Radiologic assessment of mandibular third molars: an ex vivo comparative study of panoramic radiography, extraoral bitewing radiography, and cone beam computed tomography

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Objectives. The aim of this study was to compare the performance of panoramic radiography (PAN), extraoral bitewing radiography (EBW), and cone beam computed tomography (CBCT) in the assessment of mandibular third molars.

Study Design. PAN and EBW were obtained to visualize 34 third molars. The teeth were evaluated by using PAN and EBW according to their positions, the presence of radiographic signs of proximity of the roots to the mandibular canal, the relationship of the roots to the canal, and the relationship of the second and third molars. Third molar position and root relationship with the canal were also assessed with CBCT.

Results. PAN and EBW showed significantly closer relationships compared with CBCT between the tooth and the mandibular canal ($P \leq .002$). With regard to all other parameters, no differences were seen between PAN and EBW ($P \geq .072$), although EBW, in comparison with PAN, showed a decreased overlap between the proximal surfaces of the second and third molars and a greater trend toward approximating root apices and the canal.

Conclusions. In comparison with PAN, EBW showed a tendency to project the roots closer to the mandibular canal, but there was a decrease in the proximal surfaces overlapping the second molar. The relationship between the third molar and the mandibular canal appeared closer in PAN and EBW than in CBCT. (Oral Surg Oral Med Oral Pathol Oral Radiol 2019;128:166−175)

Surgical removal of mandibular third molars is one of the most common procedures in the daily practice of oral and maxillofacial surgery. Radiographic examination is of great value in providing relevant information for treatment planning to reduce postoperative complications, such as pain, excessive bleeding, swelling, infection, and trismus, as well as transitory or permanent neurosensorial disorders.[1,2] Periapical radiography performed before third molar surgery may be adequate, provided sufficient information is obtained to meet the requirements of the diagnostic task.[3] However, some limitations—mainly related to positioning of the image receptor in the region of interest—can interfere with production of an adequate image for diagnostic purposes, making it necessary to repeat the radiographic examination.[4]

For this reason, panoramic radiography (PAN) is the most often used technique for preoperative assessment of the third molars. Its use is justified by its advantages, such as production of a broad view of the jaws, low cost, wide availability, and relatively low radiation dose.[5] Thus, the capacity to assess the relationship between the mandibular canal and the third molar, in addition to the possibility of predicting injury to the inferior alveolar nerve (IAN), also explains why PAN is often the imaging modality chosen for this diagnostic task.[6-8] Nevertheless, in specific cases, CBCT is indicated when it is believed that the 3-dimensional assessment of these structures could change surgical planning and treatment.[3]

The concept of ALADA ("As Low As Diagnostically Acceptable") has recently been introduced to emphasize the importance of optimization in medical imaging.[9,10] In this context, extraoral bitewing radiography (EBW) is a relatively new imaging modality that provides image coverage of the crowns, roots, and adjacent anatomic structures from the canines to the third molars.[11] EBW represents a scanning mode available on some panoramic devices, and although manufacturers do not provide details of the operation of these devices, it has been reported that EBW provides the ability to correct the scan rotation angle to reduce the overlapping of tooth crowns, as usually occurs in

Statement of Clinical Relevance

Bitewing extraoral radiography provides images of a smaller area compared with panoramic radiography. Therefore, the investigation of its performance in the assessment of third molars in comparison with panoramic radiography and cone beam computed tomography is important to make the right choice between these methods.

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panoramic imaging.[12,13] The EBW examination usually requires a shorter time compared with the PAN examination to acquire the image, and the patient's positioning and subjective image quality are similar in the 2 techniques.[11] Thus, taking into account the ALADA concept, EBW could be useful for different diagnostic tasks and may cause lower radiation exposure of the patient because it acquires images of smaller regions of interest compared with those of panoramic radiography.

Some studies have used EBW to survey proximal carious lesions.[11-14] However, to the best of our knowledge, no studies have evaluated EBW for preoperative assessment of mandibular third molars. Therefore, the present study aimed to compare the performance of PAN, EBW, and CBCT in assessment of mandibular third molars with regard to (1) tooth position, (2) radiographic signs of proximity between the roots and the mandibular canal, (3) the relationship of the roots to the canal, and (4) the mesial−distal relationship of the third and second molars. The null hypotheses stated that there was excellent agreement between the observers in their assessment of the parameters and that there were no significant differences among the 3 techniques in the observers' assessments for any of the measured parameters.

MATERIAL AND METHODS

The present study was approved by the local institutional research ethics committee (protocol # 108311/2016).

Study sample

The sample comprised PAN, EBW, and CBCT images of 1 skull and 20 dry mandibles. In this study, mandibles in a good state of preservation and with at least 1 third molar were included. Teeth with extensive coronal destruction resulting from carious lesions and with incomplete root formation, and mandibles with intraosseous lesions in the third molar region and dentoalveolar or bone fractures were excluded. The final sample included 34 mandibular third molars, of which 30 were adjacent to the second molar.

Image acquisition

PAN and EBW images were obtained by using a Cranex 3D unit (Soredex, Tuusula, Finland) operating at 57 kVp, 6.3 mA, and acquisition time of 16.4 seconds and 8.6 seconds, respectively. Each mandible was fixed to the dry skull, and both were inserted in a cylindrical plastic container filled with water to simulate the attenuation of radiation by soft tissues. Each set was guided into position by the apparatus, with the median sagittal plane perpendicular to the Frankfurt plane and the Frankfurt plane parallel to the horizontal plane. PAN and EBW images of each skull/mandible set were obtained without changes in position, with the purpose of standardizing image acquisition with both modalities.

CBCT was performed for comparison of the PAN and EBW findings related to tooth position and the relationship between the third molars and the mandibular canal. CBCT images were obtained by using a Picasso Trio unit (Vatech, Hwaseong, South Korea), operating at 90 kVp, 5mA, 0.2-voxel size, and an 8.5×12 cm of field of view (FOV). The mandibles were positioned inside a cylindrical plastic container with the aid of utility wax adapted to the anterior and posterior regions of the mandibular body and centered in the middle of the FOV aided by the reference lights. In addition, the container was filled with water to simulate soft tissue attenuation of the X-rays.[15]

Image assessment

All images were individually evaluated by 2 oral radiologists who had at least 5 years of experience in image evaluation and who were calibrated through analysis of 20 panoramic and CBCT images that were not part of study. Analysis was conducted until the radiologists reached a consensus. The assessments were performed on a 24.1-inch LCD monitor with a spatial resolution of 1920×1200 (MDRC-2124, Barco N.V., Courtray, Belgium) in a quiet room under dim lighting conditions. Examiners were allowed to manipulate the zoom, brightness, and contrast features.

PAN and EBW images were exported in TIFF (tagged image file format) and examined by using ImageJ software (National Institutes of Health, Bethesda, MD). Each examiner was asked to indicate the type of tooth position, according to Winter's[16] classification (vertical, mesioangular, horizontal, or distoangular) and Pell and Gregory's[17] classification (which considers the impaction depth and the relationship with the mandibular ramus), as shown in Figures 1 and 2, respectively. The presence of radiographic signs of proximity between the dental roots and the mandibular canal was also recorded. Of these signs, only darkening of the roots, deflected roots, and interruption of the cortical line were observed in this study (Figure 3).[18]

The relationship between the third molars and the mandibular canal was classified, considering the root apex closest to the canal, as "distant" (when there is a space between the root apex and the upper cortical border of the mandibular canal), "in contact" (when the root apex is in contact with the upper cortical border), and "overlapped" (when the apex extends inferiorly to the upper cortical border). In the "distant" cases, measurements were performed by using the straight-line measurement tool of ImageJ software, and the

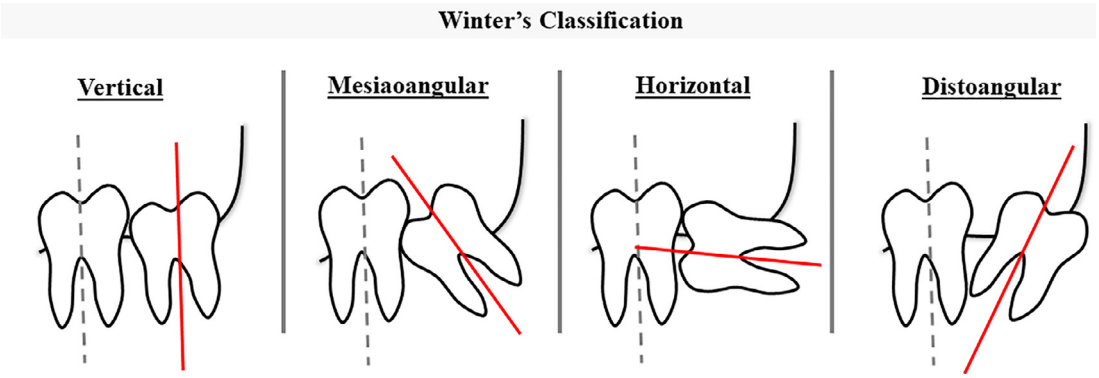

Fig. 1. Schematic drawings showing Winter's classification, which is based on the angulation of the third molars.

distances were subclassified as greater than 1 mm or as 1 mm or less, as proposed by Bell (Figure 4).[19]

The CBCT images were analyzed by using OnDemand3D software (Cybermed Inc., Seoul, Republic of Korea). Because both the presence of radiographic signs of proximity between the tooth and the mandibular canal and the mesiodistal relationship between the second and third molars (described below) are based essentially on data obtained from 2-dimensional geometric projections, CBCT was used only for the evaluation of third molar positioning and the vertical relationship of third molar roots with the mandibular canal.

The assessment of the vertical relationship between the third molars and the mandibular canal, as depicted on CBCT scans, was based on the methodology proposed by Chong et al.[20] Oblique multiplanar reconstructions (axial, coronal, and sagittal) were adjusted according to the long axis of the roots of mandibular third molars and assessed by using the following parameters: Initially a horizontal line was defined passing through the root apex closest to the mandibular canal. Next, a classification was established based on the vertical relationship between the upper cortical border of the canal and the above-mentioned predefined horizontal line. In cases in which the mandibular canal was below the horizontal line, it was classified as "distant," and a vertical measurement was performed. When the upper cortical border of the canal touched the horizontal line, this relationship was classified as "in contact." And finally, when the upper cortical border of the canal was above the horizontal line, the relationship was classified as "adjacent to the dental root" (Figure 5). Thus, the adjacent relationship in CBCT images would be equivalent, in the 2-dimensional radiographic images, to an overlapped relationship.

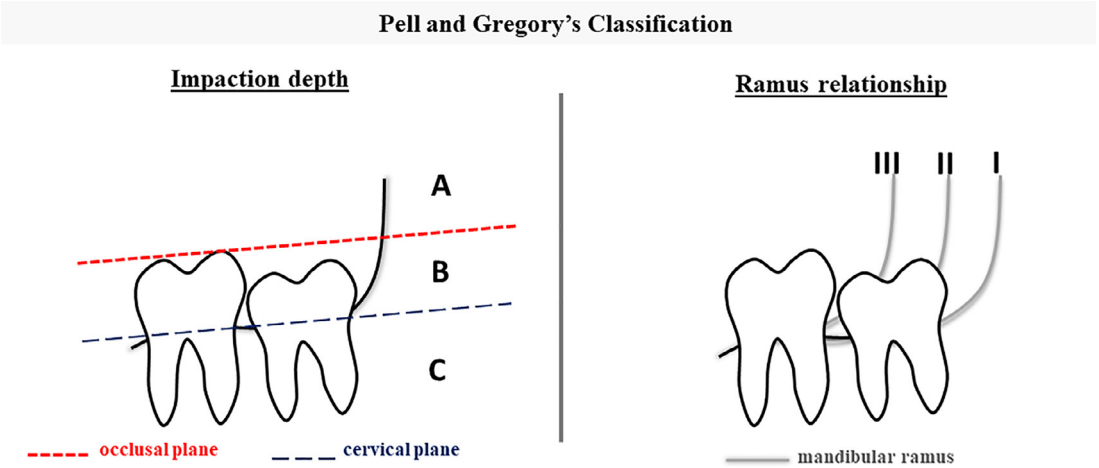

Fig. 2. Schematic drawings representing of Pell and Gregory's classification related to the impaction depth—**A,** When part of the third molar is above the occlusal plane. **B,** When the uppermost part of the tooth is located between the occlusal plane and the cervical region of the adjacent tooth. **C,** The uppermost part of the tooth is located below the plane passing through the cervical region of the adjacent tooth The relationship between the third molar and the mandibular ramus—**I,** When there is sufficient space for accommodation of the mesiodistal diameter of the third molar. **II,** When there is insufficient space for accommodation of the mesiodistal diameter of the third molar. **III,** All or most of the third molar is in the mandibular ramus.

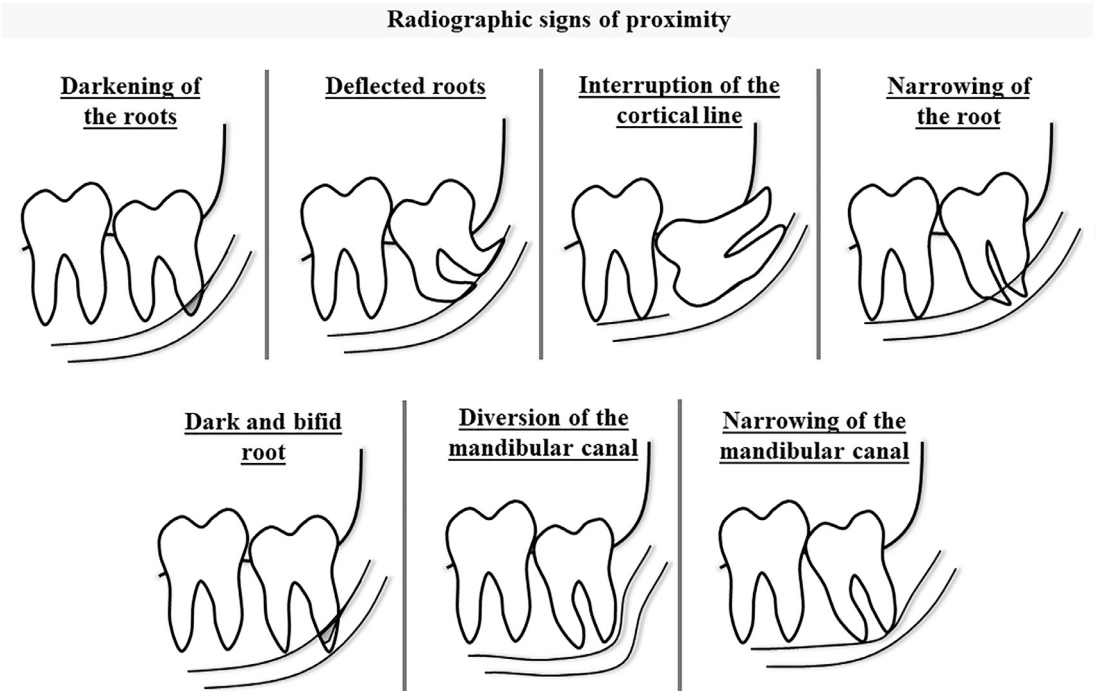

Fig. 3. Schematic drawings illustrating the radiographic signs of proximity of the third molar roots to the mandibular canal.

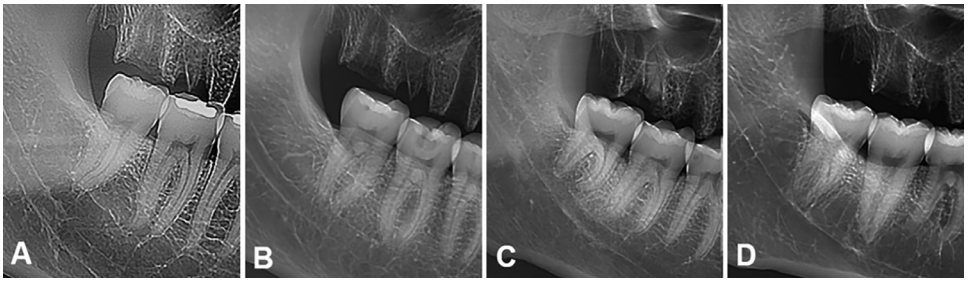

Fig. 4. Cropped images of panoramic radiography (PAN) showing the anatomic relationships between the third molar root apex and the mandibular canal, classified as: "distant" greater than1 mm **(A)**; "distant" 1 mm or less **(B)**; "in contact" **(C)**; and "overlapped" **(D)**.

The mesiodistal relationship between the second and the third molars was also assessed and classified, as follows: "distant," when there was no point of contact between these teeth; "in contact," when there was a point of contact between their proximal surfaces; or "overlapped," when there was overlapping of their proximal surfaces (Figure 6).

PAN, EBW, and CBCT images were evaluated separately and at different times and sequences, with an interval of 2 weeks between them. After the evaluations, the findings of the examiners were compared, and in cases of disagreement, the images were re-evaluated by both examiners together until a final consensus was reached. For numerical variables (distance between the root apex and the mandibular canal), the mean values from the 2 examiners were calculated and used to compare the imaging modalities.

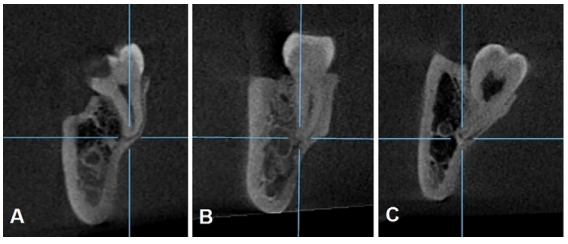

Fig. 5. Cone beam computed tomography images showing the vertical relationship of the mandibular canal classified as "distant" **(A)**, "in contact" **(B)**, and "adjacent to the third molar root" **(C)**.

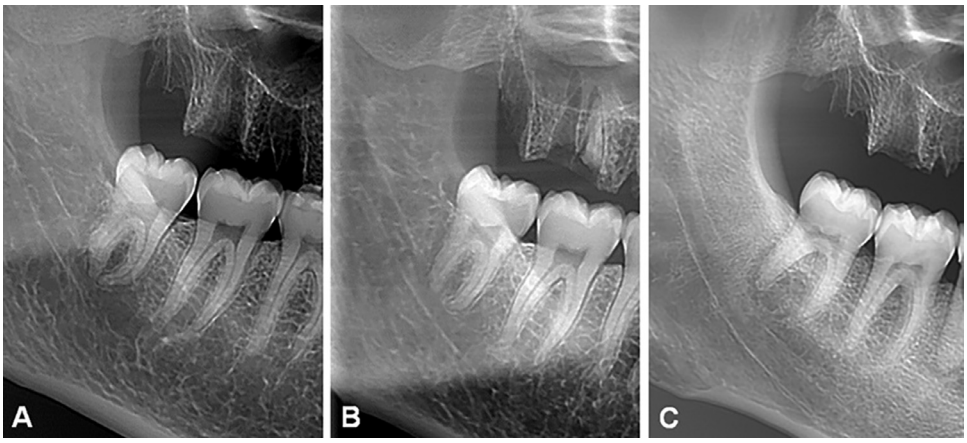

Fig. 6. Cropped images of panoramic radiography (PAN) showing the mesiodistal relationship between the second and third molars, classified as "distant" **(A)**; "in contact" **(B)**; and "overlapped" between the proximal surfaces **(C)**.

Statistical analysis

Data were analyzed by using the SPSS software version 22.0 (SPSS Inc., Chicago, IL). The assessments of each examiner before the consensus were used to calculate interexaminer agreement by means of weighted κ test (0.00−0.20, poor; 0.21−0.40, reasonable; 0.41−0.60, moderate; 0.61−0.80, good; 0.81−1.00, excellent).[21] Subsequently, the results obtained from the consensus were used to compare the 3 imaging modalities. The responses obtained for PAN, EBW, and CBCT were compared by using the McNemar-Bowker test. The level of significance was established at 5% ($\alpha = 0.05$).

RESULTS

The κ values for interexaminer agreement before consensus regarding the PAN, EBW, and CBCT scans was almost perfect (0.80−0.95) for all of the parameters evaluated.

With regard to assessment of the tooth position, according to the angular classification (Winter's classification), the same diagnosis was achieved with PAN, EBW, and CBCT in all cases ($P = 1.000$). Thus, the sample was composed of 25 teeth in the vertical position, 6 in the horizontal position, and 3 in the mesioangular position. For tooth impaction evaluation (Pell and Gregory's classification), the 3 imaging modalities presented the same scores of impaction depth ($P = 1.000$). With regard to the ramus relationship, CBCT showed more cases where there was sufficient space for accommodation of the third molars (classification I) compared with PAN and EBW, but the difference was not significant ($P = .500$) (Table I).

With regard to the detection of radiographic signs of proximity, more signs were observed in the EBW images, in particular, darkening of roots, although no significant difference was found between the 2 radiographic modalities (Table II).

Table III summarizes the PAN and EBW findings related to the assessment of the anatomic relationship between the root apices of mandibular third molars and the mandibular canal. In the PAN images, a uniform

Table I. Evaluation of tooth impaction according to Pell and Gregory's classification in the imaging modalities studied

CBCT	*PAN/EBW Impaction depth*	*A*	*B*	*C*	*Total*	*P value* P = 1.000*
	A	**3**	0	0	3 (8.8)	
	B	0	**30**	0	30 (88.2)	
	C	0	0	**1**	1 (2.9)	
	Total	3 (8.8)	30 (88.2)	1 (2.9)	**34 (100)**	
	Ramus relationship	I	II	III		*P* = .500
	I	**27**	2	0	29 (85.3)	
	II	0	**5**	0	5 (14.7)	
	III	0	0	**0**	0 (0)	
	Total	27 (79.4)	7 (20.6)	0 (0)	**34 (100)**	

**P* value, according to the McNemar-Bowker test.Bold numbers in the diagonal represent the cases of agreement between the imaging modalities. As there were no differences between PAN and EBW ($P = 1.000$), the results of the 2 imaging modalities were expressed together and compared to the results of the CBCT.*CBCT,* cone beam computed tomography; *EBW,* extraoral bitewing radiography; *PAN,* panoramic radiography.

Table II. Radiographic signs of proximity detected on PAN and EBW radiographs

	EBW					Total*
	Absent	*Darkening of the roots*	*Deflected roots*	*Interruption of the cortical line*	*≥2 radiographic signs together*	
PAN						
Absent	**22**	4	0	0	0	26 (76.5)
Darkening of the roots	1	**3**	0	0	0	4 (11.7)
Deflected roots	0	0	**1**	0	0	1 (2.9)
Interruption of the cortical line	0	1	0	**1**	0	2 (6.0)
≥2 radiographic signs together	0	0	0	0	**1**	1 (2.9)
Total	23 (67.7)	8 (23.5)	1 (2.9)	1 (2.9)	1 (2.9)	**34 (100)**

*$P = .247$, according to the McNemar-Bowker test.Bold numbers in the diagonal represent the cases of agreement between the imaging modalities.*EBW*, extraoral bitewing radiography; *PAN*, panoramic radiography.

distribution was observed among the proximity relationships (distant >1 mm, distant ≤ 1 mm, in contact, and overlapped), each presenting a frequency between 17.7% and 29.4% of the sample. In contrast, there was an increase in the number of cases of overlapped relationships when the EBW images were evaluated (from 29.4% in PAN to 41.2% in EBW). In an overview, any disagreement between the imaging modalities occurred with regard to closer relationships being identified on EBW (Figure 7). Therefore, although no statistically significant difference was found between PAN and EBW in the evaluation of the third molar relationship with the mandibular canal ($P = .072$), a tendency toward closer approximation between these anatomic structures was observed when EBW was used.

The evaluation of the anatomic relationship between mandibular third molars and the mandibular canal in PAN and EBW compared with CBCT is shown in Table IV. In 2 cases, the cortical border of the mandibular canal was not clearly observed on the CBCT images, hence only 32 teeth were assessed. Both PAN and EBW were statistically different from CBCT ($P = .002$ for PAN, and $P = .001$ for EBW). The most frequent vertical relationship found in CBCT was "distant" greater than 1 mm (59.4%). In contrast, the most frequent relationship in both PAN and EBW was "overlapped" (31.2% for PAN and 37.5% for EBW). In addition, in all cases of disagreement found between the 2-dimensional radiographic images and the CBCT images, both PAN and EBW showed closer relationships between the tooth and the mandibular canal (see Table IV).

With regard to the mesiodistal relationship between the third and second mandibular molars, in 76.7% of cases, PAN showed overlapping of their proximal surfaces, whereas this number decreased to 50% in the EBW images of the 30 teeth that were adjacent to a second molar (Table V). Most cases identified as "overlapped" in EBW coincided with the results of PAN. However, in cases of "distant" and "in contact," there were more disagreements between the imaging modalities. In most of these cases, there was a trend toward distancing the interproximal contacts in EBW images (Figure 8). However, this was not statistically significant ($P = .079$).

DISCUSSION

Several studies have reported that third molar extraction is associated with risk of IAN injury,[1,2,7,8,19] which can be reduced by preoperative radiographic evaluation of the anatomic relationship between this tooth and the mandibular canal.[22] Although PAN and CBCT are the examinations most commonly used for this purpose,[1,23] the search for imaging modalities that provide an adequate diagnosis associated with a lower radiation dose is necessary to comply with the ALADA principle of

Table III. Comparison of PAN and EBW imaging findings related to evaluation of the anatomic relationship between the mandibular third molars and the mandibular canal

	EBW				*Total**
	Distant (> 1 mm)	*Distant (≤ 1 mm)*	*In contact*	*Overlapped*	
PAN					
Distant (>1mm)	**8**	2	0	0	10 (29.4)
Distant (≤ 1 mm)	0	**5**	1	0	6 (17.7)
In contact	0	0	**4**	4	8 (23.5)
Overlapped	0	0	0	**10**	10 (29.4)
Total	8 (23.5)	7 (20.6)	5 (14.7)	14 (41.2)	**34 (100)**

*$P = 0.072$, according to the McNemar-Bowker test.Bold numbers in the diagonal represent the cases of agreement between the imaging modalities.*EBW,* extraoral bitewing radiography; *PAN,* panoramic radiography.

radioprotection.[9,10] In this sense, it would seem that the present study was the first to assess the performance of EBW in the evaluation of mandibular third molars and to compare its findings with those of PAN and CBCT. No significant differences were found between PAN and EBW relative to this specific diagnostic task.

Tooth position was assessed because it is often associated with a pathologic change, such as marginal bone loss and resorption in the second molar, especially when horizontal/mesioangulated third molars overlap the second molar.[24] Among the parameters evaluated, consistent results were found for Winter's classification[16] of tooth position because there was no disagreement among PAN, EBW, and CBCT. With Pell and Gregory's classification,[17] PAN and EBW underestimated the space for the accommodation of the third molars in comparison with CBCT in 2 cases, and this can be attributed to the overlap of the mandibular ramus in the evaluated region. There were, however, no significant differences between PAN and EBW. The identical performances of the 2 radiographic modalities can be attributed to macroscopic features of this condition because the possible differences in the image acquisition process were not sufficient to change the perception of tooth positioning.

Identification of the radiographic signs that suggest a close relationship between the dental roots and the mandibular canal is valuable for establishing an adequate treatment plan. In comparison with PAN, EBW showed a greater number of cases of darkening of the roots, although no significant difference was found between the 2 modalities in detecting these signs. Darkening of mandibular third molar roots can be considered a useful radiographic sign for determining the proximity between these anatomic structures, which increases the risk of IAN injury.[25]

Assessment of the vertical relationship between the root apices of the third molars and the mandibular canal is directly related to clinical decision making. The intraoral radiographic technique is known to result in changes in the apparent vertical relationship between these anatomic structures, depending on the vertical

Table IV. Assessment of the anatomic relationship between mandibular third molars and the mandibular canal on PAN and EBW images compared with CBCT images

Radiographic modalities		*CBCT*				*Total*
		Distant (> 1 mm)	*Distant (≤ 1 mm)*	*In contact*	*Adjacent*	
*PAN**						
	Distant (> 1 mm)	**10**	0	0	0	10 (31.2)
	Distant (≤ 1 mm)	6	**0**	0	0	6 (18.8)
	In contact	3	1	**2**	0	6 (18.8)
	Overlapped	0	0	7	**3**	10 (31.2)
	Total (%)	19 (59.4)	1 (3.1)	9 (28.1)	3 (9.4)	**32 (100)**
EBW†	Distant (> 1 mm)	**8**	0	0	0	8 (25.0)
	Distant (≤ 1 mm)	7	**0**	0	0	7 (21.9)
	In contact	3	1	**1**	0	5 (15.6)
	Overlapped	1	0	8	**3**	12 (37.5)
	Total (%)	19 (59.4)	1 (3.1)	9 (28.1)	3 (9.4)	**32 (100)**

*$P = .002$, according to the McNemar-Bowker test.
†$P = .001$, according to the McNemar-Bowker test.Bold numbers in the diagonal represent the cases of agreement between the imaging modalities. Note that the term "overlapped" was used only for the PAN and EWB modalities, which is equivalent to "adjacent" relationship on CBCT images. *CBCT,* cone beam computed tomography; *EBW,* extraoral bitewing radiography; *PAN,* panoramic radiography.

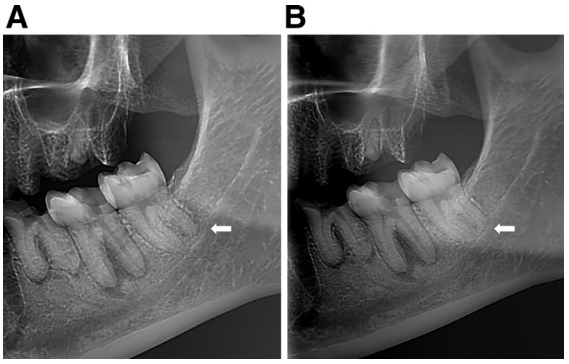

Fig. 7. Cropped panoramic radiograph **(A)** and extraoral bitewing (B) of the same tooth showing a relationship of a distance 1 mm or less **(A)** and contact **(B)** between the root apex of the third molar and the mandibular canal *(white arrow)*, respectively.

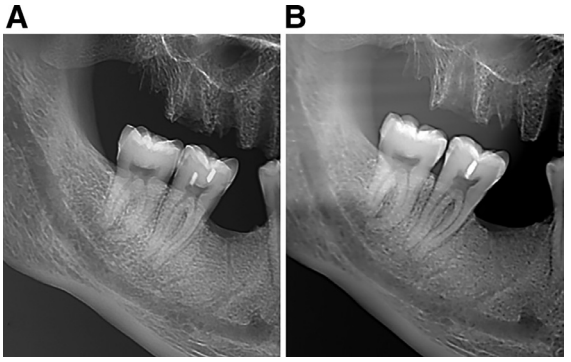

Fig. 8. Cropped panoramic radiograph shows the interproximal contact overlapping the second and third molar **(A)**. Cropped extraoral bitewing showing the distance between proximal surfaces **(B)**.

angle used.[26] However, PAN and EBW do not allow the operator to make changes in angulation in the X-ray beam. Because changes in the imaging modality of the radiographic equipment result in a change in the process of image formation, possible variations in the angulation could explain the subtle differences observed in the vertical relationship between the third molars and the mandibular canal.

Although no significant difference was found in the vertical relationship between the third molar root and the mandibular canal in PAN and EBW images, EBW had a tendency to approximate these structures. Overestimation of the anatomic proximity between the root apex and the mandibular canal may lead to a change in the treatment plan or in the performance of radiographic examinations and, consequently, affect the surgical approach or increase the radiation dose to the patient to obtain the intended diagnosis. Because of proprietary protection by the manufacturer, the authors did not have access to specific information regarding the mechanisms of EBW image formation. However, we suggest that this approximation phenomenon observed in EBW images may be related to a possible change in the shape of the image layer in comparison with that of PAN, which could lead to the relative change of mandibular positioning within it.

Table V. Horizontal relationship between the proximal surfaces of the mandibular second and third molars in the PAN and EBW images

	EBW			*Total* n (%)*
	Distant	*In contact*	*Overlapped*	
PAN				
Distant	**1**	2	1	4 (10)
In contact	2	**1**	0	3 (13.3)
Overlapped	4	5	**14**	23 (76.7)
Total	7 (23.3)	8 (26.7)	15 (50)	**30 (100)**

**P* = 0.079, according to McNemar-Bowker test.Bold numbers in the diagonal represent the cases of agreement between the imaging modalities.*EBW,* extraoral bitewing radiography; *PAN,* panoramic radiography.

With regard to the anatomic relationship between the third molars and the mandibular canal, both 2-dimensional radiographic modalities differed significantly from CBCT and showed a greater proximity between the root apices of the third molar and the mandibular canal. As CBCT provides 3-dimensional and distortion-free visualization of teeth and hard tissues, it is accepted that this imaging modality presents in a more reliable way to determine the actual spatial relationship between these structures.[23] In contrast, the rotational nature of PAN and EBW produces variable magnification in the resulting 2-dimensional image, as well as upward projection of lingually positioned structures as a result of the fixed negative angulation of the multifunctional panoramic unit.[23] Added to this, the thickness of the image layer and the positioning of the object within it can influence image formation and affect diagnoses for the third molar region. Among the radiographic modalities, PAN tended to present results slightly closer to those seen on CBCT images. A gold standard could be achieved by direct measurements between the third molars and the mandibular canal to clarify that tendency; however, for ethical reasons, we opted not to section the mandibles used in the present study.

In view of the ability of EBW to provide a better view of the posterior proximal contacts, based on improvement in the geometric projection of this region compared with PAN images, previous studies have investigated the use of EBW in the detection of interproximal carious lesions.[12-14,27] However, these studies did not observe the mesiodistal relationship between the second and third molars, whose overlapping relationship can mask carious lesions or be indicative of the presence of pathologic conditions, such as external

root resorption on the distal surface of the second molar.[24,28] Although no significant differences were found, the results suggested that EBW tended to diminish the overlapping or the distance between the proximal surfaces of the second and third molars. Thus, EBW could provide a more adequate evaluation of the mesiodistal relationship of some third molars that overlap the second molars on PAN images.

In the present study, a large FOV (12 × 8.5 cm) was used in CBCT acquisitions. This choice was made on the basis of previous reports, considering that this was an ex vivo study and that in the CBCT unit used here, FOV size (12 × 8.5 cm, or 5 × 5 cm) does not influence the evaluation of mandibular third molars and their relationship to the mandibular canal.[29] However, it is noteworthy that in clinical practice, protocols with smaller FOVs (e.g., 2 FOVs of 5 × 5 cm) are generally recommended for the evaluation of the third molars. Professionals should make that decision based on the type of CBCT unit used, the FOV sizes available in it, the image quality obtained, and the radiation dose related to the scans, to maximize the risk−benefit ratio for patients.[5] When justified, CBCT can be considered mainly for its advantages in the evaluations when compared with 2-dimensional radiography.[24,30] This highlights the importance of future studies to compare the effective doses for all imaging modalities (PAN, EBW, and CBCT).

The use of dry human mandibles in this ex vivo investigation allowed for standardization of image acquisition in both 2-dimensional radiographic modalities, and this was essential to avoid possible bias related to change of position of skull/mandibles between image acquisitions with PAN and EBW. An inherent limitation of EBW that should be highlighted is the partial visualization of the mandibular ramus, which may make it difficult to evaluate teeth and pathoses associated with this region. EBW allows for better visualization of proximal caries in posterior teeth.[11-14] This study suggests that EBW can also optimize evaluation of mandibular third molars by reducing the overlap with adjacent structures. Future studies correlating radiographic and clinical data should be conducted to verify the real effectiveness of EBW in diagnosis of third molar pathoses.

Further efforts should be made to understand the effect of mandibular positioning in the image layer in EBW image formation. This highlights the real need for manufacturers to provide more information about the new imaging modalities available on radiographic units because modifying image formation may influence a number of factors, which, when understood, may aid in the prescription of radiographic examinations. Additionally, the effective dose related to EBW examinations with different devices available on the market should be investigated to assist oral health care professionals in understanding the indications for and the proper application of these techniques to comply with optimization and radioprotection principles.

CONCLUSIONS

The relationship between the third molars and the mandibular canal appears closer on PAN and EBW images than on CBCT images. When using EBW in evaluation of the third molars, its advantages and limitations should be taken into consideration. Although EBW decreased the overlap of the proximal contact with the second molar, which may be valuable to promote a better view of conditions in this specific region, in comparison with PAN, it showed a tendency to project the dental roots closer to the mandibular canal.

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