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Research / Araştırma Makalesi

Evaluation of the Mental Foramen and Accessory Mental Foramen with Cone Beam Computed Tomography

Konik Işınlı Bilgisayarlı Tomografi ile Mental Foramen ve Aksesuar Mental Foramenin Değerlendirilmesi

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ABSTRACT

Background: Some anatomical variations, such as accessory mental foramen (AMF) should be considered to prevent clinical complications. This study aimed to assess the AMF via cone beam computed tomography (CBCT) and evaluate its relationship with the mental foramen (MF).

Methods: Of 244 CBCT images, the AMF and MF diameter, AMF number, MF–crest distance, MF–mandibular basis distance, AMF–crest distance, and AMF–mandibular basis distance were measured.

Results: The prevalence of AMF was 9.4% with a total of 46. The diameters of the first and second AMFs were 0.67 ± 0.28 mm and 0.56 ± 0.11 mm on the right, 0.68 ± 0.23 mm and 0.46 ± 0.11 mm on the left, respectively. MF diameters were 2.06 ± 1.37 mm (right side) and 1.91 ± 0.45 mm (left side). The AMF–crest distances for the first and second AMFs were 15.18 ± 2.77 mm and 13.5 ± 2.0 mm (right side), 13.90 ± 3.01 mm and 12.23 ± 0.9 mm (left side), respectively. Some patients had multiple foramina in the area surrounding the MF. First and second AMF–mandibular basis distances were 16.63 ± 2.64 mm and 14.13 ± 4.36 mm (right side), 13.14 ± 2.4 mm and 14.40 ± 3.21 mm (left side).

Conclusion: Considering the presence of AMFs during surgical procedures and local anesthesia is critical. It may be damaged during surgical operations. CBCT is a useful method for determining the presence of AMFs to prevent possible complications.

Keywords: CBCT; Accessory mental foramen; Mental foramen

ÖZ

Giriş: Klinik komplikasyonları önlemek için aksesuar mental foramen (AMF) gibi bazı anatomik varyasyonlar dikkate alınmalıdır. Bu çalışma, AMF'yi konik ışınlı bilgisayarlı tomografi (CBCT) ile değerlendirmeyi ve mental foramen (MF) ile ilişkisini değerlendirmeyi amaçlamıştır.

Yöntemler: 244 CBCT görüntüsünden AMF ve MF çapı, AMF sayısı, MF-kret mesafesi, MF-mandibular kaide mesafesi, AMF-kret mesafesi ve AMF-mandibular kaide mesafesi ölçülmüştür.

Bulgular: AMF prevalansı %9,4 olup toplam 46 idi. Birinci ve ikinci AMF'nin çapları sağda sırasıyla 0,67 ± 0,28 mm ve 0,56 ± 0,11 mm, solda ise 0,68 ± 0,23 mm ve 0,46 ± 0,11 mm idi. MF çapları 2,06 ± 1,37 mm (sağ taraf) ve 1,91 ± 0,45 mm (sol taraf) olarak bulundu. Birinci ve ikinci AMF'ler için AMF-kret mesafeleri sırasıyla 15,18 ± 2,77 mm ve 13,5 ± 2,0 mm (sağ taraf), 13,90 ± 3,01 mm ve 12,23 ± 0,9 mm (sol taraf) olarak bulundu. Bazı hastalarda MF'yi çevreleyen alanda birden fazla foramina mevcuttu. Birinci ve ikinci AMF-mandibular taban mesafeleri 16,63 ± 2,64 mm ve 14,13 ± 4,36 mm (sağ taraf), 13,14 ± 2,4 mm ve 14,40 ± 3,21 mm (sol taraf) olarak bulundu.

Sonuç: Cerrahi işlemler ve lokal anestezi sırasında AMF'lerin varlığının göz önünde bulundurulması kritik öneme sahiptir. Cerrahi operasyonlar sırasında hasar görebilirler. CBCT, olası komplikasyonları önlemek için AMF'lerin varlığını tespit etmede faydalı bir yöntemdir.

Anahtar Kelimeler: CBCT; Aksesuar mental foramen; Mental foramen

Introduction

The mental foramen (MF) is an important landmark during surgical procedures. Its location and the possibility that an anterior loop of the mental nerve and accessory mental foramen may be present mesial to the MF must be considered before dental implant surgery to prevent mental nerve injury.[1] To avoid complications during the surgical operation, recently the course of the mandibular canal and its features, such as the bifurcation, anterior loop, mandibular incisive canal, and lingual foramen, have been assessed via cone-beam computed tomography (CBCT).[2]

The MF is usually found on one side of the mandibular bone. Multiple foramina in the area surrounding the MF that are smaller in diameter than the main foramen are an anatomical variation and are defined as accessory foramina. The term “accessory mental foramen” (AMF) is used in the literature to describe an additional foramen that is anatomically connected to the mandibular canal.[3-5] The AMF is as important as the MF because the neural and vascular branches pass through it. Knowing the location, shape and dimensions of the MF and AMF is particularly important for dental surgery.[6] In some recent studies, the prevalence of AMF were 6.35% to 12.24% [7-14]

CBCT is commonly used as a diagnostic tool when planning autogenous augmentation surgeries and dental implant procedures.[15-17] CBCT provides practitioners with accurate knowledge about anatomic structures before augmentation and implant surgeries, preventing complications. These advantages are provided by 3D projection.[18] A literature review revealed that studies evaluating the MF and AMF have been conducted using various radiographic methods. This study aimed to contribute to the literature by evaluating the AMF via CBCT and assessing its relationship with the MF.

Materials and methods

The ethics committee of the Alanya Alaaddin Keykubat Faculty of Dentistry approved this study (approval number: 02-2025/4-6).

Study design

CBCT images of 244 patients (128 male, 116 female) who visited the Faculty of Dentistry between January 1, 2022, and December 30, 2024, were included in the study. This study was performed in accordance with the tenets of the Helsinki Declaration 1975, as revised in 2000. All participants provided written informed consent prior to enrollment in the study. The inclusion criteria were as follows: 1) no jaw fracture; 2) good visibility in the CBCT scan; and 3) no artifacts resulting from movement during image acquisition.

CBCT image analysis

The CBCT scans were performed via KaVo OP™ 3D DVT (Kavo Dental GmbH, Biberach/Riss, Germany). The operating parameters were 90 kV and 9.23 mA, and the scan time was 8.14 s with an 8 × 15 cm field of view. The CBCT images were evaluated using the appropriate software (OnDemand3D ® version 1.0.9.1451; CyberMed, Seoul, Republic of Korea). The following parameters were noted: 1) MF diameter; 2) AMF

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diameter; 3) AMF number; 4) MF-crest distance; 5) AMF-crest distance; 6) MF-mandibular basis distance; and 7) AMF-mandibular basis distance. All the images were reviewed, and measurements were performed by an experienced oral and maxillofacial radiologist (T.Ç.).

The MF position was evaluated on a 3D model in OnDemand3D software, according to the long axis of the existing teeth in patients with first molars and first and second premolars.[11] MF-crest, AMF-crest, MF-mandibular basis, and AMF-mandibular basis measurements were performed using a two-dimensional (2D) ruler in the dental module (**Figure 1-2**).[12]

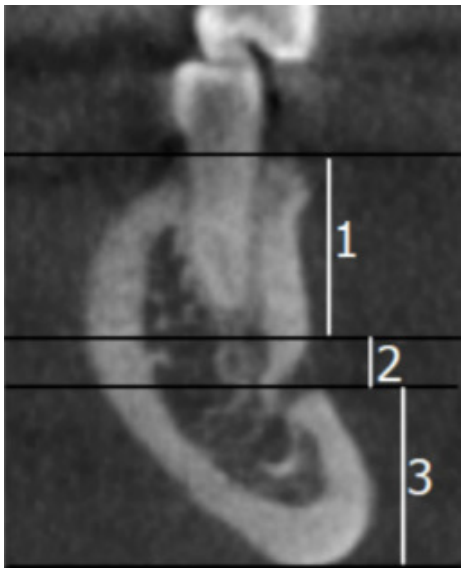

Figure 1. Evaluation of MF position. 1: MF-crest distance, 2: MF diameter, 3: MF- mandibular basis distance.

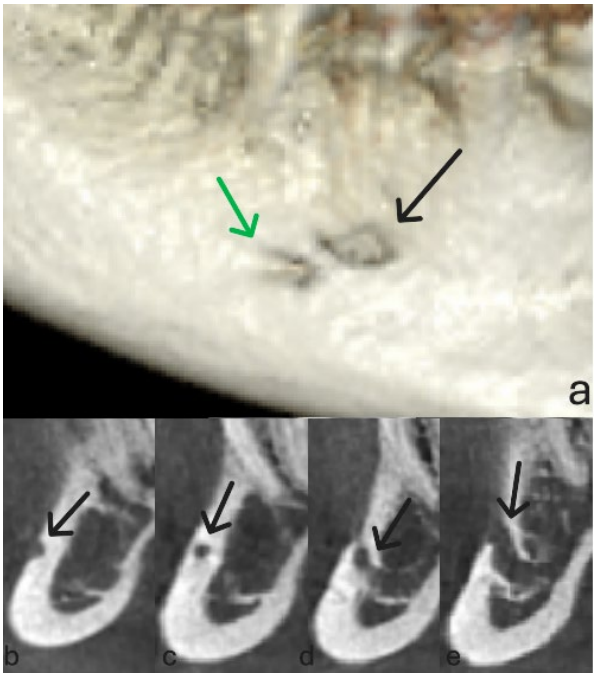

Figure 2. This is a three-dimensional cone-beam computed tomography image showing the accessory mental foramen (green arrow), which is located posterior to the right mental foramen (black arrow) (a). Anastomoses of the accessory mental foramen (black arrows in b-e) with the mandibular canal and the mental foramen were observed in the sagittal sections.

Statistical analysis

All the statistical data were processed via specialized software (IBM SPSS Statistics for Windows, Version 24.0; Armonk, NY, USA). Categorical variables are presented as the number of events and percentage. Means and standard deviations were used for descriptive statistics for numeric variables. The effect of gender on numeric values was analyzed by Student's *t* test. Comments and assessments were based on comparisons with a significance level of 0.05. Inter-class correlation coefficients were performed to assess intra-observer reliability for the measurements of randomly selected 20 CBCT scans.

Results

Intra-observer coefficients values were calculated >90%. A total of 244 CBCT images obtained from 244 patients were evaluated in the present study. The prevalence of AMF was 9.4%, with a total of 46 (26 on the right and 20 on the left) observed. The position of the MF was examined for the right and left sides: 76.6% between the first and second premolar teeth, 23.4% distal to the second premolar teeth, 79.9% between the first and second premolar teeth, 9.3% distal to the second premolar teeth, and 0.8% mesial to the first premolar teeth.

MF diameter values on the right and left were 2.06 ± 1.37 mm and 1.91 ± 0.45 mm, respectively. The diameter of the right and left mental foramen in female was 2.03 ± 1.93 mm and 1.77 ± 0.39 mm respectively. The diameter of the right and left mental foramen in male was 2.08 ± 0.48 mm and 2.04 ± 0.47 mm respectively. The MF-crest distance was 15.78 ± 2.37 mm on the right and 15.75 ± 2.51 on the left. The MF-mandibular basis distances were 13.94 ± 1.73 mm and 13.96 ± 1.79 mm for the right and left sides, respectively (**Table 1**).

Table 1. Linear measurements of distances related to MF

Parameters	Average Values of the Measurements
Right mental foramen diameter (mm)	2.06 ± 1.37
Left mental foramen diameter (mm)	1.91 ± 0.45
Right MF-crest distance (mm)	15.78 ± 2.37
Left MF-crest distance (mm)	15.75 ± 2.51
Right MF-mandibular basis distance (mm)	13.94 ± 1.73
Left MF-mandibular basis distance (mm)	13.94 ± 1.79

Some patients had multiple foramina in the area surrounding the MF. The diameters of the first and second AMFs were 0.67 ± 0.28 mm and 0.56 ± 0.11 mm for the right side, 0.68 ± 0.23 mm and 0.46 ± 0.11 mm for the left side, respectively. The diameter of the right and left first AMFs in males were 0.70 ± 0.36 mm and 0.65 ± 0.20 mm, respectively. The diameter of the right and left first AMFs in females were 0.64 ± 0.19 mm and 0.72 ± 0.28 mm, respectively. The first AMF-crest distance and first AMF-mandibular basis distance on the right and left were 15.18 ± 2.77 mm and 16.63 ± 2.64 mm on the right side, 13.90 ± 3.01 mm and 13.14 ± 2.4 mm on the left side, respectively. The second AMF-crest distance and second AMF-mandibular basis distance on the right and left were 13.5 ± 2.0 mm and 14.13 ± 4.36 mm on the right side, 12.23 ± 0.9 mm and 14.40 ± 3.21 mm on the left side, respectively.

Discussion

Various imaging modalities, including periapical, panoramic and CBCT, have been used in the literature to evaluate the morphology of the MF and AMF.[21,22] However, previous studies have revealed difficulties in detecting the AMF in 2D imaging systems.[20,23] The key strength of CBCT lies in its ability to generate 3D images, enabling a thorough assessment of the anatomy of the chosen region. Furthermore, 3D measurements can be taken on 3D models created using software.[24] CBCT has several key benefits, including superior image resolution, faster acquisition times, a lower radiation dose, and a lower cost.[25] This study makes valuable contributions to the literature through the evaluation of the AMF with CBCT and the assessment of its relationship with the MF.

In this study, the MF diameter was 2.06 ± 1.37 mm and 1.91 ± 0.45 mm for the right and left sides, respectively. In recent systematic review, the diameter of the MF was reported to range from 2.08 ± 0.53 mm to 4.44 ± 1.13 mm, most commonly measuring 3 mm.[26-29] The present

study's findings align with the lower end of the range reported in the literature. Furthermore, the present study revealed that the diameter of the left MF was greater in males than in females. The diameter of the left MF in males and females were 2.04 ± 0.47 mm and 1.77 ± 0.39 mm, respectively (p=0.001). There was no significant difference between male and female for right MF diameters. Another study demonstrated that the MF is greater in males on both sides.[20]

According to systematic reviews, the MF is commonly located between the first and second premolars.[30,31] Thomas Von Arx et al.[29] reported that the majority of MFs (56%) are located apically between the first and second premolars and that 35.7% of MFs are positioned below the second premolar. Similarly, the present study, MFs were usually located between the first and second premolars on both the right and left sides (76.6% and 79.9%, respectively). It is necessary to pay attention to the position of the MF before surgical procedures.

In the present study, more AMFs were observed on the right side, consistent with the findings of Aytugar et al.[10] In contrast, May Lam et al.[31] observed more AMFs on the left side. The differences between the studies can be explained by differences in the sample population. AMF frequencies reported in the literature range from 2% to 14.3%.[10,32-34] In the present study, the AMF frequency was 14.7%.

The mean MF–crest and MF–mandibular basis distances the present study were greater in males than in females. Similarly, Thomas Von Arx et al.[29] and Juan Muinelo et al.[35] also reported greater distances in males.

The MF is an important landmark during surgical procedures. The MF and AMF are susceptible to iatrogenic injury during surgical procedures. It may be damaged due to surgical operations. Moreover, detecting AMFs may be hardly detected by 2-dimensinal radiographic evaluation because of being very little anatomic structures. Evaluating the surgical site prior to surgery by CBCT is essential for minimizing surgical risks. In addition, the results of this study provide information about the prevalence of AMF. Our findings demonstrate that the AMF prevalence can differ across subpopulations. Surgeons should thoroughly evaluate CBCT scans to detect limiting anatomic structures before conducting dental surgeries.

Conclusion

The presence of AMF should be taken into account during surgical procedures and local anesthesia applications. CBCT is a useful method for determining the presence of AMFs to prevent possible nerve damage.

Değerlendirme / Peer-Review

İki Dış Hakem / Çift Taraflı Körleme

Etik Beyan / Ethical statement

Bu makale, 5. Uluslararası Oral Diagnoz ve Maksillofasiyal Radyoloji Derneği Kongresi'nde sözlü olarak sunulan ancak tam metni yayımlanmayan "MENTAL FORAMEN VE AKSESUAR MENTAL FORAMENİN KONİK IŞINLI BİLGİSAYARLI TOMOGRAFİ (KIBT) İLE DEĞERLENDİRİLMESİ" adlı tebliğin içerigi geliştirilerek ve kısmen değiştirilerek üretilmiş hâlidir.

Bu çalışmanın hazırlanma sürecinde bilimsel ve etik ilkelere uyulduğu ve yararlanılan tüm çalışmaların kaynakçada belirtildiği beyan olunur.

This article is the version of the presentation named "EVALUATION OF MENTAL FORAMEN AND ACCESSORY MENTAL FORAMEN WITH CONE BEAM COMPUTED TOMOGRAPHY (CBCT)", which was presented orally at the 5th International Congress of Oral Diagnosis and Maxillofacial Radiology Society, but whose full text was not published, by improving and partially changing the content.

It is declared that during the preparation process of this study, scientific and ethical principles were followed and all the studies benefited are stated in the bibliography.

Benzerlik Taraması / Similarity scan

Yapıldı – ithenticate

Etik Bildirim / Ethical statement

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Çıkar Çatışması / Conflict of interest

Çıkar çatışması beyan edilmemiştir.

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Yazar Katkıları / Author Contributions

Çalışmanın Tasarlanması | Design of Study: OD (%100)
Veri Toplanması | Data Acquisition: TÇ (%100)
Veri Analizi | Data Analysis: YYS (%40), HYÜ (%40), OD (%20)
Makalenin Yazımı | Writing up: TÇ (%100)
Makale Gönderimi ve Revizyonu | Submission and Revision: TÇ (%50), OD (%50)

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