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ORIGINAL ARTICLE

CBCT-Based Anatomical and Morphometric Analysis of the Accessory Mental Foramen: a Cross-Sectional Study

Mahshid Botsheka[1], Azadeh Torkzadeh[2*], Parisa Ranjbarian[3], Parisa Barouti[4]

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Abstract

Background: One anatomical variation in the mental foramen area is the presence of an accessory mental foramen (AMF). This study aimed to investigate the position and anatomical features of the accessory mental foramen using CBCT imaging.

Materials and methods: This cross-sectional descriptive study analyzed 500 CBCT images (one per patient) to assess the prevalence and characteristics of the accessory mental foramen. Parameters recorded included the patient's gender, location of the accessory mental foramen to the main foramen, number, diameter, and distance between the main and accessory mental foramina. Data were analyzed using the Chi-square test, Fisher's exact test, and the independent t-test ($\alpha = 0.05$).

Results: AMF was observed in 3.4% (17 patients). Among them, 70.6% (12 patients) had bilateral AMF, 17.6% had unilateral right-sided AMF, and 11.8% had unilateral left-sided AMF. Most accessory mental foramina were positioned apically (86.2%), distally (72.4%), and buccally (89.7%), with the apical-distal-buccal combination (55.2%) being the most common. The prevalence of accessory mental foramen was not significantly associated with gender, mandibular side, or age ($p>0.05$). However, the mean AMF diameter was significantly greater in men than in women ($p=0.003$). The mean distance between the main and accessory mental foramina showed no significant gender-related difference ($p>0.05$).

Conclusion: Based on this study, given the anatomical variability and individual differences in AMF characteristics, CBCT is recommended for accurate identification before periapical or implant surgery to prevent complications such as nerve injury or inadequate anesthesia.

Keywords: Anatomic variation; Cone-Beam Computed Tomography; Mental foramen

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Introduction

The inferior alveolar nerve traverses forward in the mandibular canal and passes the mandible from lingual to buccal, and exits via the mental foramen, accompanied by blood vessels. IT innervates the skin of the mental region, lower lip, mucosa, and gingiva, extending to the second premolar and incisor areas (1).

Corresponding author: Azadeh Torkzadeh

Department of Oral & Maxillofacial Radiology, Faculty of Dentistry, Isf.c, Islamic Azad University, Isfahan, Iran
Email: azadeh.torkzadeh@iau.ac.ir

1. Faculty of Dentistry, Isf.c, Islamic Azad University, Isfahan, Iran
2. Department of Oral & Maxillofacial Radiology, Faculty of Dentistry, Isf.c, Islamic Azad University, Isfahan, Iran
3. Department of Endodontics, Faculty of Dentistry, Isf.c, Islamic Azad University, Isfahan, Iran
4. Department of Endodontics, Faculty of Dentistry, Isf.c, Islamic Azad University, Isfahan, Iran

In approximately 1% of individuals, the mandibular canal branches superiorly, inferiorly, or laterally, so the mandibular canal will be divided into two branches, and more than one mental foramen will be revealed, which may not be detected on panoramic or periapical photographs (1).

The mental foramen is typically oval or round and commonly located near the apex of the second premolar or between the apices of the premolars (1). A notable anatomical variation in this region is the presence of the accessory mental foramen (AMF) (2). Studies have indicated variation in AMF prevalence and location across different populations, with higher prevalence in certain ethnic groups and genders. (2,3). In the Korean population, the prevalence of AMF in men is higher than in women. Also, most AMFs were located more anteriorly and above the main mental foramen (2).

The mental foramen is a critical anatomical landmark during osteotomy procedures. Accurate identification of its location, along with awareness of the potential presence of an anterior loop of the mental nerve extending mesially to the mental foramen, should be considered before implant surgery (1). Additionally, detecting the presence of an accessory mental foramen prevents collateral nerve damage during periapical surgery (4).

Given the clinical relevance of these structures in local anesthesia, implant placement, and periapical surgery. Comprehensive knowledge of their anatomical preservation is critical.

This study aims to evaluate the prevalence and characteristics of AMF using CBCT.

Despite the shortcomings of two-dimensional imaging, the need for new technologies is felt more than ever. CBCT (cone beam computer tomography) technology is a new generation of CT, which provides 3D data with less cost and received dose than conventional CT (5).

Materials and methods

This retrospective, cross-sectional, descriptive study examined 500 CBCT scans from 257 male patients (51.4%) and 243 female patients (48.6%), aged 17 to 65 years. CBCT scans were obtained through convenience sampling. The inclusion criteria were high-quality CBCT scans clearly depicting the mental foramen. Exclusion criteria comprised a history of jaw surgery, trauma to the mandible, pathological lesions involving the mandibular bone, or the presence of impacted teeth in the region of insertion. Scans were obtained from the Department of Radiology, Department of Dentistry, School of Isfahan Azad University, with an ethics code. IR.IAU.KHUISF.REC1402.226) using Sirona (Galileos CBCT system/ made in the USA) with high resolution and exposure conditions of 85-100 kV and 5-7mAs, total filtration greater than 2.5 mm Al, 0.5 mm2 focal point, and 14 seconds scanning time.

Images were evaluated using SIDEXIS 3D (Dentsply Sirona, USA) software in axial panoramic and cross-sectional views. Axial slices of 0.5 mm thickness were used for precise measurement. Parameters such as the presence of AMF, the patient's gender, anatomical position (apical/distal/buccal), and side (left/right), the diameter of AMF, and the distance between the main and secondary mental foramina were investigated and recorded. All CBCT scans were evaluated by a trained final-year dental student under the supervision of a radiology and endodontics specialist.

For each image analyzed, the mental foramen was identified at its widest dimension. All the foramina other than the largest one on each side of the mandible were defined. The position of AMF relative to the corresponding primary mental foramen, as well as the distance between them, was calculated using the $d = \sqrt{(x2+y2)}$.

Data were analyzed using SPSS version 27 at a significance level of 0.05, employing the Chi-square test, Fisher's exact test, and the independent t-test.

Results

Out of 500 patients, AMF was identified in 17 patients (3.4%), with AMF detected in total (2.9% of sides). AMF was bilateral in 12 patients (70.6%), right unilateral in 3 patients (17.6%), and left unilateral in 2 patients (11.8%).

Anatomical position of AMF relative to the main foramen is shown in Table 1. The apical distal buccal position (55.2% /16 patients) was the most common.

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Table 1. Frequency distribution of accessory mental foramen position in CBCT images Gender distribution

Category	N	%
Apical	25	86.2
Coronal	4	13.8
Total	29	100.0
Mesial	8	27.6
Distal	21	72.4
Total	29	100.0
Apical-Distal-buccal	16	55.2
Apica-mesia-buccal	6	20.7
Coronal-distal-buccal	3	10.3
Apical-distal-lingual	2	6.9
Apical-mesial-lingual	1	3.4
Coronal-mesial-buccal	1	3.4
Total	29	100.0
Buccal	26	89.7
Lingual	3	10.3
Total	29	100.0

Among male patients, AMF was observed in 18 patients (3.5%), and among female patients, in 11 patients (2.3%). The Fisher's exact test showed no significant gender difference (p=0.243).

Laterality:

Accessory mental foramen was present in 15 samples (3.0%) on the right and in 14 samples (2.8%) on the left. The McNemar's test did not show a significant difference between the sides (p = 0.851).

Age distribution:

The prevalence percentage of the age group of the examined patients is shown in Table 2. The result of the chi-square test showed that no significant age-related difference was found (p = 0.077).

Table 2. Frequency distribution and prevalence of AMF in different age groups

Ages	Absent	Present	Total	P value
	n (%)	n (%)	n (%)	
< 20 years	73 (98.6)	1 (1.4)	74 (100.0)	0.077
20–30 years	153 (98.1)	3 (1.9)	156 (100.0)	
30–40 years	184 (94.8)	10 (5.2)	194 (100.0)	
40–50 years	251 (95.8)	11 (4.2)	262 (100.0)	
50–60 years	218 (98.2)	4 (1.8)	222 (100.0)	
> 60 years	92 (100.0)	0 (0.0)	92 (100.0)	

Diameter and distance

The diameter of the accessory mental foramen and its distance from the main foramen are shown in Table 3. According to the independent t-test, the diameter of AMF in male patients was significantly larger than in female patients (p=0.003). However, there was no significant difference in the average distance between the main and accessory mental foramen between male and female patients (P=0.343).

Table 3. Comparison of the AMF diameter and the mean distance from the main foramen in male and female patients (mm)

Variable	Gender	n	Mean ± SD (mm)	p value
Diameter of the accessory mental foramen	Male	18	3.46 ± 0.49	0.003
	Female	11	2.93 ± 0.26	
Distance between the main and accessory mental foramen Variable	Male	18	4.09 ± 0.48	0.343
	Female	11	4.29 ± 0.68	

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Discussion

Accurate localization of the mental foramen and its variations is essential for safe and effective dental treatments, anesthesia injection, and endodontic or maxillofacial surgery. Identifying the anatomy of the mental foramen (position and number) is not only diverse in terms of age, gender, and race, but even within the same race. Similarly, such diversity is observed in different geographical areas and the settlements of the same geographical area.

Based on the results of the present study, AMF prevalence was 3/4%, consistent with findings of Imada et al. (3) who reported AMF in 3% of examined CBCT. The prevalence of AMF varies widely across studies, ranging from 1.4% to 10%, depending on the population studied, and may be attenuated to genetic, racial, methodological, and sample size differences (8-12).

This study found no significant gender-differentiated differences in AMF prevalence, aligning with Xiao et al (15) but contrasting with Imada et al (3), who reported the prevalence rate of AMF in Asian men was much higher, or others that report higher prevalence in either men or women (13-15). Inconsistency may stem from differences in sample size, research methods and ethnicity.

The most frequent AMF position in this study was apical-distal buccal, consistent with Xiao et al (15), though other studies as Kalender et al. showed that in the Turkish population, AMF were located in a lower anterior position than the main mental foramen (16), and Imada et al suggested that most of AMF are located between premolars, either superior or mesial to the main mental foramen (3).

The average distance between the main and accessory mental foramen was 4.17mm, and the average diameter of the accessory mental foramen was 3.25 mm. While the diameter is significantly larger in males, the distance between the main and accessory mental foramen did not differ significantly by gender. The mean measurements vary across studies, ranging from 3.5mm to over 6mm(1,5,11), replacing the dynamic nature of alveolar bone remodeling and the lack of a universal standard for these anatomical features.

Given the potential risk of nerve injury and anesthesia failure, identifying AMF and its anatomical variations by means of CBCT enables clinicians to tailor treatments for individual patients.

Conclusion

Given the anatomical variability and individual differences in AMF characteristics, CBCT is essential for accurate identification before periapical or implant surgery to prevent complications such as nerve injury or inadequate anesthesia.

Conflict of Interests: The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial, or non-financial in this article

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