig. 2, *A*), or with the first molar (Fig. 2, *B*). These locations may be inconvenient for anesthesia or could lead to damage when performing invasive procedures, such as periapical surgery. Occasionally there are two mental foramina (Fig. 2, C).

Vertical height had a larger variability than previously reported,<sup>2,6</sup> ranging from 8 to 21 mm inferior to the CEJ (Fig. 3). Although the average of 16 mm would be apical to most teeth, 20% of the foramina were less than 12 mm from the CEJ, which would be at or above the apex of the majority of teeth. It is important to positively identify the mental foramen radiographically before surgery in the region. Modifying the flap design accordingly, as previously suggested,<sup>1</sup> would be beneficial.

In the present study, three times as many foramina were distal to the second premolar as in previous reports.<sup>2-6</sup> However, the number examined was too low to determine if this difference was statistically different from previous studies and therefore whether this was an ethnic difference. In general, the position of the mental foramen appears to be the same in this sample as in other reports. However, a clinically significant amount of individual variation exists, including variability in the position of the mental foramen on the contralateral side. This is in agreement with a radiographic study of 323 individuals<sup>7</sup> that is the only previous report of a North American population. However this was a nonstandardized radiographic study with the inherent unreliability of radiographic interpretation. Similarly, while the vertical position is generally in close agreement with previous data,<sup>2</sup> considerable variability also exists between individuals.

I thank Drs. William Huffines and Charles Daw and Mr. Manfred Phelps of the UNC School of Medicine, Medical Teaching Laboratories for assistance and encouragement during this project.

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