Original Article

Correlation of mandibular premolar roots with mental foramen in periapical radiographs

Homa Rastegar[1]^, Amir Motealemi[2]

[1]Department of Oral and Maxillofacial Radiology, School of Dentistry, Birjand University of Medical Sciences, Birjand, Iran; [2]School of Dentistry, Birjand University of Medical Sciences, Birjand, Iran

Contributions: (I) Conception and design: H Rastegar; (II) Administrative support: H Rastegar; (III) Provision of study materials or patients: H Rastegar; (IV) Collection and assembly of data: A Motealemi; (V) Data analysis and interpretation: A Motealemi; (VI) Manuscript writing: Both authors; (VII) Final approval of manuscript: Both authors.

Correspondence to: Prof. Homa Rastegar, PhD. Department of Oral and Maxillofacial Radiology, School of Dentistry, Birjand University of Medical Sciences, 9717853577, Pasdaran Street, Birjand, Iran. Email: hrastegar.98@bums.ac.ir.

Background: The location of the mental foramen and its relationship with the roots of mandibular premolars is essential in surgeries and endodontic treatments, premolar extractions, and placing implants in the region. The current study aims to investigate the frequency of variations in the correlation of mandibular premolars with the mental foramen of the patients referred to the Birjand Dental School.

Methods: During this study, 328 periapical radiographs of the patients referring to the oral & maxillofacial radiology (OMFR) department were evaluated. The horizontal and vertical relationship of the mental foramen to the mandibular premolars was assessed and noted in the checklist.

Results: Horizontally, 47.2% of mental foramen were in line with the vertical axis of second premolars. After that, the most frequent horizontal location of mental foramen was between the roots of the first and second premolars, with a prevalence of 37.1%. Vertically, the most frequent location of mental foramen was reported below the line connecting the root apexes of the mandibular premolars, with a prevalence of 78.7%. The horizontal and vertical location of mental foramen did not significantly differ between genders or age groups (P>0.05).

Conclusions: In this local population, the most frequent horizontal location of mental foramen is along with the vertical axis of the mandibular second premolar and, after that, between the roots of the second and first premolars. The most prevalent vertical location of mental foramen is below the line connecting the apexes of the premolars.

Keywords: Periapical radiography; mental foramen; premolar; mandible

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Introduction

Background

The mental foramen is located on the buccal surface of the mandible through which a branch of the trigeminal nerve passes. This branch is called the mental nerve, which transmits the sense of chin skin, lower lip, and labial mucosa of mandibular anterior teeth and premolars. The mental foramen is located on the anterior surface of the mandible in the shapes of a circle and an oval (1). Mental foramen could be varied widely in terms of shape, location (horizontally and vertically), and symmetry (2). There have even been

^ ORCID: 0000-0001-6473-8256.

reports of accessory mental foramen observed using cone beam computed tomography (CBCT) in different patients, but the general use of panoramic and periapical radiographs can make them more important (3,4).

The location of the mental foramen and its correlation with mandibular premolar roots are essential in periapical infection, endodontic surgery, extracting teeth, and placing implants. This foramen is also biologically crucial because of containing nerves and vessels. Involvement of mental foramen during dental procedures due to the dental infection spreading to this anatomic region, which can cause some problems like paresthesia and temporary or permanent paresthesia (5).

Moreover, the foramen's location is critical when dentists apply local anesthetics in surgeries and dental treatments (6).

In different populations, the location of the foramen can vary due to geographical and ethnic factors (3).

In previous studies, some results show us how ethnicity can make differences in normal anatomical variations. For example, the prevalence of accessory mental foramen is noted like that: 2.6% in French; 1.4% in American Whites; 5.7% in American Blacks; 3.3% in Greeks; 1.5% in Russians; 3.0% in Hungarians; 9.7% in Melanesians; and 3.6% in Egyptians (7). On the other hand, a high frequency was reported at 6.7–12.5% in the Japanese population (8).

In the other comparison, mental foramen location was reported between the first and second premolar in Caucasoids and Sri Lankan populations, but in Turkish and Mongoloid populations, results showed mental foramen in line with the second premolar axis. Mental foramen was detected between the second premolar and first molar in the Japanese and Tanzanian populations (9-11). This outcome reveals how ethnicity, race, and geographic factors can vary in location, shape, and number of mental foramen. Moreover, the foramen's location is critical when dentists apply local anesthetics in surgeries and dental treatments (10). It is often difficult to determine the exact location of the mental foramen and various methods are used to examine it, like panoramic imaging, periapical imaging, and CBCT (12,13).

Objective

The periapical view is used as the most common radiograph in dentistry. Moreover, errors regarding patient positioning in panoramic radiography do not occur using periapical radiographs. Panoramic radiography provides a bigger, more extensive view of the foramen due to the buccal location of the mental foramen (14). Various studies have evaluated the role of panoramic radiography and CBCT in determining the relationship between mandibular premolars and mental foramen. However, there are a few studies assessing these factors using periapical radiography (15,16).

Considering the evaluating of the correlation between premolar roots and the mental foramen is essential and periapical radiography is mainly used to investigate, this study aimed to assess the prevalence of the relationship between mandibular premolars roots and mental foramen in periapical radiography.

Highlight box

Key findings

- The most frequent horizontal location of mental foramen is along with the vertical axis of the mandibular second premolar and, after that, between the roots of the second and first premolars. The most prevalent vertical location of mental foramen is below the line connecting the apexes of the premolars.

What is known and what is new?

- Report here about what is known. There was some information about location and shape of normal variation all around the world and limited data in our country.
- Report here about what does this manuscript adds. Now we added more information about a new local population in view of periapical radiographies.

What is the implication, and what should change now?

- Dentists and health care concern about anatomical landmark about location of mental foramen in this local population and it can be useful for clinician during dental operations.
- Report here about implications and actions needed.

Methods

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the ethics committee of Birjand University of Medical Sciences (No. IR.BUMS.REC.1398.416) and informed consent was taken from all the patients.

At first, 328 periapical radiographs were examined randomly in the OMFR department of Birjand Dental School. The radiographs were taken using a parallel technique by a film holder. All images were taken with a perpendicular angle to the contact between the first and second molar. Researchers repeated radiography with digital artifacts and other distorting factors. Patients with the malocclusion class II, III (upper and lower molar relationship) and any history of surgery on the mandible

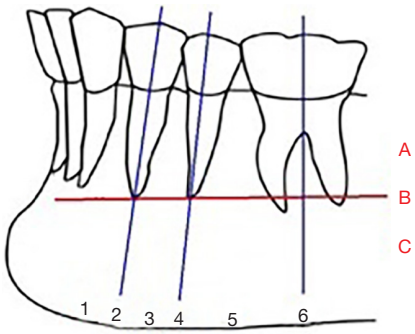

Figure 1 The vertical axis of premolars and molar teeth are shown with blue lines. Redline presents a line that connected two apexes of premolars.

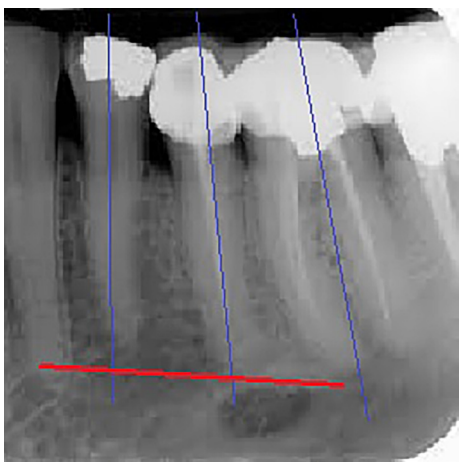

Figure 2 These blue and red lines of *Figure 1* are shown in the periapical radiography.

body were removed from the study. In addition, patients who performed orthodontic treatment or extraction of mandibular premolars and first molar in the past were excluded from the study. The images were taken with an excessive vertical angle that causes elongation or foreshortening were deleted.

The main stage of the project implementation and completion of the researcher checklist was performed by the radiologist, which consisted of 4 parts: patients' ages, sexes, horizontal placement of mental foramen towards mandibular premolar roots, and vertical placement of mental foramen towards mandibular premolar roots.

Samples studied were assessed in terms of gender (male-female) and age groups (25 to 40 years old and more than 40 years old). The orientation of the mental foramen towards mandibular premolars was examined in horizontal and vertical dimensions by two oral and maxillofacial radiologists. In terms of the horizontal orientation of the foramen, reference lines were drawn along with the vertical axes of the first premolar, second premolar, and first molar. The six positions were noted on the checklist regarding the horizontal relationship between mandibular premolars and mental foramen. All the checklists were completed without the names of patients.

The orientation of mental foramens towards premolar roots were: (I) mesial towards mandibular first pre molar, (II) along vertical axis of mandibular first premolar, (III) between mandibular first and second premolars, (IV) along mandibular second premolar, (V) distal towards mandibular second premolar, (VII) along the mandibular first molar.

Vertically, a reference line was drawn between the apexes of teeth 4 and 5 roots. Three positions were been stated for the vertical correlation of mental foramen and mandibular premolar roots (*Figures 1,2*).

(I) Above the line connecting the apexes of two mandibular premolars.
(II) On the line connecting the apexes of two mandibular premolars.
(III) Below the line connecting the apexes of two mandibular premolars.

Statistical analysis

After completing the checklists, data was entered into the computer. The data were analyzed using the SPSS (Statistical Package for the Social Sciences) software [International *Business* Machines *Corporation* (*IBM*), New York, USA] for Windows version 22.

Descriptive information was reported using frequency and percentage. In order to analyze the information, the Chi test or Fisher's exact test was used at a significance level of 0.05.

The inter-examiner and intra-examiner reliability was determined by comparing two repeated measurements at 20 (1.22%) randomly chosen images 1 month later, with 95% limits of agreement extended by a 95% confidence interval for differences between the means (using the Kappa coefficient).

Results

The most prevalent horizontal orientation of mental foramen was the orientation, along with the second

premolar observed in 47.2% of cases. Horizontal orientation group 3 was 37.1%. The horizontal orientation of group number 6 was not seen (*Table 1*).

The most common vertical orientation was location C, observed in 78.7% of cases. Then the prevalence of the B group was 19.5%, and finally, the orientation of the A group was seen in six patients (1.8%) (*Table 2*).

The statistical Chi-square test showed there was no significant statistical difference in the horizontal orientation of mental foramen regarding patients' ages (P=0.94). In addition, the most frequent orientation for both age groups was respectively location 4, location 3, location 2, location 5, and finally, orientation number 1. Orientation number 6 was not seen in any patient (*Table 3*).

Also, the most frequent vertical orientation of mental foramen for both age groups was, respectively, the orientation of the C group, the orientation of the B group, and the orientation of the A group (*Table 4*). Although the orientation of the A group was more prevalent among people older than 40 years old compared to those under 40 years, this difference was not statistically significant (P=0.09) (*Table 4*).

The prevalence of different horizontal orientations was the same for both genders. The prevalence of orientation 4 in men and location 5 in women was higher than in the opposite sex, but this difference was not found notable (P=0.35) (*Table 5*). The prevalence of the vertical orientation was the same for both genders (C>B>A). The prevalence of orientation B in women and orientation C in men was higher than in women, but this difference was not statistically significant (P=0.6) (*Table 6*).

Table 1 The frequency distribution of correlation types between premolar roots and mental foramen in the horizontal orientation

Horizontal orientation	Frequency	Percent
1	2	0.6
2	34	10.3
3	122	37.1
4	155	47.2
5	15	4.5
6	0	0
Total	328	100

Table 2 The frequency distribution of correlation types between premolar roots and mental foramen in the vertical orientation

Vertical orientation	Frequency	Percent
A	6	1.8
B	64	19.5
C	258	78.7
Total	328	100

Discussion

Key findings

The mental foramen is an anatomical structure that is usually placed below the mandibular premolars. This structure has significant clinical importance, and awareness of its exact position towards mandibular premolar roots is crucial to prevent incidence complications and reduce the risks during clinical-surgical procedures in the region.

The current study reported the most prevalent horizontal

Table 3 Frequency distribution of correlation types between premolar roots and mental foramen in the horizontal orientation for two age groups

Horizontal orientation	25–40 years old		More than 40 years old	
	Frequency	Percent	Frequency	Percent
1	1	0.4	1	1
2	23	9.9	11	11.3
3	86	37.2	36	37.1
4	111	48	44	45.3
5	10	4.3	5	5.1
6	0	0	0	0
Total	231	100	97	100

Table 4 The frequency distribution of correlation types between premolar roots and mental foramen in the vertical orientation for two age groups

Vertical orientation	25–40 years old		More than 40 years old	
	Frequency	Percent	Frequency	Percent
A	2	0.8	4	4.1
B	48	20.7	16	16.4
C	181	78.3	77	79.3
Total	231	100	97	100

Table 5 Comparing correlation types between premolar roots and mental foramen in the horizontal orientation in terms of gender

Horizontal orientation	Men		Women	
	Frequency	Percent	Frequency	Percent
1	1	0.5	1	0.7
2	17	9.1	17	11.9
3	66	35.4	56	39.4
4	96	51.6	59	41.5
5	6	3.2	9	6.3
6	0	0	0	0
Total	186	100	142	100

Table 6 Comparing correlation types between premolar roots and mental foramen in the vertical orientation in terms of gender

Vertical orientation	Men		Women	
	Frequency	Percent	Frequency	Percent
A	3	1.6	3	2.1
B	33	17.7	31	21.8
C	150	80.6	108	76
Total	186	100	142	100

orientation of mental foramen towards mandibular premolars roots along a vertical axis of the second premolar. Moreover, during the examination of the vertical placement of the mental foramen, the most prevalent orientation was below the line connecting mandibular premolar root apexes. These findings were similar to some studies and different from others, depending on the anatomical variations in the different races and populations.

Strengths and limitations

Despite the wide usage of advanced modalities for dental purposes, periapical radiography is the most popular and available method worldwide.

Compared with panoramic radiography, distortions in size and shape are at the minimum amount in periapical radiography, and the position of the object has the most negligible effect on the movement of the image.

In addition, navigating the instruments to avoid critical anatomical landmarks injury always is in concern for all clinical operations. The present study aimed to plan and classify the normal variations in a particular population. Although we used periapical radiography as the most common method for determining the location of the

mental foramen, advanced modalities such as CBCT are recommended in future studies.

In this *in vivo* study, applying a gold standard for accurate locating, such as more CBCT examination or exploring surgery, was not possible; all these preparations can suggest an *in vitro* study.

Comparison with similar research

The study by Chkoura *et al.* (17) was performed on 794 panoramic radiographs in 2013. The most prevalent horizontal orientation of mental foramen was detected along the vertical axis of the second premolar (62.7%) and with less prevalence between mandibular first and second premolar roots (30%). These results are consistent with the current study. This consistency could be due to similarities in the genetic resemblances of these two populations. Additionally, in Chkoura's study, the differences in the mental foramen orientation of the two genders were not significant like the present study.

In another study by Afkhami *et al.* (18), which was conducted in 2013, the general results are the same as the result of the present research. Panoramic radiographs of 100 patients were examined. In 67% of cases, the orientation of the mental foramen was under the second premolar apex's root, while in 24% of cases, it was between mandibular premolar roots.

The horizontal orientation of mental foramen was reported along the vertical axis of the second premolar in the Turkish population (19). Also, in the Tanzanian population, the most common horizontal orientation was along the vertical axis of the mandibular second premolar (20). In the Jordanian race, this orientation is mostly reported between the vertical axes of the first and second premolars (21). In the Korean population, for 65% of cases, the orientation of mental foramen was reported along the vertical axis of the second premolar (22), which was similar to the result obtained from the study on the Malaysian population (23). In a study by Haghanifar *et al.* was performed to investigate the location of mental foramen in the Iranian population in Babol, 400 panoramic radiographs were examined. In 47.2% of cases, mental foramen was detected between mandibular first and second premolars, and in 46% of cases, below the vertical axis of mandibular second premolars (24). That was very near to our result in terms of prevalence. The prevalence of the orientation along the vertical axis of the tooth was almost similar to the present study. However, the prevalence of the orientation between the roots of the two premolars was higher. It was reported as the most common horizontal orientation. Also, like in our study, there was no significant statistical difference between the sexes.

Another study by Dehghani *et al.* (25), which assessed 300 panoramic images of the selected Iranian population, was not consistent with the result of the present study. The most prevalent horizontal orientation of the mental foramen was between mandibular premolar roots (41.5%). In this study, the vertical orientation of mental foramen was below the apexes of mandibular premolars in 78.8% of cases which is consistent with the present study results. The inconsistency of the horizontal dimension of mental foramen can be due to the position depending feature of the panoramic radiography.

This condition is more severe in the horizontal dimension than vertical in panoramic radiography. In addition, unlike the present study, horizontal and vertical orientation of mental foramen have significant differences between the age groups.

Moreover, radiographic examination, another method to investigate the orientation of mental foramen, is evaluating dry mandibles. In 2011, 400 mandibles were assessed by Kqiku *et al.* (26), who reported that the typical orientation of mental foramen was between the roots of the premolars. These results are not consistent with our study outcomes regarding horizontal orientation.

Guo *et al.* (27) also investigated the orientation of mental foramen based on soft and hard tissue landmarks by examining 21 adult embalmed bodies in China. In 73.8% of cases, mental foramen was along the vertical axis of the second premolar, which, in general, is similar to the result of the present study.

Unlike horizontal orientation, studies show almost similar results regarding vertical orientation.

In a study by Fuentes *et al.* (15) conducted in Chile in 2017, the most prevalent vertical orientation of mental foramen was below the apexes of premolars (95.6%) which was consistent with our results with a higher prevalence rate. Moreover, there was no significant difference regarding age and sex.

In a study by Parnami *et al.* (13) in India aimed to examine 600 digital panoramic radiographs, the most prevalent vertical orientation of mental foramen was below the apexes of premolars, with a prevalence rate of 72.2%. It was near to the result of our study regarding the vertical orientation of mental foramen.

Also, in another study by Al-Khateeb *et al.* (21) in 2007 in Jordan, 860 panoramic radiographs were examined.

Unlike the result of the present study regarding the horizontal orientation of mental foramen, the most prevalent placement was between the first and second premolar roots, with a prevalence rate of 47%. The most common vertical placement of mental foramen was below the line connecting apices of mandibular premolar roots, with a prevalence rate of 78%, the same as in the current study. Additionally, this study showed a significant statistical difference in the orientation of mental foramen in terms of age and sex. The orientation between mandibular premolar roots was more common in men, and the orientation along the vertical axis of the second premolars was significantly more in women. Moreover, among older age groups, the posterior orientation of the mental foramen was observed in the horizontal dimension. This condition in older age groups in different societies may be due to different diets or paying attention to dental care. In the present study, no significant difference was observed regarding the prevalence of different horizontal and vertical orientations of mental foramen in terms of sex.

Like the result of our study, Kim *et al.* (22) did not report any significant correlation between sex and the orientation of mental foramen. Dabbaghi *et al.* (28) did not observe a significant correlation between sex and the placement of mental foramen either. In the study by Guo *et al.* (27), no significant correlation was observed between sex and the orientation of mental foramen among the Chinese population. In addition, in our study, consistent with the research by Naser *et al.* (29), no significant correlation was found between the orientation of mental foramen and age. The study by Rastegar *et al.* (30) showed that 2D imaging was selected for landmark assessment beacuse of the common used, and simple availability of these 2D radiographic moldalities.

In another study by Hui *et al.*, there was no significant relationship between age, gender, sides, and dentition status and the prevalence and length of the anterior and caudal loop on the mental nerve (31).

According to the recent study, that assessed mental foramen location in the Thai Population, the outcomes are consistent with our result, they reported along with the second premolar most common location of mental foramen (32).

In the study that aimed to detect anatomical variation of the mandibular canal and mental foramen in the Iranian population, the vertical position of the mental foramen confirmed our results in male patients' most reported cases that were closer to the inferior border of the mandible (33). Additionally, research was done by AlOtaibi *et al.* on the Saudi population to determine the location of mental foramen using CBCT. They noted that the most prevalent location of mental foramen is below the second premolar in the male patient. These results are similar to our study outcomes regardless of gender (34).

Conclusions

The most prevalent horizontal orientation of the mental foramen was the orientation, along with the second premolar. The most common vertical orientation was below the line connecting the apexes of two mandibular premolars.

Concerning the population differences and normal variations of mental foramen among has been suggested. Also, applying advanced imaging techniques such as computed tomography (CT) and CBCT will be helpful.

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Footnote

Data Sharing Statement: Available at https://fomm.amegroups.com/article/view/10.21037/fomm-22-62/dss

Peer Review File: Available at https://fomm.amegroups.com/article/view/10.21037/fomm-22-62/prf

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://fomm.amegroups.com/article/view/10.21037/fomm-22-62/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the ethics committee of Birjand University of Medical Sciences (No. IR.BUMS.REC.1398.416) and informed consent was taken from all the patients.

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