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ORIGINAL ARTICLE

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Anatomic characterization of mental foramen through cone beam computed tomography at dentate and edentulous areas

Caracterização anatômica do forame mentual em áreas dentadas e edêntulas por meio de Tomografia Computadorizada de Feixe Cônico (TCFC)

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ABSTRACT

Objective: To characterize and compare the positions and dimensions of the mental foramen (MF) openings between dentate and edentulous areas on cone beam computed tomography (CBCT) images. **Material and Methods:** Seventy-two CBCT images (i-CAT Next Generation, Imaging Sciences International, Hatfield, PA, USA) of the mandible were analyzed. The CBCT images were divided into two groups: Group D (dentate) - with first and second mandibular premolars; Group E (edentulous) - without first and second mandibular premolars. At the transversal cuts, two measurements were obtained: MF height – the vertical distance between the lowest point of the mandibular canal to the external cortical of the mandible's base (MFH); MF opening – the greatest vertical distance between the superior and inferior MF external corticals (AbMF). Also, in Group D, the MF position was studied in relation to four landmarks: 1st premolar, between 1st and 2nd premolar; 2nd premolar; and other locations. Independent sample t-test and descriptive analysis were applied. **Results:** Only the distance AbMF showed statistically significant difference between groups, with tendency towards increasing in group D. Group E exhibited statistically significant difference between genders for the distance AbMF, with tendency towards greater values for males. Group D showed that MF was more frequently located at the area of the 2nd premolars (65.9%), while the area of the 1st premolars was that of smallest frequency (4.9%). **Conclusion:** the edentulism only reduced the dimension of MF opening. Edentulous males had a greater MF opening than edentulous females.

RESUMO

Objetivo: Caracterizar e comparar as posições e dimensões de abertura dos Forames Mentuais (FM) entre áreas edêntulas e dentadas em imagens por tomografia computadorizada de feixe cônico (TCFC). **Material e Métodos:** Analisou-se 72 exames de TCFC, abrangendo toda a mandíbula, obtidos em tomógrafo da marca i-CAT Next Generation (imaging Sciences International, Hatfield, PA, EUA). Estes foram divididas em 02 grupos: Grupo D (dentados) apresentando o 1º e 2º pré-molares inferiores correspondentes e Grupo E (edêntulos) sem ambos os pré-molares inferiores correspondentes. Foram realizadas, nos cortes transversais, 02 medidas em cada região: altura FM – correspondente à distância vertical entre o ponto mais inferior do canal mentual à cortical externa da base da mandíbula (AlFM) e abertura FM - correspondente à maior distância vertical entre as corticais externas superior e inferior do FM (AbFM). Adicionalmente, no Grupo D, foi estudada a posição do FM em relação a 04 referenciais: 1º pré-molar, entre 1º e 2º pré-molares, 2º pré-molar e outras localizações. Foi realizado o Teste t para amostras independentes e a análise descritiva. **Resultados:** Os resultados evidenciaram que houve diferença, estatisticamente significante, apenas na AbFM, entre os dois grupos, com tendência a um aumento desta no grupo D. No Grupo E, a houve diferença estatisticamente significante entre os sexos em relação à AbFM, com tendência a um maior valor para o sexo masculino. No grupo D, a localização do FM de maior frequência foi na região de 2º pré-molares (65,9%) e a de menor frequência na região de 1º pré-molares (4,9%). **Conclusão:** o edentulismo influenciou, apenas a dimensão da abertura do FM, com redução da mesma, pacientes edêntulos do gênero masculino, tendem a ter um valor maior de abertura de forame que pacientes edêntulos femininos.

KEYWORDS

Cone beam computed tomography; Mandible; Anatomy, regional; Anatomic variation.

PALAVRAS-CHAVE

Tomografia Computadorizada de Feixe Cônico; Mandíbula; Anatomia regional; Variação anatômica.

INTRODUCTION

The Mental Foramen (MF) is an important anatomic structure in the mandible's external cortical, at the apexes of the mandibular premolars. The knowledge of MF position is important for performing such procedures as regional anesthesia, incision, and osteotomy. Particularly, caution is necessary during surgical procedures of dental implant insertion, endodontic surgery, removal of root remnants, cysts, tumors, orthognathic surgeries, and fixture of bone fractures to avoid any damage to the neurovascular bundle coming from MF. Thus, the literature recommends a minimum distance of 2.0 mm between the implant end and the MF margin. [1-3]

Taking into account the sagittal and vertical planes, MF exhibits many anatomic variations of position and dimension. Most of the studies on corpses reveal that MF is more prevalent located at the periapical area of the mandibular second premolar, but the location may range from the mandibular canine to first premolar area. [4-6]

Because of the ascendant path of the mandibular canal from the first molar to the MF opening, the MF is close to the periapex of the tooth adjacent to this area. Furthermore, the MF may still locate coronally to the apex of the adjacent tooth. After the extraction and subsequent resorption of the local alveolar ridge, MF may locate close to the alveolar bone ridge and more prone to damage during surgical procedures. [4,5]

Conventional radiographs may detect MF anatomic variations, but errors of projection and identification can occur. The techniques of conventional radiographs lead to the superposition of three-dimensional structures on a two-dimensional plane. The superposition of the resulting anatomic structures makes difficult the interpretation of the images, so that, the magnification and distortions may result in errors of identification. Moreover, the greatest the bone density, the most difficult is the MF identification on conventional radiographs. Also, the technique has an inherent limitation in detecting the variations of the mandibular canal and MF. [7-12]

The cone beam computed tomography (CBCT) advantages are: smaller dose of radiation than that of fan beam computed tomography (FBCT); no superposition of the images; high degree of spatial resolution of bone tissues; possibility of performing accurate multiplanar reconstructions, measurements, and distances among important structures of the maxillofacial complex. [13] The literature reports the use of CBCT in locating MF and the anatomic variations, in some populations. [14-16]

To the best of our knowledge, the literature lacks studies on the comparison of some parameters that would characterize MF in dentate and edentulous subjects. Thus, this study aimed to compare the positions and dimensions of MF openings between edentulous and dentate subjects matched by gender through CBCT. The tested null hypotheses were: ho – no difference in the opening and height of MF between edentulous and dentate subjects; h1- no difference in the opening and height of MF between males and females.

MATERIAL AND METHODS

This study was submitted and approved by the Institutional Review Board regarding ethical

aspects (Protocol CAAE 38058514.2.0000.5374). Seventy-six CBCT images of individuals aged from 15 to 75 years, both sexes (dentate = 24 males and 24 females; edentulous = 14 males and 14 females), were obtained and selected from the personal archives of the researcher, totalizing 110 mental foramens. All CBCT images of the mandibles were obtained in i-CAT Next Generation scanner (Imaging Sciences International, Hatfield, PA, EUA), for many indications, e.g.: implant planning, orthodontics, etc. Exclusion criteria comprised the presence of lesions, fractures, dental anomalies, in the area of the mandibular premolars.

The CBCT images were divided into two groups for analysis: Group D (dentate) – with the 1st and 2nd mandibular premolars; Group E (edentulous) - without the 1st and 2nd mandibular premolars.

Analysis of CBCT images

All images were evaluated through Xoran software (Xoran Technologies, Ann Arbor, MI, USA), on 17-inch LCD screen, at darken environment, by one examiner, specialist in radiology, trained, and with experience in computed tomography.

The image reformatting and measurements followed this protocol, for both groups (D and E), at both sides (right and left), of the same image:

• At the axial window, after adjustment of the mid and occlusal line, the cut that best showed the internal and external mandibular corticals was selected and named as Reference Axial Cut;

• On this Reference Axial Cut, the tool oblique was applied to trace a harmonic panoramic curve, equidistant from the mandibular buccal and lingual corticals, thus determining the Central panoramic cut and a sequence of transversal cuts (trans), at buccal-lingual direction, with 1.0 mm width and 1.0 mm of spacing (Figure 1).

• Next, on the Trans cut that the mental foramen was best seen, the tool distance was applied for obtaining the following measurements:

a) MF height (MFH) – the vertical distance between the lowest point of the mental canal and the lowest point of the external cortical of the mandible's base (Figure 2);

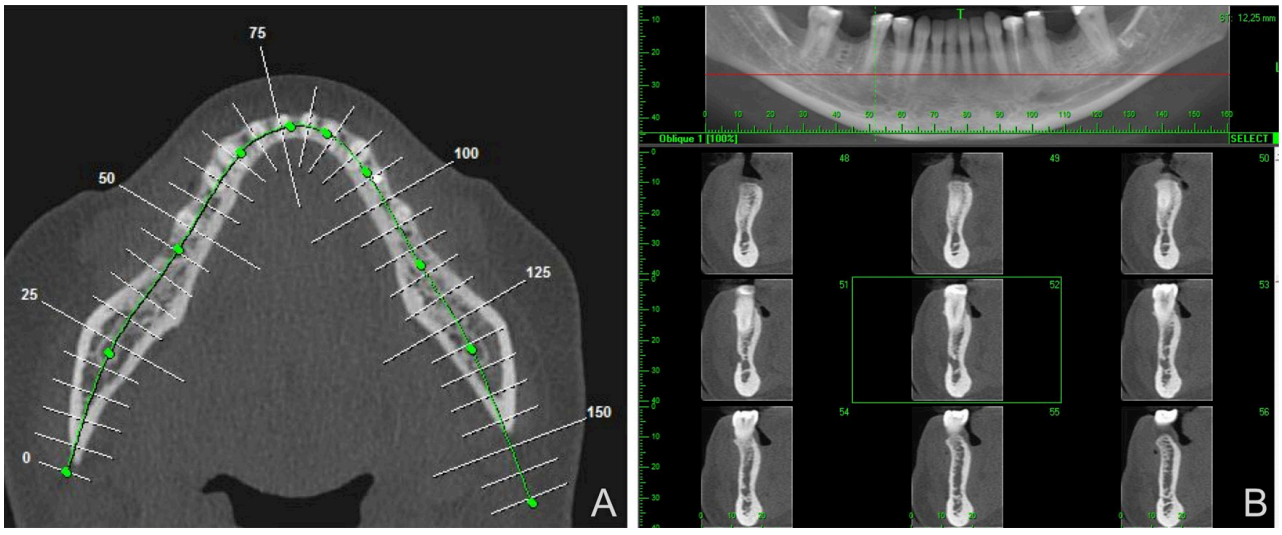

Figure 1 - (A) Reference Axial Cut exhibiting the panoramic curved marked with the respective transaxial cuts. (B) Reference panoramic cut and transversal cuts of the premolar area exhibiting the mental foramen (MF) opening.

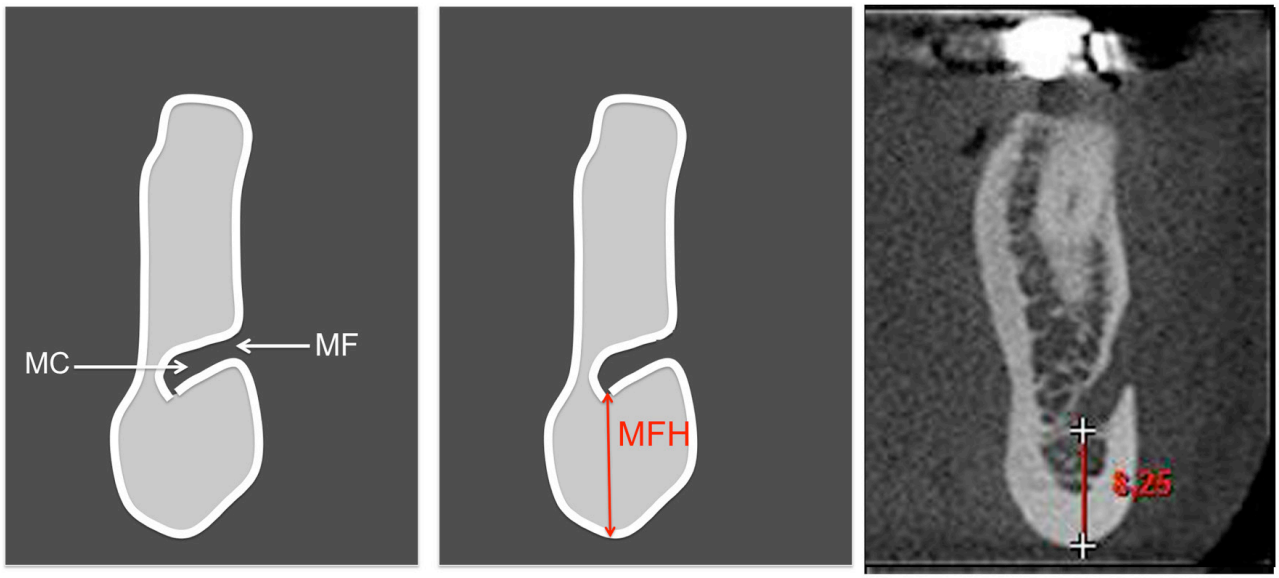

Figure 2 - Transversal cut showing the MFH measurement, exhibiting the mandibular canal (MC) mental foramen (MF); transversal cut with measured height.

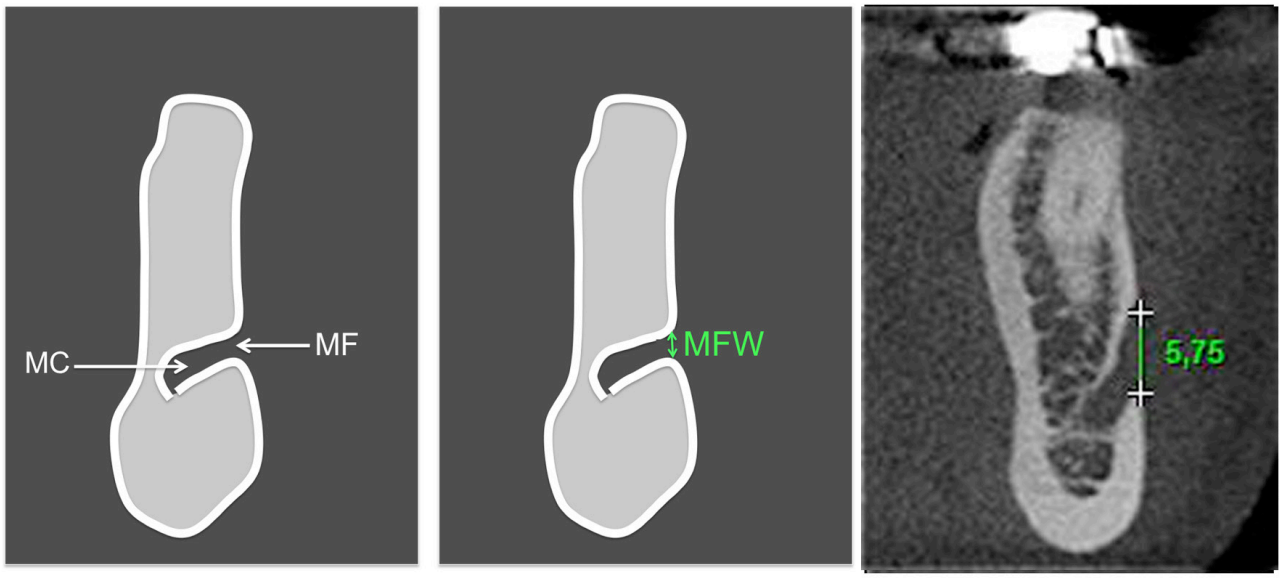

Figure 3 - Transversal cut showing the measurement of MF opening (MFW), exhibiting the mandibular canal (MC) mental foramen (MF); transversal cut with measured opening.

b) MF opening (AbMF) - the vertical distance between the lowest point of the superior external cortical and the highest point of the inferior external cortical of MF (Figure 3).

• In Group dentate (presence of the premolars), on the axial and trans windows, we verified the MF proximity to the following structures:

a) Apically to the first premolar;

b) Between first and second premolars;

c) Apically to the second premolar;

d) other location.

The data were registered and statistically analyzed through descriptive statistics and independent sample t-test. All analyses were performed in BioStat V5 software.

RESULTS

The comparison of both variables analyzed – height and opening of the mental foramens – between the groups dentate and edentulous showed statistically significant difference for MF opening with tendency towards increasing in group D over group E (Table I). Considering the gender, for group D, the studied variables showed no statistically differences between males and females (Table II). In group E, for MF opening, statistically significant differences occurred between males and females, with increased value for males (Table III). MF location in group D showed that most of the foramens opened at the area of the 2nd premolars (65.9%) (Table IV).

Table I - Values of sample size (N), means (M), standard deviation (SD) for both measurements (MFH and AbMF), between groups D and E

Variable (mm)	Group D			Group E			p value
	N	M	SD[a]	N	M	SD[a]	
MFH	49	9.43	4.50	18	9.94	1.11	0.1934
AbMF	49	2.41	0.50	18	1.56	0.38	<0.001[b]

a – standard deviation
b – statistically significant difference

Table II - Values of sample size (N), means (M), standard deviation (SD) for both measurements (MFH and AbMF), in group D, between males and females

Group D (Dentate)							
Variable (mm)	Females			Males			p value
	N	M	SD[a]	N	M	SD[a]	
MFH	24	8.96	5.09	16	10.25	3.40	0.0645
AbMF	24	2.21	0.26	16	2.56	0.80	0.1647

a – standard deviation
b – statistically significant difference

Table III - Values of sample size (N), means (M), standard deviation (SD) for both measurements (MFH and AbMF), in group E, between males and females

Group E (Edentulous)							
Variable (mm)	Females			Males			p value
	N	M	SD[a]	N	M	SD[a]	
MFH	14	9.71	1.14	4	10.75	0.25	0.0828
AbMF	14	1.36	0.25	4	2..25	0.25	0.0060[b]

a – standard deviation
b – statistically significant difference

Table IV - Frequency of the distribution of MF location in group dentate (D)

1st PM		1st and 2nd PM		2nd PM		Others		Total	
N	%	N	%	N	%	N	%	N	%
4	4.9	16	19.6	54	65.9	8	9.7	82	100

DISCUSSION

The correct location of the mental foramen on images is important for the planning of surgeries, local anesthesia, and implant positioning. [1,18] The literature reports some studies that analyzed through CBCT the MF anatomic variation as: accessory foramens, hypoplasia, and absence of MF. [3,11,19] However, the study of anatomic variations of MF was not the aim of this present study. Some studies [6,11] emphasize the importance of the knowledge of accessory MF, thus justifying the use of CBCT for clinical planning. CBCT is an imaging examination that enables accurate cuts, without superposition and minimum magnification of the structures, so that CBCT allows the appropriate study of the anatomic structures by exact measurements. [1,6,10]

This study characterized the MF in relation to the opening and height between the MF inferior limit and the mandible cortical. Some previous studies [2] measured the distance between MF and 1) lingual bone cortical; 2) mandible's base; and 3) alveolar bone ridge, with different results. As far as we are concerned, the literature lacks study taking into consideration the presence or absence of teeth: dentate and edentulous subjects.

In this study, the MF opening reduced when premolars were missed. The rationale behind this fact is the bone resorption affecting edentulous subjects that led to the atrophy in MF opening. Also, the edentulous subjects showed statistically significant difference in MF opening between males and females. Females exhibited smaller values than males. This fact could be explained by the hormonal alteration in females that results in progressive mineral bone mass, but the literature lacks studies on this issue.

MF was mostly located in the area of the second premolars of dentate subjects (Group D). Other study [2] also found this same location, i.e., the longitudinal axis of the second premolar. Notwithstanding, these authors failed in reporting the smallest frequency of MF position.

We believe that mental foramen characterization is important for planning many dental procedures and CBCT is the imaging examination of choice due to the inherent properties. However, because of CBCT high radiation dosage, caution is necessary for indication such imaging examination only for the study of the mental foramen, corroborating with Benavides et al. [1]

CONCLUSION

Based on the methodology and sample of this study, it can be concluded that the edentulism only reduced the dimension of the mental foramen opening. Males had a mean value of mental foramen opening greater than that of females. Most of the mental foramen opening was located in the area of the second premolars.

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