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ARTICLE

INTEREXAMINER AGREEMENT BETWEEN TWO DENTAL SPECIALTIES FOR THE DETECTION OF BIFID MANDIBULAR CANAL AND ACCESSORY MENTAL FORAMEN IN CONE-BEAM COMPUTED TOMOGRAPHY.

Concordancia inter-examinador entre dos especialidades odontológicas para la detección del canal mandibular bífido y foramen mental accesorio en tomografía computarizada de haz cónico

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ABSTRACT:

Introduction: The aim of this study was to assess the agreement between oral and maxillofacial radiologists (OMFR) and oral and maxillofacial surgeons (OMFS) for the detection of bifid mandibular canal (BMC) and accessory mental foramen (AMF) using cone-beam computed tomography (CBCT).

Material and Methods: This retrospective study involved 22 examiners (11 OMFR and 11 OMFS) who independently assessed 30 CBCT volumes from patients (n = 60 hemi-mandibles) under preoperative radiographic evaluation for implant placement. The examiners scored the presence of BMC and AMF in each hemimandible. The interexaminer agreements were assessed using Fleiss' kappa statistics.

Results: For intra-examiner agreement, 40% of the sample was reevaluated. The interexaminer agreement between OMFR and OMFS was slight (0.12) for the detection of BMC and fair (0.24) for AMF. The agreement among OMFR for detection of BMC was fair (0.22), and it was slight among OMFS (0.15). The agreement among OMFR for detection of AMF was substantial (0.61), and among OMFS it was fair (0.22). Agreements between OMFR and OMFS were slight for BMC and fair for AMF, independently of the years of experience. Intraexaminer agreement ranged from 60% to 90% among OMFR and from 55% to 90% among OMFS.

Conclusion: A slight and a fair agreement between OMFR and OMFS was found for the detection of BMC and AMF, respectively. In general, OMFR obtained higher agreement among themselves, mainly for detection of AMF.

KEYWORDS:

Anatomic variation; Cone-Beam Computed Tomography; Mandible; Mental Foramen; Mandibular Canal; Reproducibility of Results.

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RESUMEN:

Introducción: El objetivo de este estudio fue evaluar la concordancia entre los radiólogos orales y maxilofaciales (ROMF) y los cirujanos orales y maxilofaciales (COMF) para la detección del canal mandibular bífido (CMB) y el foramen mentoniano accesorio (FMA) mediante tomografía computarizada de haz cónico. CBCT).

Material y Métodos: Este estudio retrospectivo involucró a 22 examinadores (11 ROMF y 11 COMF) que evaluaron de forma independiente 30 volúmenes CBCT de pacientes (n = 60 hemimandíbulas) bajo evaluación radiográfica preoperatoria para la colocación de implantes. Los examinadores puntuaron la presencia de CMB y FMA en cada hemimandíbula. Los acuerdos entre examinadores se evaluaron utilizando las estadísticas kappa de Fleiss.

Resultados: Por concordancia intraexaminador se reevaluó el 40% de la muestra. El acuerdo entre examinadores entre ROMF y COMF fue ligero (0,12) para la detección de CMB y regular (0,24) para FMA. La concordancia entre ROMF para la detección de CMB fue regular (0,22) y leve entre COMF (0,15). El acuerdo entre ROMF para la detección de FMA fue sustancial (0,61), y entre COMF fue justo (0,22). Los acuerdos entre ROMF y COMF fueron leves para CMB y justos para FMA, independientemente de los años de experiencia. La concordancia entre examinadores varió del 60 % al 90 % entre ROMF y del 55 % al 90 % entre COMF.

Conclusión: Se encontró un acuerdo leve y justo entre ROMF y COMF para la detección de CMB y FMA, respectivamente. En general, se obtuvo mayor acuerdo entre ROMF, principalmente para la detección de FMA.

PALABRAS CLAVE:

Variación Anatómica; Tomografía Computarizada de Haz Cónico; Mandíbula; Foramen Mental; Canal Mandibular; Reproducibilidad de los Resultados

INTRODUCTION.

The mandibular canal and the mental foramen are usually considered single structures in each hemimandible. However, anatomical variations such as bifid mandibular canal (BMC) and accessory mental foramen (AMF) have been reported by several studies.[1-5]

In some cases, BMC and AMF contain the same nerves and blood vessels that already exist in the mandibular canal and mental foramen.[4,6] For that reason, BMC and AMF have important clinical implications during oral procedures, such as dental implant placement, sagittal split ramus osteotomy, teeth extraction, periapical surgery, fracture osteosyn-thesis, bone block harvesting, root canal treatment of teeth, and removal of mandible lesions.[1,3,7]

The detection of these anatomical variations can prevent potential transient or persistent complications (bleeding, paresthesia, traumatic neuroma and/or even disabling dysesthesia)[2,7] and help in an adequate inferior alveolar nerve block.[2,3]

Some studies have assessed BMC and AMF through panoramic radiography (PAN) and cone-beam computed tomography (CBCT)[1-3,7] in order to improve early diagnosis of these anatomic variations. However, inherent limitations relative to conventional radiographic technique, suggest that CBCT may be the most appropriate imaging method to assess the mandibular canal and mental foramen[7] regions. CBCT provides better visualization of anatomical structures, including location, shape, and relationship with adjacent structures.[5]

Despite different diagnostic methods used in the studies to assess BMC and AMF, the main methodological limitations are about the examiners.[5] Most studies do not report the number of examiners, their field of study, if they were calibrated, or even the agreement among them.

However, agreement studies are important for quality control of the diagnostic task, development of diagnostic techniques and improved training.[8] Interexaminer agreement can determine the de-

gree of reproducibility among clinicians,[8] helping in the development of diagnostic criteria,[9] comparing consistency of different source of diagnostic information,[10] assessing effects of educational formation and process of diagnostic decision-making,[11] and understanding variability in treatment planning.[12]

Dentists from different dental specialties can interpret imaging exams differently and report different diagnoses observing the same exam. Two oral specialties that routinely deal with imaging exams are oral and maxillofacial radiology and oral and maxillofacial surgery. Oral and maxillofacial radiologists (OMFR) must interpret the entire imaging exam.[13]

On the other hand, oral and maxillofacial surgeons (OMFS) usually interpret imaging exams focusing on the region of interest for the procedure. Our hypothesis was that OMFR and OMFS could give different diagnoses for the presence of BMC and AMF even using CBCT images. Clinicians from different oral specialties report the same information to the patients and other professionals? The aim of this study was to assess the interexaminer agreement between OMFR and OMFS for the detection of BMC and AMF through CBCT.

MATERIALS AND METHODS.

This retrospective study was approved without restrictions by the Research Ethics Committee from Piracicaba Dental School, University of Campinas (CAAE protocol #59852516.9.0000.5418) and was conducted in accordance with the Declaration of Helsinki Ethical Principles. Written informed consent was obtained from the volunteers of this study.

Sample of examiners

Twenty-two dentists (12 males and 10 females) with a mean age of 33.5 years old were randomly selected as volunteers. According to their dental specialty, they were divided into two groups: 11 OMFR and 11 OMFS. Also, they were divided into three groups of years of experience:

- Ranging from 2 to 4 years of experience (n=3 OMFR; n=3 OMFS);
- Ranging from 5 to 9 years of experience (n=4 OMFR; n = 4 OMFS);
- More than 10 years of experience (n=4 OMFR; n=4 OMFS).

Sample of imaging exams

In consensus, three other OMFR, with an average of 8.3 years of experience selected a total of 30 CBCT volumes (n=60 hemimandibles) from 12 male and 18 females, who were under preoperative radiographic evaluation for implant placement, as a convenient sample. The inclusion criteria for this sample were CBCT volumes acquired with the same CBCT unit, adjusted at similar exposure parameters and with a field of view (FOV) that comprehended the entire mandible.

CBCT images with positioning errors, previous diagnosis of pathological conditions or congenital abnormalities in the maxillofacial region and exams from patients that had already undergone any surgical approach were excluded.

CBCT volumes were acquired with an i-CAT Classic scanner (Imaging Sciences International, Inc, Hatfield, PA, USA), adjusted at 120 kVp, 8 mA, acquisition time of 29.6s, voxel size of 0.25 mm, and field of view of 8 x 16 cm. All CBCT volumes selected were divided into three groups:

BMC group (10 CBCT volumes from patients diagnosed with BMC);

AMF group (10 CBCT volumes from patients diagnosed with AMF) and;

Control group (10 CBCT from patients diagnosed without BMC and AMF), following the definitions of BMC, according to Naitoh *et al.*,[1] and AMF, according with Oliveira-Santos.[14]

Assessment of the images

Examiners were instructed to evaluate the presence of BMC and AMF in each hemimandible through CBCT images, considering their own experience and knowledge about these anatomical variations.

The CBCT volumes were exported as a DICOM format file using Xoran® 3.1.62 software (Xoran Technologies, Ann Arbor, Michigan, USA), and dynamically evaluated using Carestream CS 3D imaging software v3.1.9 (Carestream Health Inc., Rochester, MN, USA), a public domain software newer than Xoran software.

Axial, coronal, sagittal, cross-sectional, and panoramic reconstructions were allowed to be assessed. The examiners were allowed to adjust contrast and brightness, and use zoom settings.

The CBCT volumes were randomly evaluated by the examiners independently in a dimly lit room, with LCD displays of 17 inches and resolution of 1024x768 pixels. After 2 weeks, the examiners reassessed 40% of the total of the CBCT images to obtain the intra-examiner agreement.

Statistical analysis

Data were analyzed using the SPSS® v.22.0 software (IBM Corp, Armonk, NY, USA). Agreements were assessed using Fleiss' kappa statistics which allows a chance-corrected measure of agreement among more than three examiners. Fleiss' kappa test was used to obtain the agreement among OMFR themselves, among OMFS themselves and between OMFR group and OMFS group. Moreover, Fleiss' Kappa was also used to obtain the agreement considering the years of experience of the examiners. Kappa index was interpreted following the classi-fication of Landis and Koch[15]:

<0 poor agreement;
0.00 - 0.20 slight agreement;
0.21 - 0.40 fair agreement;
0.41 - 0.60 moderate agreement;
0.61 - 0.80 substantial agreement;
0.81 - 1.00 almost perfect agreement.

RESULTS.

Table 1 summarizes the agreement among the dental specialists for the detection of BMC and AMF in CBCT. For BMC, the agreement among OMFR was fair (0.22), while among OMFS, a slight (0.15) agreement was found.

For AMF, the agreement among OMFR was sub-

Table 1. Interexaminer agreement for the detection of BMC and AMF in CBCT.

	BMC		AMF	
	Fleiss' kappa	*p*-value	Fleiss' kappa	*p*-value
Oral and MaxilloFacial Radiologists x Oral and MaxilloFacial Radiologists	0.22	0.000	0.61	0.000
Oral and MaxilloFacial Surgeons x Oral and MaxilloFacial Surgeons	0.15	0.000	0.22	0.000
Oral and MaxilloFacial Radiologists x Oral and MaxilloFacial Surgeons	0.12	0.000	0.24	0.000

BMC: Bifid Mandibular Canal. **AMF:** Accessory Mental Foramen.

Table 2. Interexaminer agreement among OMFR and among OMFS for the detection of BMC and AMF through CBCT, according to years of experience.

	OMFR		OMFS		OMFR x OMFS	
	BMC Fleiss' kappa (*p*-value)	AMF Fleiss' kappa (*p*-value)	BMC Fleiss' kappa (*p*-value)	AMF Fleiss' kappa (*p*-value)	BMC Fleiss' kappa (*p*-value)	AMF Fleiss' kappa (*p*-value)
2 - 4 years of experience	0.20 (0.000)	0.41 (0.000)	0.10 (0.000)	0.29 (0.000)	0.15(0.000)	0.25 (0.000)
5 - 9 years of experience	0.32 (0.000)	0.52 (0.000)	0.16 (0.002)	0.32 (0.000)	0.10 (0.000)	0.27 (0.000)
> 10 years of experience	0.37 (0.000)	0.65 (0.000)	0.21 (0.007)	0.48 (0.000)	0.23 (0.000)	0.32 (0.000)

BMC: Bifid Mandibular Canal. **AMF:** Accessory Mental Foramen. **OMFR:** Oral and maxillofacial radiologists. **OMFS:** Oral and maxillofacial surgeons.

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stantial (0.61), while among OMFS, a fair (0.22) agre-ement was found.

In relation to the agreement between both dental specialties, a slight (0.12) and fair (0.24) agreement was found for the detection of BMC and AMF, respectively.

Table 2 shows the inter-examiner agreement regarding years of experience. Among OMFR, examiners with 2 to 4 years of experience obtained a slight (0.20) and fair (0.41) agreement in the detection of BMC and AMF, respectively. OMFR with 5 to 9 and OMFR with more than 10 years of experience obtained a fair agreement (0.32 and 0.37, respectively) in the detection of BMC and a moderate agreement (0.52 and 0.65, respectively) in the detection of AMF.

On the other hand, OMFS obtained slight agreement (0.10, 0.16, 0.21), independently of the years of experience, in the detection of BMC. Regarding AMF, the agreement obtained from examiners with 2 to 4 and with 5 to 9 years of experience was fair (0.29 and 0.32, respectively).

OMFS with more than 10 years of experience obtained a moderate agreement (0.48), (Table 2). Also, the agreement between both OMFR and OMFS gro-ups for the detection of BMC was slight (0.15, 0.10 and 0.11), independently of the years of experience. For AMF, the agreement was fair (0.25, 0.27 and 0.32), also independently of the years of experience. In general, Kappa values were higher for the detection of AMF than for the detection of BMC, (Table 2).

The percentage of intraexaminer agreement ranged from 60% to 90% among OMFR and from 55% to 90 among OMFS for the detection of BMC. It ran-ged from 65% to 90% among OMFR and from 60% to 90% among OMFS for the detection of AMF.

DISCUSSION.

It is important to highlight that agreement studies should not be confused with studies of accuracy.[8] Diagnostic accuracy studies are generally focused on sensitivity, specificity, predictive values, and likelihood ratios.[16]

However, if the examiners who actually interpret the exams cannot agree on the interpretation, the exams, results will be of little use. Examiners related issues such as personal skills, intra- and interexaminer variability cannot be neglected because they also are potentially able to influence the early detection of BMC and AMF.

The interexaminer agreement has not been investigated in depth yet. Most of the available studies have described the presence of BMC and AMF, considering the potential influencing factors in the imaging methods without evaluating the importance of the examiners in the imaging interpretation.

Studies that assessed BMC and AMF had a rate of one to three examiners which the Kappa index in most studies was not mentioned.[5] Interexaminer agreement studies using kappa statistics are only one way to quantify the subjective component of human image interpretation.[16] The present study included a large number of examiners (n=22), which allows to obtain more precise kappa values with possible reproducibility for other clinicians.[8] Rivera-Herrera *et al*.,[17] assessed interexaminer agreement in the radiographic asse-ssment of third molars, and the authors also involved a large number of examiners (n=20).

However, we expected that by increasing the number of examiners, the chance to obtain high values of agreement among them could decrease.[18] In general, the low agreement values found in this study can be explained by the number of examiners, but also by the lack of calibration among them. However, not making a calibration was a decision of the pre-sent authors since the intention of this study was not to influence the diagnostic decision-making of the examiners.

Thus, the examiners were instructed to consider their own experience and knowledge about BMC and AMF. The choice of a diagnostic hypothesis can be based on the combination of the professional intuition and analytical thinking skills.[19] Further knowledge on anatomy, including the understanding of anatomical variations may improve diagnostic tasks. The more the clinicians dedicate themselves in

the diagnostic task and acquire knowledge, the more they improve the diagnostic decision-making process, decreasing doubts.[8]

The interexaminer agreement was higher between the OMFR group than between the OMFS group. It can be explained by the greater experience of OMFR with CBCT exams, with different CBCT DICOM viewers and the use of multiplanar reformatted ima-ges from CBCT data. Also, the different approach that OMFR and OMFS interpret the image may influence in this agreement. OMFR must interpret and make a report based on the entire CBCT volume in all reconstructions, while OMFS frequently focuses on the region of interest. Also, the slight (0.12) and fair (0.24) agreement between OMFR and OMFS for the detection of BMC and AMF, respectively, showed that these different groups of dental specialties have different criteria for detecting BMC and AMF in CBCT exams, what confirms the hypothesis of this study.

Some studies showed variation on the radiological detection for different diagnostic tasks.[20,21] It can express the necessity of further training, calibration, and adjustment of diagnostic criteria between different dental specialties. The present authors believe that clinical case discussions involving dentists from different dental specialties (such as OMFR and OMFS) can help to determine, in consensus, the adequate diagnostic criteria for the detection of BMC and AMF. We are in line with Fatahi *et al.*,[22] since the authors believje that improved communication between radiologists and referring clinicians should be encouraged to ensure diagnostic quality, involving them in active educational activities, such as lectures, seminars, and conferences in order to optimize the use of imaging exams.

Also, the present authors suggest that before the interpretation of the imaging exams, the clinicians should have the maximum clinical information about the patient, medical history (*i.e.* failures in anesthetic efficacy during the surgical procedure, important complications during previews oral surgeries) and any other patient complaints to better guide the diagnostic task and to help in an adequate treatment planning for each patient.

In general, the kappa values for AMF were higher than for BMC. It can be explained because the most AMF occurs close to the main foramen.[3] In the other hand, BMC can occur in any region along the main mandible canal. Also, AMF is easier to find in CBCT, especially in the axial reconstruction.

Regarding the years of experience, the highest kappa values were found between the examiners with more than 10 years of experience for both BMC and AMF detection. It seems that the experience can influence the level of agreement for this diagnostic task. Some authors found that the years of experience influenced in the inter-examiner agreement for other radiographic diagnostic tasks.[23,24]

The present authors understand the limitation in the sample size of the imaging exams for this study. However, we focused on the number of examiners, since our main objective was to evaluate the diagnostic decision-making of the dental specialists when they need to evaluate examinations of the same patients.

We also understand that the lack of calibration by the examiners may have led to a low agreement, compared with studies that do previous calibration.

However, the lack of calibration was intentional, since the present authors intended to know the real situation of agreement for the detection of BMC and AMF, without interference

CONCLUSION.

There is a slight agreement between OMFR and OMFS for the detection of BMC, and a fair agreement between them for the detection of AMF. Also, in general, OMFR obtained higher agreement among themselves, mainly for the detection of AMF.

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Conflict of interests:

All authors declare no conflict of interest.

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Authors' contributions:

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Carlos Groppo F: (Conceptualization; Data curation; Formal Analysis; Funding acquisition; Investigation; Methodology; Project administration; Supervision; Validation; Writing – original draft; Writing – review & editing)

Haiter-Neto F: (Conceptualization; Data curation; Formal Analysis; Funding acquisition; Investigation; Methodology; Project administration; Supervision; Validation; Writing – original draft; Writing – review & editing)

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