

Detection of the Mandibular Canal and the Mental Foramen in Panoramic Radiographs: Intraexaminer Agreement

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The aim of this study was to evaluate the intraexaminer agreement in the detection of the mandibular canal roof (MCR) and mental foramen (MF) in panoramic radiographs. Forty panoramic radiographs of edentulous patients were used. Two calibrated examiners (A and B) read the images 2 times, for both sides independently, under blind conditions. The interval between the readings was 10 days. The intraexaminer agreement in the interpretation of MCR and MF was performed by kappa statistics with linear weighting (κ). The intraexaminer agreement for the detection of MCR, in the left side, was good for both examiners (A: $\kappa = 0.67$; B: $\kappa = 0.71$). Related to the right side, it was found to be $\kappa = 0.47$ and $\kappa = 0.62$, respectively to A and B. The intraexaminer agreement for the detection of MF was good for both examiners interpreting the left side (A: $\kappa = 0.61$; B: $\kappa = 0.63$), and in relation to the right side, it was moderate (A: $\kappa = 0.51$) and fair (B: $\kappa = 0.38$). The intraexaminer agreement in the detection of MCR was good and from good to fair in the detection of MF.

Key Words: radiography, panoramic, mandible, mandibular nerve, reproducibility of results

INTRODUCTION

The treatment protocol for replacing teeth with dental implants requires radiographic imaging before implant placement.¹⁻³ Radiographic examination is an important part of implant surgery. It is primarily

used to locate anatomic structures and to evaluate bone quality and quantity; it is also indicated for postsurgical follow-up.⁴

During the implant treatment planning, it is important to determine anatomic landmarks such as the mandibular canal^{5,6} and mental foramen⁷ in the posterior edentulous mandible to avoid damage to the nerve or a vascular trauma which may result in paresthesia of the lower lip and chin.^{7,8}

Panoramic radiography is widely prescribed for implant planning because it provides an overview, giving a broad coverage of the facial bones and teeth, which is useful in the initial evaluation.^{3,9,10} Other advantages of panoramic radiography are

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low cost, low dose of radiation, and greater availability.^{4,10} On the other hand, the disadvantages are the magnification, lower sharpness, and lack of information in the third dimension.³ Therefore, measurements are not indicated for this radiographic imaging.⁵

Radiographic interpretations rely on some degree of subjective interpretation by the examiner. This way, it is interesting to measure the agreement between 2 interpretations of the same radiography by the same examiner within an interval, and it should include a statistic that takes into account that the interpretation could vary simply by chance. The kappa statistic is used for this purpose, and in such a situation, it is called intraexaminer agreement.

Studies concerning intraexaminer agreement in the detection of the mandibular canal and mental foramen are rare in literature. Therefore, the aim of this study was to evaluate the detection of the roof of the mandibular canal (MCR) and the mental foramen (MF) in panoramic radiographs, and verify the intraexaminer agreement.

MATERIALS AND METHODS

Forty panoramic radiographs of edentulous patients from the department files were used. The characteristics for taking panoramic radiographs and the criteria for image selection were described in a previous study.¹¹

Two examiners (J.A.S. and M.C.M.) were trained before reading sessions advised by an experienced radiologist in using the criteria related to MCR and MF. Both examiners read the panoramic images on a masked view box under reduced room lighting. Masks were used to improve the visual perception by reducing the amount of light to their eyes. Each examiner read the images 2 times, independently and under blind conditions. The interval between the readings was 10 days.

For both sides, the criteria for reading the radiographs related to MCR are as follows:

- (1) full detection of the MCR course from mandibular foramen to the mental foramen,
- (2) half detection of the MCR,
- (3) one third detection of the MCR, and
- (4) no detection of the MCR.

We have decided to apply these criteria for having a real situation about the radiographic aspects of MCR. The determination of MRC was made based on a visual inspection.

For both sides, the criteria for reading the radiographs related to MF according to Yosue and Brooks¹² are as follows:

- (1) continuous: the mental foramen is continuous with the mandibular canal;
- (2) separated: the mental foramen is separated from the mandibular canal;
- (3) diffuse: the mental foramen has an indistinct border; and
- (4) unidentified: the mental foramen cannot be visualized.

The intraexaminer agreement in the interpretation of the roof of the mandibular canal and mental foramen was performed by kappa statistics with linear weighting according to Cohen,¹³ with estimation by point (κ) and by 95% confidence interval (lower limit–upper limit). κ values were classified according to Landis and Kock¹⁴ and can be interpreted as follows:

- $\kappa < 0.00$: poor agreement,
- 0.00–0.20: slight agreement,
- 0.21–0.40: fair agreement,
- 0.41–0.60: moderate agreement,
- 0.61–0.80: good agreement, and
- 0.81–1.00: almost perfect agreement.

RESULTS

For intraexaminer agreement related to the roof of the mandibular canal examination, the κ values are shown in Table 1.

TABLE 1

Kappa values by point (κ) and 95% CI for the detection of the roof of the mandibular canal, right and left sides, on panoramic radiographs

Examiner	Left		Right	
	κ	CI	κ	CI
A	0.67*	0.50–0.83	0.47†	0.25–0.69
B	0.71*	0.55–0.86	0.62*	0.21–1

*Good: 0.61–0.80.

†Moderate: 0.41–0.60.

TABLE 2

Kappa values by point (κ) and 95% CI for the detection of mental foramen, right and left sides, on panoramic radiographs

Examiner	Left		Right	
	κ	CI	κ	CI
A	0.61*	0.44–0.78	0.51†	0.33–0.69
B	0.63*	0.47–0.80	0.38‡	0.16–0.60

*Good: 0.61–0.80.

†Moderate: 0.41–0.60.

‡Fair: 0.21–0.40.

Considering the left side of the MCR, the κ values for both examiners were classified as “good,” and in relation to the right side, the intraexaminer agreement was “good” for examiner B and “moderate” for A. It has to be considered that the reproducibility of the MCR diagnoses was statistically significant ($P < .001$).

Table 2 shows κ values for intraexaminer agreement related to the mental foramen examination.

Considering the MF diagnoses in the left side, the intraexaminer agreement was “good” for A and B, and for the right side it was “moderate” and “fair,” for A and B examiners, respectively. Despite the estimated κ values, they were statistically significant ($P < .001$).

Indeed, considering the confidence intervals, the interpretations of both examiners were similar in relation to a radiographic interpretation of MCR and MF, in both sides.

DISCUSSION

The results of this study showed a “good” to “fair” intraexaminer agreement of the 2 types of landmarks analyzed. The 2 examiners proved to be in “good,” “moderate,” and “fair” agreement when they classified the roof of the mandibular canal and the mental foramen. Because the intraexaminer agreement was classified as “fair” and “moderate” in some instances, it was not possible to have an interexaminer agreement. To

achieve interexaminer agreement, it is necessary to have at least a “good” intraexaminer agreement, which was not achieved in this study. The interpretations of both examiners were similar in relation to the detection of MCR and MF with “good” agreement of the left side. This may be explained by the preradiographic interpretation calibration that was advised by an experienced radiologist and supported by the confidence intervals results. On the other hand, the agreement for both examiners and for both landmarks of the right sides was not similar. The results showed similar tendencies; however, in that “good” and “moderate” ratings were given respectively for examiner B and A for MCR and “moderate” and “fair,” respectively, for examiner A and B for MF. These results may be attributed to the subjectivity of the method and the examiners’ human characteristics such as visual, neurologic, and emotional features.

The agreement variation between “fair” and “good” for both examiners in detecting MCR and MF might also be explained by the poor sharpness of panoramic imaging.³ Other explanations are: the roof’s resorption of the mandibular canal as a result of an alveolar ridge resorption¹⁵ and the intraosseous course of inferior alveolar nerve. The mandibular canal frequently loses the bony walls.¹⁶ Klinge et al⁶ showed that 35% of the mandibular canal was not visible in panoramic radiographs of mandibular specimens. Another study¹⁷ about the intrabony course

of the inferior alveolar nerve showed a 41% of a plexus of branches in a posterior molar area from 69.2% of human cadavers that have the inferior alveolar nerve located at half-way or closer to the inferior border of the mandible. These statements can support our results on the difficulty in the detection of the MCR, mainly in the right side, as previously stated.

The most common radiographic locations of MF are the apex of the second premolar and between the first and second premolar.^{7,18,19} However, this affirmation did not guarantee a higher agreement between the examiners during the radiographic interpretation. Our results might be supported by the classification of MF according to Yosue and Brooks¹² including an unidentified type, when the MF cannot be identified during the radiographic interpretation of panoramic radiographs under ideal conditions of interpretation and good imaging quality. On the other hand, there were different results related to the mandible sides. These results can be explained by the different sizes of MF related to the right and left mandible sides.²⁰ Perhaps the MF located on the right side was of a smaller size than the left side, and consequently the observers had more difficulty in detecting the MF on the right side.

Considering the criteria to classify the MCR and MF, in this paper the classification of 2 landmarks applied was easier when compared with the method related to a 5-point confidence scale for the mandibular canal. However, the results of a previous paper¹¹ using a 5-point confidence scale were not similar to this paper. Therefore, a confidence scale using fewer variables should improve the agreement.

The true detection of MCR and MF in panoramic radiographs was not possible to know because the real anatomic position of these landmarks is not possible to detect in the patients.

The clinician must be aware of the limitation of panoramic radiographs to detect such anatomic structures. The position paper

of the American Academy of Oral and Maxillofacial Radiology³ recommends cross-sectional imaging for implant site evaluation by computerized tomography, and nowadays cone-beam computerized tomography has been the indicated method for implant cases because it gives a lower radiation dose to the patient than computerized tomography,²¹ and it is indicated for implant planning in the posterior mandible.²²

In conclusion, the intraexaminer agreement in the detection of MCR was good and from good to fair in the detection of MF.

ABBREVIATIONS

MCR: mandibular canal roof
MF: mental foramen

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