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Original Article

Determining the Size of the Mental Foramen: A Cone-Beam Computed Tomography Study

Seda Falakaloglu, Artemisa Veis

[1] Dicle University, Faculty of Dentistry, Department of Endodontics, Diyarbakır, TURKEY
[2] Hasan Prishtina University, Faculty of Dentistry, Prishtina, KOSOVO

Correspondence:
Artemisa VEIS
Hasan Prishtina University, Faculty of Dentistry, Prishtina, KOSOVO.
e-mail:teaveis@hotmail.com

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Abstract

Aim: Knowledge of the position of the mental foramen is important to prepare strategy when administering regional anesthesia, performing dental surgical procedures, endodontic treatments. Also, it is critical to analyze diameter of mental foramen in sagittal, coronal, and axial images. The aim of this retrospective study was to determine the diameter of the MF in different planes from CBCT images.
Methodology: This study was designed at Department of Endodontics, Dicle University, Diyarbakır, Turkey. One hundred twenty three (67 female, 56 male) CBCT scans that met the study criteria were obtained. All images were obtained from i-CAT (Imaging Sciences International, Hatfield, PA). Data were analyzed using Student's t-tests and Tukey HSD tests.
Results: For the analysis of age, data were divided into four groups: 12–17, 18–29, 30–49, and ≥50 years. The data were also divided into two groups by gender. Axial and coronal image measurements were also divided into right and left. There was a statistical difference compared with females and males ($p<0.05$). In the coronal plane, the right region showed significant differences in measurements between the groups ($p<0.05$). In the axial plane, there was no statistically significant difference between them ($p>0.05$). The differences between the groups in the left region in the axial plane measurements were significant ($p<0.05$).
Conclusions: Using CBCT imaging superimposition of anatomical structures can be eliminated. It is important that determine that the size of the mental foramen. This study is a retrospective study using CBCT from patient and find that the size of the mental foramen.

Keywords: Mental foramen, cone-beam computed tomography, CBCT, anatomical variations

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Introduction

The location of the mental foramen (MF) in the mandibular bone can be important in endodontic treatments, surgical procedures, and regional anesthesia. Although it is possible to determine the position of the foramen with radiographic examinations and palpation, it is important to appreciate the limitations of these techniques (1). Bone remodeling, a lack of mechanical simulation, and changes in occlusion can lead to differences in the position of the MF (2). In endodontics, especially in root canal treatment of premolars, determining the location of a small MF is important (3). Despite recent techniques, material filling from the canal can cause labiomandibular paresthesia (4), feeding the outer surface of the mandibular through the MF and neurovascular bundle. The shape of the MF has been found to be oval in 54% of cases and round in 46%. The direction of the MF opening is typically 44% posterosuperior, 10% labial, 3% anterior (mesial), and 3% posterior (5).

In an anatomical study, Hu et al. (6) described four branching patterns of the mental nerve as it exits from the MF. The branches were dissected carefully and described as angular (A, mouth corner region), medial inferior labial (ILM, medial half of the lower lip), lateral inferior labial (ILl, lateral half of the lower lip), or mental (M, mental region), according to the distribution area. The mental nerve was also classified based on the shape of the anterior loop into loop, straight, and vertical patterns, as seen in 61.5%, 23.1%, and 15.4% of cases, respectively.

Regarding the MF position, anatomical variations in the vertical and horizontal planes have been identified. In most cadaver studies, the MF is near the position of the second premolar, although it may be visible at the level of the lower first molar tooth to the canine tooth (7). Differences have been observed in MF position according to ethnicity (8). The mandibular canal curves upwards from its normally lowest level, below the first molar, to the MF; the latter is located close to the root apices of the neighboring teeth. In the vertical plane, the MF may even be located coronally to the apices of close roots (9).

Cone-beam computed tomography (CBCT) was developed for detailed anatomical examinations. Three-dimensional (3D) images of dentomaxillofacial structures have been used in addition to radiographic examinations. Measurements of the MF position made from CBCT images are more accurate that those from conventional radiography (10). Moreover, by avoiding examination of 3D anatomy via conventional radiography in two-dimensional (2D) CBCT images help to provide a 3D image that includes neighboring structures. Also, with CBCT, the availability of sagittal, coronal, and axial images eliminates the superimposition of anatomical structures.

Thus, the use of CBCT is becoming increasingly important in endodontics. Indeed, its use is invaluable in evaluating periapical periodontitis and outcomes of root canal treatment, vertical root fractures, surgical procedures, and root resorption, as well as for diagnosing root canal anatomy and dental trauma (11). The purpose of this study was to determine the diameter of the MF in different planes from CBCT images.

Materials and Methods

This study involved a retrospective analysis of CBCT images taken with an I-CAT Vision device (Imaging Sciences International, Hatfield, PA, USA) at Dicle University, Faculty of Dentistry, Department of Oral and Maxillofacial Radiology. The scanning parameters were set at 120 kVp, 18.54 mA, 8–9 s, 0.3-mm voxel size, and a 13 cm × 10 cm image area.

CBCT images were viewed on a computer screen and were reformatted into multiplanar reconstructions to obtain the most appropriate sections for assessments and measurements. The same observer made the assessment in all cases. Images of the mandible at the lower, upper, buccal, and lingual edges were assessed. The mandibular first and second premolars and first molars were identified in their normal positions. The teeth assessed had no endodontic or periodontal pathology. In total, measurements were made from CBCT images from 123 patients (67 females, 56 males).

CBCT images were screened and evaluated in terms of the following parameters: the course of the mental canal in the vertical plane, the angulation of the mental canal to the buccal bone surface, the distance from the superior margin of the MF to the alveolar bone crest, and the distance from the inferior margin of the MF to the lower border of the mandible. In the coronal view, the maximum coronal height of the MF was measured (Fig. 1).

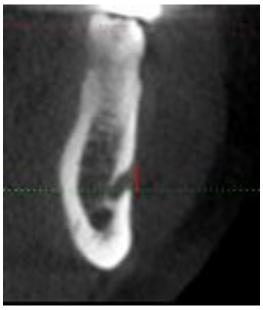


Figure 1. Coronal view

In the axial view, the maximum width of the MF was measured. A curved line was drawn along the external border of the mandible at the level where the greatest extent of the MF was visible. This curve served as a reproducible landmark for reference measurements across all scanned volumes (Fig. 2).

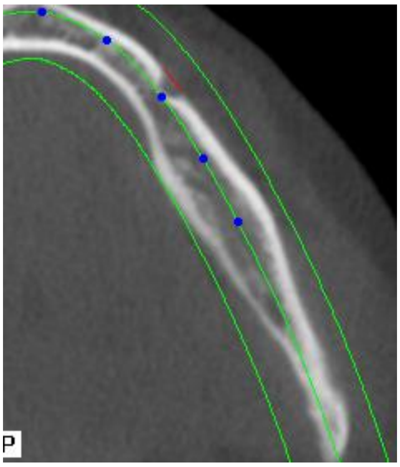
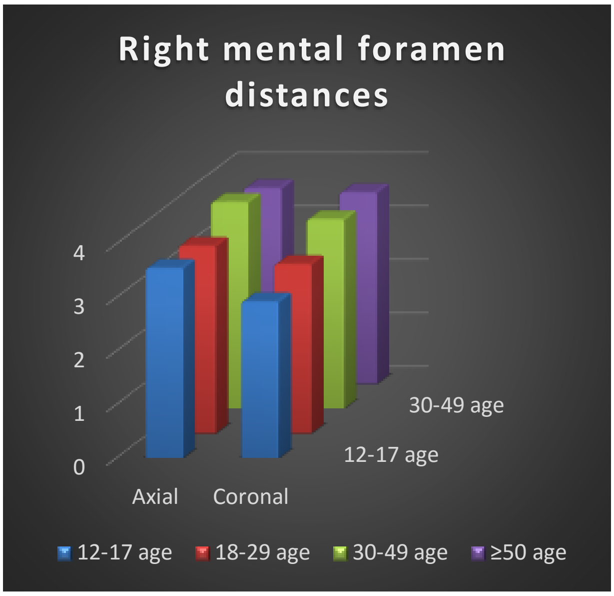


Figure 2. Axial view

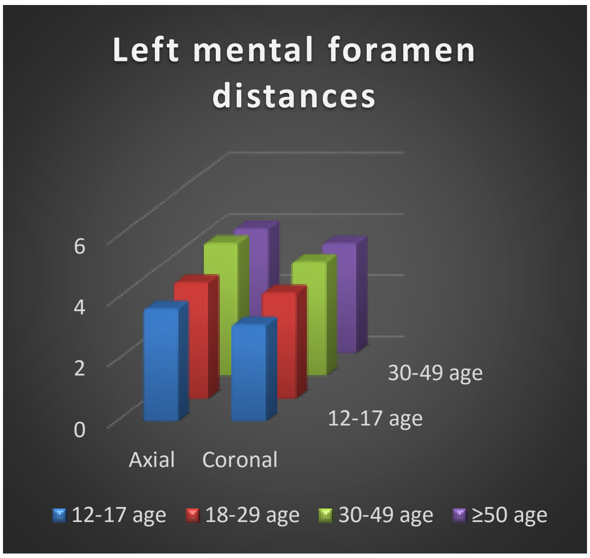
For the analysis of age, data were divided into four groups: 12–17, 18–29, 30–49, and ≥50 years. The data were also divided into two groups by gender. Axial and coronal image measurements were also divided into right and left.



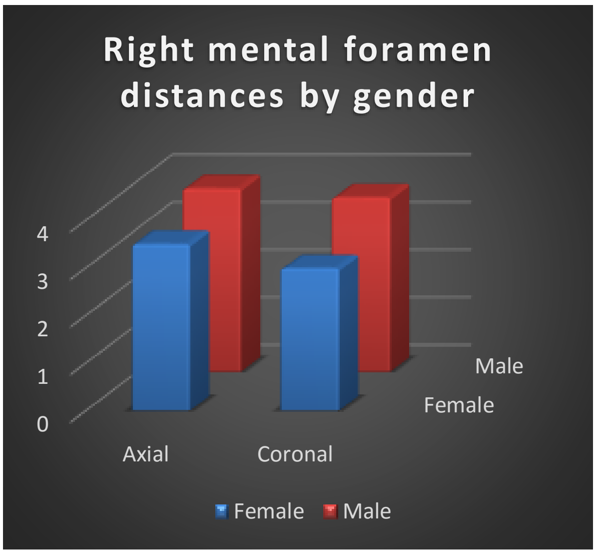
Graphic 2: Right mental foramen distances

Statistical analyses

The Kolmogorov–Smirnov test showed normal distributions; thus, parametric tests were used for comparisons of all groups. Specifically, a one-way analysis of variance (ANOVA) was used except for gender, in which an independent-group Student's t-test was applied. For comparisons within groups, Tukey's honest significant difference (HSD) test for multiple comparisons was used. A p-value of <0.05 was considered to indicate significant difference.



Graphic 1: Left mental foramen distances



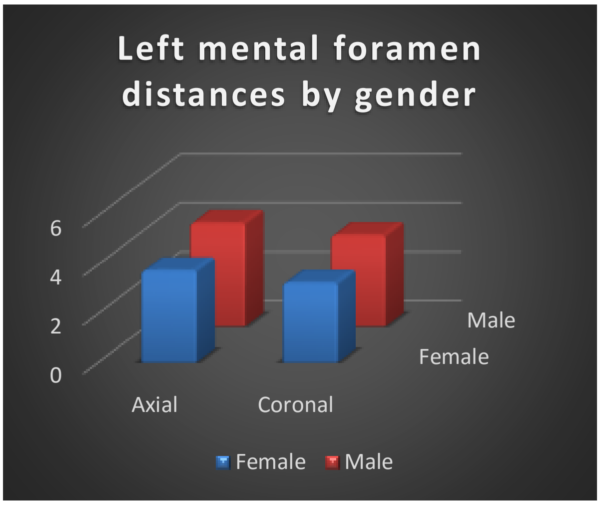
Graphic 3: Right mental foramen distances by gender.

Results

In the coronal plane, the right region showed significant differences in measurements between the groups (p<0.05). However, in the axial plane, there was no statistically significant difference between them (p>0.05). The right region of the coronal plane also showed no significant difference between measurements in the 12–17 and 30–49 age groups (Graph.1, 2).

The differences between the groups in the left region in the axial plane measurements were significant (p<0.05). In the axial plane of the region, no significant difference between the 12–17 and 30–49 age groups was found (p>0.05). No statistically significant difference was found between the groups in the coronal plane of the left region (p>0.05).

The parameters were statistically significantly different by gender (p<0.05). The right and left measurements of males for all parameters measured were larger than for females (Graph.3, 4).



Graphic 4: Left mental foramen distances by gender.

TABLE 1. Mental foramen measurements according to gender (mean ± standard deviation, mm)

		Right		Left	
Gender	**Number**	**Axial**	**Coronal**	**Axial**	**Coronal**
Female	67	3.4981±0.85882	2.9875±1.01759	3.7740±1.06823	3.2661±1.24785
Male	56	3.8529±0.91410	3.6636±0.91787	4.2220±0.98736	3.7261±1.12414

TABLE 2. Mental foramen measurementsaccording to different ages (mean ± standard deviation, mm)

		Right		Left	
Age	**Number**	**Axial**	**Coronal**	**Axial**	**Coronal**
12-17	32	3,5572±0,85706	2,9269±1,07794	3,6791±1,00406	3,1428±1,18784
18-29	30	3,5043±0,88750	3,1643±0,74986	3,7840±0,84401	3,4487±1,31272
30-49	40	3,8603±0,94387	3,5408±1,12875	4,3242±1,19723	3,7138±1,17486
≥50	21	3,6552±0,87889	3,5762±0,94025	4,0510±0,95773	3,5671±1,12186

Discussion

In this study, we evaluated the size of the MF in axial and coronal dimensions using CBCT images. It is important to have information on MF size, because the MF is a key anatomical landmark for many dental procedures in the posterior segment of the mandible. In past studies regarding MF size, the evaluation was based on periapical and panoramic radiographs and cadavers (12). CBCT is a modern technique that allows the evaluation of maxillofacial structures in three dimensions. While CBCT is an accurate, practical, and non-invasive method to reliably determine MF size in all three dimensions, it still has several shortcomings, such as radiation exposure and cost (13).

This study used a similar methodology to that of Carruth et al. (14). However, they only made comparisons by gender and racial groups; they did not determine differences among age groups. In our study, we examined differences in terms of age and between right and left regions with measurements in the axial and coronal planes.

Measurements of MF size showing no statistically significant difference by age group have been reported (14,15). Our study differed in that we included younger patients who had not yet completed skeletal development.

According to the results of our study, axial and coronal plane measurements of the MF were higher in males than females. This is believed to be due to the female mandibular bone being smaller than that of males. Other reports are consistent with this finding (16, 17).

Apinhasmit et al, showed that the vertical position of the MF could be determined by calculating the ratio of the distance between the center of the MF and the lower border of the mandible to the distance between the alveolar crest across the MF and the lower border of the mandible (17). In our study, measurements were obtained in the axial plane in this respect.

CBCT has been used increasingly in dentistry practice. Oral and maxillofacial surgery applications, bone and tooth fractures, temporomandibular joint examinations, orthodontic cases, and third-molar removal and endodontic cases are examples of areas using CBCT (10, 18, 19). Furthermore, CBCT has been used for MF measurements. In particular, in making individual anatomical measurements before a surgical procedure, CBCT use is widespread because multiple measurements can be made from the same images. To prevent neurovascular damage that may arise due to iatrogenic errors, the use of CBCT is important (14).

A risk of using CBCT imaging is ionizing radiation exposure to the patient. Higher radiation doses are associated with CBCT imaging than with conventional radiography (11) Chau and Fung compared typical patient radiation doses in implant imaging among three imaging modalities: spiral multislice CT, conventional spiral CT, and CBCT imaging. They reported that in implant imaging, spiral multislice CT imaging delivered the highest radiation dose to the salivary glands and CBCT imaging, the lowest (20). However, adverse effects of radiation exposure may not be apparent until years after exposure (21). When considering the use of CBCT, the risks and benefits should be considered (22).

Conclusions

CBCT imaging is the best available imaging technology for determining MF size. In panoramic radiography, MF diameters cannot be determined in the axial or coronal planes, but these can be measured from CBCT images. There were statistically significant differences in MF size with gender and age. In conclusion, this study adds information to the literature concerning the size of the MF using CBCT images.

Acknowledgments

The authors deny any conflicts of interest related to this study.

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