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Assessment of morphological and anatomical characteristics of mental foramen using cone-beam computed tomography in terms of age and gender

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Abstract

Objective: Accurate recognition of morphological characteristics of mental foramen reduces the possibility of adverse effects. This study investigated the morphological characteristics of the mental foramen and compared them between two different genders and on both sides of the mandible in different age ranges using CBCT.
Materials and methods: In this study, 258 mandibular CBCT scans were used to describe the morphological and anatomical characteristics of mental foramen in terms of gender and age. The data were analyzed with SPSS using chi-squared test and independent t-test.
Results: The results showed no significant difference in the frequency of foramen shapes on the right and the left sides. There were also no significant differences in the frequency of foramen shapes and the horizontal and vertical positions of the mental foramen between males and females on the right side.
Conclusion: In this study, no significant difference was observed in the frequency of the vertical position of the mental foramen in terms of side (right and left), age ranges, and gender.

Keywords: *Age, CBCT, gender, mental foramen.*

Introduction

The mandibular canal is an anatomical intraosseous structure in the mandible, beginning from the mandibular foramen and ending at the mental foramen (MF). During its path close to the first molar, this canal is mostly located on the medial or lingual side and reaches the mandible buccal body surface while arriving at MF (1).

Exact information on MF's position and vertical size in clinical dentistry is essential to perform mental nerve block, apical surgery, and osteotomy. Meanwhile, the correlation between the position and height of the foramen may provide important clinical information for surgeons (2). This structure plays a critical role in mandible body surgeries, and it is necessary to recognize its structure during periapical surgeries, dental implant placement, orthognathic surgeries, osteotomy, genioplasty, plate placement for fixing fractures, bone grafting, etc. (3).

MF is a bilateral opening located toward the anterolateral surface of the mandible body cortex, usually between the first and second premolars (4). Based on existing anatomical diversities, the horizontal position of this opening can vary from the canine apex to the mesiobuccal roots of the first molar (5). These diversities have been reported in the horizontal position of foramen among different geographical populations (6-8). Accurately recognizing these characteristics reduces the odds of paresthesia, anesthesia, and hemorrhage in the mental area, lower lip, and gums, from the foramen to the midline (5). Accurate knowledge of the foramen characteristics, particularly its horizontal position in the local anesthesia injection of the terminal branches of the inferior alveolar nerve

and incisive and mental nerves, is important for surgeries and dental treatments (2,3).

Various techniques are used to identify MF, including macroscopic investigations on dry skulls and 2D radiographic and CT images (9). Due to the superimpositions of other structures, overlapping, anatomical disorder, and geometric deviations, the foramen is probably not seen in 2D images like panoramic views (2). Panoramic views suffer limitations in diagnosing the diversities of the mandibular canal and other structures (10). The CBCT technique has attracted attention as the most appropriate and safest method for patients (9). CBCT provides 3D images, helping to obtain detailed information on the maxillofacial complex and making accurate examination and identification of anatomical diversities possible (11).

This study investigated the morphological characteristics of MF and compared them between two different genders and both sides of the mandible in different age ranges.

Materials and Methods

In this retrospective descriptive-analytical study, 258 mandibular CBCT scans performed by Newtom VGI were studied in individuals >18 years of age, referred to the Radiology Department of Tabriz Faculty of Dentistry from 2016 to 2019. The sample size was estimated at 258 using the ratio estimation method with limited size (P=0.5, α=0.5, and β=0.2), where seven samples were added to increase validity. The studied CBCT images were sufficiently clear, with teeth #3, #4, #5, and #6 on both sides of the mandible where the MF was visible. The patients had no history of maxillofacial trauma and orthognathic surgery after bone growth was complete; they also had no systemic diseases and took no drugs affecting bones. The CBCT images also revealed no lesions in the MF and bone loss at the foramen level.

The cross-sectional profile was used to measure the foramen angle (where the mandibular canal ends and the foramen appears). One line of this angle was drawn from the lowest point on the cortical bone of the MF into the MF, and the second line was drawn from the highest point on the cortical bone of the MF. The angle between these lines was measured in degrees.

On the axial view, the horizontal and vertical positions of the MF relative to the relevant tooth were evaluated and categorized into five categories: 1) between the canine and first premolar; 2) at the first premolar level; 3) between the first and second premolars; 4) at the second premolar level; and 5) between the second premolar and first molar. The vertical position of the MF was categorized as above the apex, at the apex level, and below the apex. The foramen shape was classified into three categories: round, horizontal oval, and vertical oval. By drawing two lines from the highest and lowest edges of the cortical foramen, the maximum foramen height in the cross-sectional profile was measured in millimeters, and the thickness of the cortical bone was also measured in the same cross-section 2 mm above the highest border and 2 mm below the lowest border in millimeter. To describe the statistical population, the gender and age of the patients were initially reported in means and percentages. The subjects were divided into seven age ranges. The data were analyzed with SPSS, using the chi-squared test and independent t-test.

Results

In this study, 258 CBCT images were investigated; 51.16% and 48.84% of the participants were male and female, respectively. Investigating the frequencies of age ranges showed that the subjects were within the following categories: 39.92% in the age range below 20 years old, 22.48% in the range of 20–30 years old, 18.6% in the range of 30–40 years old, 9.3% in the range of 40–50 years old, 5.81% in a range of 50–60 years old, and 3.88% in a range of 60–70 years old.

The round and horizontal oval shapes had the highest and lowest frequencies, respectively. There was no significant difference in the frequency of shapes between the right and left sides (P=0.489). The highest frequency of the horizontal position of the mental foramen was between the first and second premolars, followed by alignment with the second premolar. There is no significant difference in the frequency of the horizontal position of the MF between the right and left sides (P=0.754). There was also no significant difference in the frequency of the vertical position of MF between the right and left sides (P=0.319). The results indicated no significant differences in the frequencies of foramen shapes, the horizontal positions of the mental foramen, and the vertical and horizontal positions and shapes in age ranges on the right side (Table 1) (P>0.05).

MF angle in the cross-sectional profile and the maximum height in the cross-sectional profile are shown in Figure 1.

The results showed no significant difference in the vertical size of a foramen in the cross-sectional profile and MF angle based on the age groups on both the right and left sides (Table 2). There was also no significant difference in the vertical size of the foramen in the cross-sectional profile and MF angle between males and females on both sides (P>0.05).

Studying the mean thickness of the cortical bone around the mental foramen showed no significant difference between the superior part on the right side (2.05±0.54) and the left side (2.1±0.54). In the inferior part, the right side (2.18±0.52) was not significantly different from the left side (2.18±0.53) (P>0.05).

Table 1. Comparing the frequencies of the foramen shape, horizontal position, and vertical position on both right and left sides based on the age groups

			Age ranges						P Value
			<20 (%)	20-30 (%)	30-40 (%)	40-50 (%)	50-60 (%)	60-70 (%)	
Shape	**Right**	Round	61.2	60.3	60.7	53.3	53.8	70	0.159
		Vertical oval	22.5	20.6	25.1	26.7	30.9	15	
		Horizontal oval	16.3	19.1	14.2	20	15.3	15	
	Left	Round	58	63.7	57.1	60	61.5	80	0.218
		Vertical oval	22.7	18.9	25.1	26.7	23.2	20	
		Horizontal oval	19.3	18.4	18.7	13.3	15.3		
Horizontal position	**Right**	Canine and fiorst premolar	3.2	3.4	3.5				0.137
		Aligned with the first premolar	6.4	6.8	3.5	6.6	7.6	6.5	
		Between the first and second premolar	51.6	58.4	53.5	53.3	53.8	60.2	
		Aligned with the second premolar	32.4	29.6	32.4	33.5	31	26.8	
		Between the second premolar and first molar	6.4	6.8	7.1	6.6	7.6	6.5	
	Left	Canine and first premolar	3.2	3.4	3.5				0.308
		Aligned with the first premolar	6.4	5.4	3.3	6.5	6.3		
		Between the first and second premolar	54.8	55.1	57.1	54.7	55.2	70	
		Aligned with the second premolar	29.2	29.3	32	31.3	30.3	30	
		Between the second premolar and first molar	6.4	6.8	5.1	6.8	6.4		
Vertical position	**Right**	Above the apex	4.8	3.4	3.5	6.6			0.126
		Apex	23.8	20.8	25.1	20.1	20.6	23.1	
		Below the apex	71.4	75.8	71.4	73.3	79.4	76.9	
	Left	Above the apex	5.8	3.4	3.5				0.108
		Apex	20.5	27.7	25.9	28.6	27	23.1	
		Below the apex	73.7	68.9	70.6	71.4	73	76.9	

Table 2. Comparing the vertical sizes of the foramen in cross-sectional profile and mental foramen angle based on the age groups on both the right and left sides

		Age ranges						P-value
		<20	20–30	30–40	40–50	50–60	60–70	
		Mean (SD)						

Vertical size of the foramen in the cross-sectional profile [mean (SD)]	Right	2.06 (0.50)	2.13 (0.47)	2.08 (0.51)	2.14 (0.45)	2.09 (0.49)	2.10 (0.48)	0.316
	Left	2.06 (0.50)	2.11 (0.51)	2.13 (0.48)	2.10 (0.46)	2.09 (0.52)	2.08 (0.50)	0.359
Mental foramen angle [mean (SD)]	Right	46.2 (10.2)	44.3 (11.3)	44.5 (9.7)	45.1 (10.6)	46.3 (11.7)	45.6 (10.5)	0.361
	Left	45.8 (11)	43.9 (9.9)	44.4 (11)	46.1 (9.1)	45.5 (10.4)	45.2 (11.1)	0.387

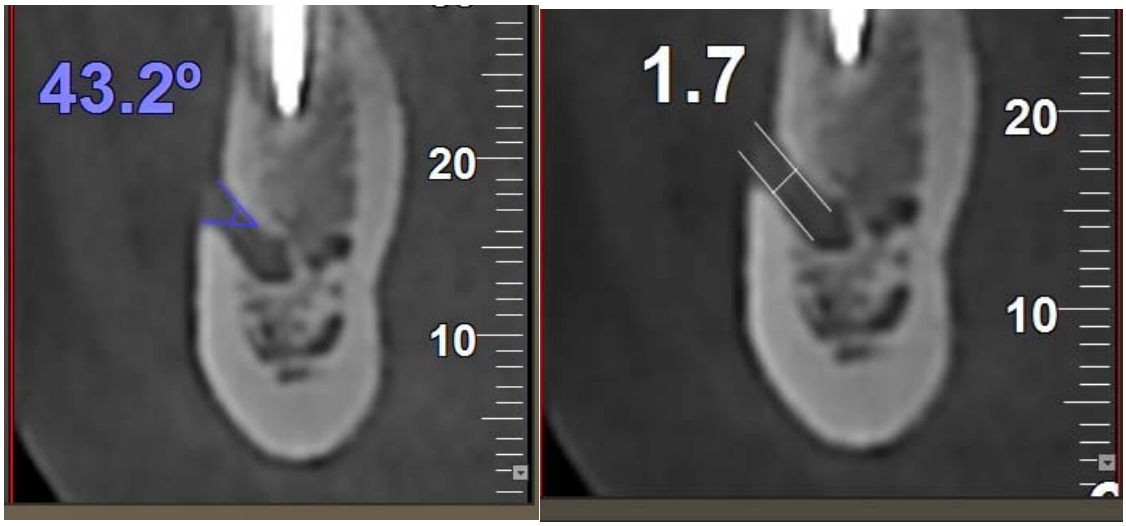

Figure 1. MF angle in the cross-sectional profile in degrees (left), the maximum foramen height in the cross-sectional profile in millimeters (right).

Discussion

The horizontal position of MF, between the first and second premolar and at the level of the second premolar, had the highest frequency, consistent with other studies.

A systematic review by Pele et al. (2021) of 72 qualified articles showed that MF is mostly located between two premolars (50.4–61.95%) or apical to the second premolar (50.3–59.9%) (12). Chappidi et al. (2019) showed that the position of MF is between the first and second premolar teeth in >62% of the cases (13). Zamani Naser et al. (2011) reported the area below the apex of second premolar teeth, with a frequency of 56%, as the most common location for the MF in panoramic radiographs (14).

In this study, no significant differences were observed in the frequencies of the foramen's horizontal position regarding direction, age ranges, and gender. A study by Rodriguez-Cardenas et al. (2020) showed the line below the second premolar teeth as the most common MF location, with no significant difference in foramen position between males and females (15).

In this study, no significant difference was observed in the frequencies of the vertical position of the mental foramen concerning direction, age ranges, and gender. Direk et al. (2018) reported no significant difference in the position of the MF based on age (16). Tafakhori et al. (2016) indicated no effect of age and gender on the position of the MF (17).

In the present study, no significant difference was observed in the vertical and horizontal positions of the foramen between various age groups. The evolution of the mandible can explain the difference in the results of different studies.

Yesilyurt et al. reported that differences in dietary habits could explain differences in the results of studies concerning the foramen position since they affect the evolution of the mandible (18). Furthermore, based on Green's study, the relative position of MF can be affected by factors such as the size of dental mesiodistal aspects and attrition of their proximal surfaces (19).

In the study by Chappidi et al. (2019), the foramen was reported as oval in >69% of the subjects (13). Ezoddini-Ardakani (2016) showed that the mental foramen was round or oval, and its most common direction was superior-posterior (5). Al-Shayyab reported that with aging, the MF becomes more irregular (20).

In the present study, the thickness of cortical bone surrounding the mental foramen was not significantly different on the superior and inferior parts regarding direction and gender. Pelé

et al. (2021) showed that the mean thickness of the mental foramen in men was 0.62 mm more than that in women (12). In this study, the mean MF angle on the exit point of the canal was the same on the right and left sides, and the vertical size of the foramen in the cross-sectional profile was not significantly different in terms of direction and gender.

Conclusion

In this study, no significant difference was observed in the frequency of the vertical position of MF in terms of direction, age ranges, and gender.

Ethics Committee Approval

This study was approved by the Ethics Committee of the Tabriz University of Medical Science with the approval no: IR.TBZMED.REC.1399.416.

Authorship Contributions

Concept: FF and FEG, design and analysis or interpretation: FEG, SK, and HRM, data collection, literature search, and writing: SK, MA, and HRM

Conflict of Interest

The authors declare no conflict of interest.

Financial Disclosure

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