Evaluation of mental foramen location in the 10–70 years age range using cone-beam computed tomography

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Abstract

Introduction: Mental foramen (MF) locations were determined according to gender and age in terms of the vertical distance from the surrounding anatomical structures and the vertical and horizontal size of the MF.
Materials and Methods: One hundred-seven male and 103 female patients in the age group between 10 and 70 years were included in our retrospective study and were examined using cone-beam computed tomography (CBCT). The right and the left MF locations were determined from panoramic and cross-sectional images. On the cross-sectional CBCT images, the distance of the MF upper limit from the alveolar crest edge, the distance of the MF lower limit from the lower edge of the mandible, and vertical size of the MF were measured.
Results: MF location differed in males and females ($P < 0.001$); it was generally located at the first and second premolar in females, and at the level of the second premolar in males. However, the MF location was not different on the right and left sides ($P = 0.436$). The distance of the MF from the surrounding anatomic structures were found to be lower in females than in males in all measurements ($P < 0.001$). The horizontal size of the MF was found to be less on the left side ($P < 0.001$).
Conclusions: Knowing both the position and the distance of the MF from the surrounding anatomical structures is not only useful information for surgery, but will also help avoid complications such as paresthesia.

Key words: Age, cone-beam computed tomography, gender, mental foramen

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Introduction

The mandibular canal, with the nerve and artery inside, starts from the mandible foramen and it ends at the mental foramen (MF), located on the labial surface, generally between the first and second premolar tooth roots in an arch shape. The MF is generally located between premolar teeth and the lower edge of the mandibular, with alveolar crests on both sides of the mandible.[1] The location of the MF has been suggested to vary by race/ethnicity.[2-5] Knowing the exact localization, the borders, and the size of the MF is useful in cases of surgery, root canal treatment, apical surgery (apicoectomy), anesthesia, and implant treatment,

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because serious complications, such as paresthesia, can result if damage to the neurovascular bundle within the MF occurs.

The MF may not be apparent during conventional two-dimensional panoramic radiography due to positioning error and patient movement. A small MF may not be seen by radiologists even in a panoramic radiograph. Even if identified, its borders and distance from surrounding tissues may not be determined readily.[6,7]

Three-dimensional cone-beam computed tomography (CBCT), which has been in use for maxillofacial imaging since 2001, can provide many benefits for the dentist in radiological evaluation. Axial, sagittal, coronal, cross-sectional, and three-dimensional reconstructed images can help to clearly determine both the location and the distance of the MF from surrounding structures.[8] CBCT uses less radiation and is less expensive than conventional computed tomography (CT). In addition, CBCT imaging with a 0.125 mm isotropic voxel resolution has higher resolution than conventional CT. The image quality and ability to perform three-dimensional evaluation has led to a rapid increase in the use of CBCT among dentists. Using information from CBCT, complications such as paresthesia can be avoided, depending on the surgical procedure.[9,10]

Although many studies attempted to determine the position of the MF, few have evaluated the MF in terms of distance from surrounding tissues.[11-14] In this study, we tried to determine the location, size, and distance of the MF from surrounding structures.

Materials and Methods

This was a retrospective study performed with CBCT images obtained from patients in making diagnoses and treatment planning for various dental pathologies. The patients were seen at Dicle University, Faculty of Dentistry, Oral and Maxillofacial Radiology Department clinic between September 2009 and March 2013. In assessing medical history information for the patients with CBCT data in the oral and maxillofacial radiology department clinic, 107 male and 103 female patients (210 in total) without bone diseases or skeletal anomalies and between 10 and 70 years old were included in this study. Subjects with missing or incorrect images and individuals with cystic tumors in the MF region were excluded. The mandibles with malocclusion, alveolar bone resorption and proximal decays and patients with missing teeth in the lower jaw (between 33–36 and 43–46) were also excluded from the present study.

With the procedures performed routinely in our clinic, all CBCT images were from the same device (i-CATVision, Imaging Sciences International, Hatfield, USA, 2008). In patient positioning, care was taken so that the vertical lines formed in the device were parallel to the patient's sagittal plane and horizontal lines passed through the Frankfurt plane and were parallel to the floor. Imaging parameters were 120 kVp, 18.54 mA, 8.9 s, voxel size = 0.3 mm^3, and display area 13 cm × 10 cm wide.

MF locations were evaluated using panoramic images [Figure 1]. MFs that could not be seen on the panoramic image were evaluated using cross-sectional images [Figure 2]. The Telford classification was used for classification of MF location into 6 groups:

- MF is between the canine and first premolar
- MF is at the level of the first premolar
- MF is between the first and second premolars
- MF is at the level of the second premolar
- MF is between the second premolar and first molar
- MF was determined at the level of first molar.

On the cross-sectional CBCT images, the distance of the MF upper limit from the alveolar crest edge, the distance of the MF lower limit from the lower edge of the mandible, and the vertical size of the MF were measured. The horizontal size of the MF was measured on axial sections [Figure 3].

All CBCT images were evaluated by two oral and maxillofacial radiologists who had 6 years of experience. Radiographic evaluations were performed after providing calibration information to the radiologists. In the event of disagreement between them, cases were discussed with another radiologist until consensus was reached. Intra-examiner variation was determined by repeating the evaluation of the images, and inter-reviewer reliability was assessed using Cohen's κ analysis. All analyses were performed using the SPSS software (Versions 18.0.1; SPSS, Chicago, IL, USA). Differences in gender and MF location were evaluated using χ^2 tests. Evaluation of distance measurements between anatomical points specified by MF was performed with Student's *t*-test according to gender and location (right vs. left side).

Results

The Cohen κ coefficient was found to be 0.879, showing high reliability and statistical significance ($P = 0.001$). The

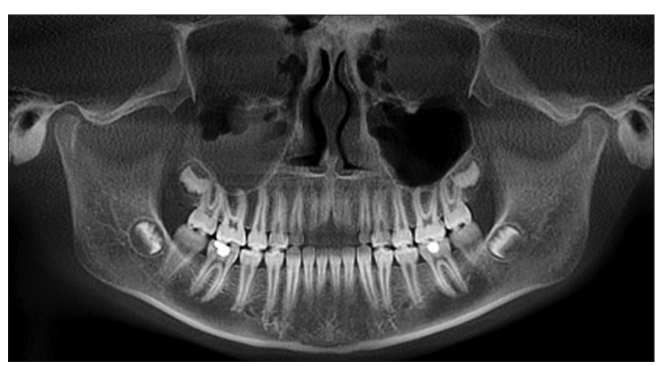

Figure 1: Panoramic image of mental foramen locations

Table 1: Distribution of MF position by side and gender

	Female (%)	Male (%)	*P*	Right (%)	Left (%)	*P*
Situated anterior to the first premolar	0 (0)	0 (0)	0.000*	0 (0)	0 (0)	0.436
In line with the first premolar	5 (2.4)	4 (1.9)		5 (2.4)	4 (1.9)	
Between the first and second premolar	114 (55.3)	88 (41.1)		106 (50.5)	96 (45.7)	
In line with the second premolar	59 (28.6)	105 (49.1)		74 (35.2)	90 (42.9)	
Between the second premolar and first molar	28 (13.6)	17 (7.9)		25 (11.9)	20 (9.5)	
In line with the first molar	0 (0)	0 (0)		0 (0)	0 (0)	
Total	206 (100)	214 (100)		210 (100)	210 (100)	

*$P \leq 0.001$. MF=Mental foramen

Table 2: Distance of the MF from neighboring anatomical structures according to gender and location

	Female	Male	*P*	Right	Left	*P*
Vertical dimension of MF	2.93±0.59	3.31±0.73	<0.001	3.12±0.74	3.12±0.64	0.785
Horizontal dimension of MF	3.31±0.62	3.56±0.72	<0.001	3.56±0.68	3.31±0.66	<0.001
Distance between MF and border of mandible	12.02±1.76	13.35±2.08	<0.001	12.75±2.19	12.65±1.88	0.607
Distance between MF and crest of mandible	12.53±2.54	14.03±2.85	<0.001	13.36±2.84	13.22±2.76	0.552

MF=Mental foramen

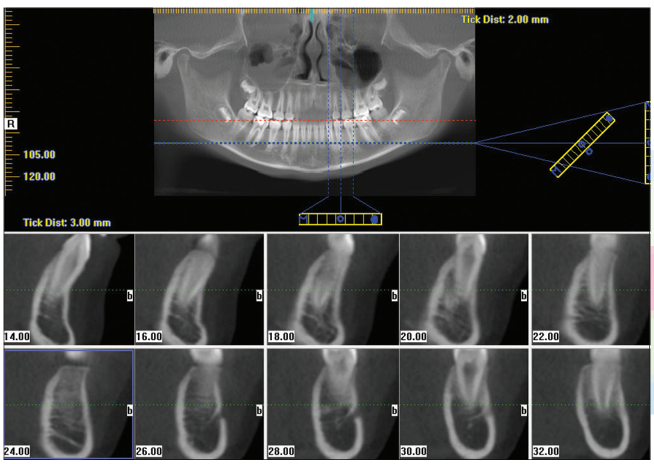

Figure 2: The mental foramen location was determined using cross-sectional images if it could not be determined using panoramic images

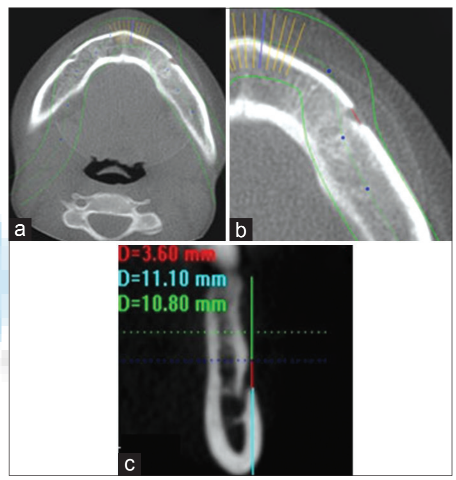

Figure 3: Determining the section on which the horizontal size of the mental foramen is largest in axial sections of (a and b) images. The vertical size of the mental foramen (red line), the distance of the mental foramen from the lower edge of the mandible (blue line), and the distance of the mental foramen from the alveolar crest edge (green line) are shown in (c), a cross-sectional image

MF in females was typically located between the first and second premolars (114, 55.3%), and then at the level of the second premolar (59, 28.6%). In males, the MF was located mostly at the level of the second premolar (105, 49.1%), and then between first and second premolar (88, 41.1%). The MF location was also found to differ significantly according to gender ($P < 0.001$). The MF was located most frequently between the first and second premolar on the right and left sides, and then at the level of the second premolar, with no difference between the right and left sides [$P = 0.436$; Table 1].

The vertical and horizontal sizes of the MF, the distance between the MF and the lower edge of the mandible, and the distance between the MF and the mandibular crest were smaller in females than males ($P < 0.001$). The vertical size of MF was similar on the right and left sides ($P = 0.785$).

The horizontal size of the MF, the distance between the MF and the lower edge of the mandible, and the distance between the MF and the mandibular crest were smaller on the left than the right side. In addition, while a significant difference was found in the horizontal size of the MF on the left and right sides ($P < 0.001$), there was no difference in the distance between the MF and the lower edge of the mandible ($P = 0.607$) or the distance between the MF and the mandibular crest ($P = 0.552$) and on the left and right sides [Table 2].

Discussion

Several studies have sought to determine the location of the MF and its distance from the neighboring anatomical structures in the skull;[11,13,15,16] panoramic radiography[4,17,18] has been applied, as has CBCT, which has been used in dentistry in recent years.[19-21] Studies using skull and panoramic radiography in Turkish populations have been reported.[3,22,23] In our study, 210 Turkish individuals were evaluated from 420 MF images. Among the reported studies performed with CBCT, it appears that only our study evaluated the MF. We believe that our study provides an important contribution to the literature, because we evaluated a large number of MF images and used CBCT.

We considered that CBCT would be more successful in determining the location of the MF and its distance from the neighboring structures than panoramic radiography, because the location of the MF cannot always be determined by panoramic radiography due to incorrect positioning of the patient and/or a small MF. The exact location of the MF in a small volume can be seen in coronal, axial, sagittal, cross-sectional, and three-dimensional reconstructed images using CBCT. In addition, for reasons such as incorrect positioning of the patient in panoramic radiography, lack of standardization in positioning during radiography, variations in anatomical structure, and conditions such as distortion and magnification in the radiographs, some differences in length measurements were identified. In measurements carried out by CBCT, more reliable results can be obtained because problems such as magnification and distortion will be eliminated.[24-26]

The MF was present at the first and second premolar teeth in females, and located at the level of the second premolar in males, and differed between males and females ($P \leq 0.01$). In a previous study conducted in a Turkish population, Kalender *et al.*, reportedthat the MF was generally located between the first and second premolar teeth and that the position was not different between males and females.[12] In studies performed on skulls in a Turkish population, the MF was reported to be between the first and second premolars.[14,22] In other studies performed with skulls in Turkish populations, the MF has been found at the level of the second premolar.[3,23] Therefore, studies in different races/ethnicities suggest that the MF is generally between the first and second premolars[4,5,27] or at the level of the second premolar.[2,13,15,16,28] We found that the right and left positions of the MF were symmetrical; there was no significant difference ($P = 0.436$). Other studies have reported similar findings.[3,14,15,22,28]

In our study, the vertical length of the MF on the right side was 3.12 ± 0.74, and 3.12 ± 0.64 mm on the left side. We found no difference between the right and left sides ($P \geq 0.01$). The horizontal length of the MF was 3.56 ± 0.68 on the right side and 3.31 ± 0.66 mm on the left side; the difference between right and left was significant ($P \leq 0.01$). Çaglayan *et al.*, in a study in a Turkish population and CBCT with the same sections used here, reported that the average vertical length of the MF was 3.29 ± 0.6 mm on the right and 3.36 ± 0.9 mm on the left side; the horizontal length was 3.83 ± 0.99 mm on the right and 3.8 ± 1.01 mm on the left.[14] In another study of a Turkish population in which CBCT was used, Kalender *et al.* found that the average vertical length was 3.7 ± 0.7 mm using CBCT coronal sections and the average horizontal length was 3.4 ± 0.8 mm.[12] The vertical length on the right was 2.38 mm and 2.64 mm on the left in a study of skulls conducted by Oguz and Bozkır; the horizontal length was 2.98 mm on the right and 3.14 mm on the left.[3] Neiva *et al.* found the average vertical length of the MF was 3.47 (range: 2.5–5.5) mm; the average horizontal value was 3.59 (range: 2–5.5) mm.[11] Von *et al.* reported that the average vertical length of the MF was 3.00 (1.8–5.1) mm; the average horizontal width was 3.2 (1.8–5.5) mm, similar results to our work.[29] In our study, neither the vertical nor the horizontal length was different in males and females ($P \leq 0.001$). Previous studies were consistent with this.[12,14]

In our study, the distance between the MF and the lower edge of the mandible was 12.75 ± 2.19 mm on the right and 12.65 ± 1.88 mm on the left. Few previous studies evaluated the distance between the MF and alveolar crest and the MF and the lower edge of the mandible. In a study in a Turkish population, using CBCT, results similar to ours were reported: 12.86 ± 1.55 mm on the right and 13.13 ± 1.89 mm on the left.[14] In another study of skulls, it was reported that the MF was 12.65 ± 1.59 mm on the right and 12.77 ± 1.73 mm on the left.[13] Neiva *et al.* reported a lower value than ours; the distance between the MF and the lower edge of the mandible was 12 mm.[11] Apihasmit *et al.* found that the distance between the middle of the MF and the lower edge of the mandible was 15.40 ± 1.73 mm in males and 13.89 ± 1.40 mm in females; in contrast to our results, they found a difference according to gender.[16] We believe that this discrepancy was because they measured the distance between the middle of the MF and the lower edge of the mandible, not the distance between the lower edge of the mandible and the MF. In our study, we found no difference on the right and left sides in the measurement between the lower edge of the mandible and the MF ($P = 0.607$). Çaglayan *et al.* reported no difference between the right and left sides in a study conducted in a Turkish population. We found the distance between the edge of the mandibular alveolar ridge, and the MF was 13.36 ± 2.84 mm on the right and 13.22 ± 2.76 mm on the left. Çaglayan *et al.* obtained 11.86 ± 2.75 mm on the right and 12.08 ± 3.12 mm on the left.[14] Udhaya *et al.* reported 12.02 ± 2.48 mm on the right and 12.21 ± 2.61 mm on the left side.[13] In both studies, the difference compared to our results was 1–2 mm. No difference between the right and left sides in the measurement between the MF and the alveolar crest edge was found not only in our study but also in that by Çaglayan *et al*.[14] ($P \geq 0.01$). However, both studies reported gender differences in the measurement between the lower edge of the mandible and the MF and between the MF and the alveolar crest edge ($P \leq 0.01$).

Conclusions

Knowledge of both the position of the MF and its distance from neighboring anatomical structures provides useful information for surgery and can also help to prevent complications, such as paresthesia. Further studies in populations of different races/ethnicities should be conducted to determine the position of the MF and its distance from neighboring anatomical structures.

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Conflicts of interest
There are no conflicts of interest.

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