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The effect of two enhancement tools on the assessment of the relationship between third molars and the inferior alveolar canal



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ABSTRACT

Objective: This study aims to assess the relationship between the inferior alveolar canal (IAC) and inferior third molars using digital panoramic images (DPI) with and without enhancement and compare the panoramic signs with cone beam computed tomography (CBCT) findings.

Methods: The DPIs and CBCT of 50 patients were analyzed. The DPIs were copied and enhanced using edge enhancement and an invert tool and then analyzed by two observers using the scores: darkening of the root; deflection of the root; narrowing of the root; superimposition of the root; bifurcation of the root over the IAC; diversion of the IAC; interruption of the cortex of the IAC, and no radiographic findings noted. Kappa and exact binomial tests were used to analyze the correlation between DPIs and CBCT images. The intimate relationship scores were evaluated using a *t*-test and Mann–Whitney test.

Results: The original DPIs, and the edge enhanced and invert tool images produced kappa coefficients of 0.528, 0.528 and 0.551, respectively. There was no difference among the methods evaluated in this study ($p = 0.981$).

Conclusion: Similar agreement was observed between DPIs with and without enhancement. However, panoramic radiography is not the ideal method to analyze the relationship between lower third molars and the IAC.

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1. Introduction

The surgical removal of impacted mandibular third molars is a common procedure in oral maxillofacial surgery. Studies on impacted mandibular third molar positioning and its relationship with the inferior alveolar nerve (IAN) are of high importance due to their contribution to detailed surgical planning (Flores et al., 2009). Although the risk of permanent nerve injury is low, and the overall risk of IAN injury associated with third molar extraction ranges

from 0.5 to 5%, for affected patients there is considerable dissatisfaction and morbidity (Blaeser et al., 2003).

The anatomical proximity of the roots of the mandibular third molar and the IAN increases the risk of nerve lesion during surgical procedures. Assessment of the proximity of these structures is extremely necessary and should be done using imaging techniques with a high level of accuracy, to avoid possible damage to nerve tissues (Flygare and Ohman, 2008; Jhamb et al., 2009). However, none of the imaging techniques give this information 100% of the time (Khan et al., 2011).

Panoramic radiographs have been often used for preoperative imaging before removal of impacted mandibular third molars. When there is overlap between the third molar and the inferior alveolar canal (IAC) signs of darkening of the root, or diversion of the alveolar inferior canal have been found to be significantly related to nerve injury (Suomalainen et al., 2010). The advantages of

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panoramic radiographs include low cost and wide availability, it does not fulfill the precise observation of the anatomical relationship between structures due to its two-dimensional nature and unequal magnification (Kamrun et al., 2013).

Some cases require a tridimensional view of the topographic relationship between the roots of the third inferior molar and the IAC (Gomes et al., 2008). Previous studies have shown that computed tomography (CT) and cone beam computed tomography (CBCT) used preoperatively permit a precise determination of the relationship between the inferior third molar and the IAC (Jhamb et al., 2009; Suomalainen et al., 2010; Kamrun et al., 2013). However, patients are often exposed to unnecessary radiation and the use of methods with lower doses should be encouraged.

Digital panoramic images (DPI) permit the enhancement of the original image with different enhancement tools. Studies have compared the overall quality of enhanced and non-enhanced DPI (Gijbels et al., 2000); for caries diagnosis (Akarlan et al., 2008); for visibility of anatomical structures (Yalcinkaya et al., 2006; Baksi et al., 2010) and for the diagnosis of mandibular radiolucent lesions (Raitz et al., 2012). Although image enhancement processing may increase the interpretation time, if this increases the accuracy of determination of the anatomical proximity of third inferior molar roots to the IAC, this could enhance the use of DPI in preoperative planning.

Based on what was stated above, this study aims to assess the relationship between the alveolar canal and inferior third molars using digital panoramic images with and without enhancement and compare the panoramic signs with CBCT findings.

2. Material and methods

This study was approved by the last author Institutional Review Board (protocol number 10764313.4.0000.5187) and is in compliance with the Helsinki Declaration.

DPIs and their corresponding CBCT images of 73 inferior third molars were selected from a private practice archive. Images were acquired between January 2012 and March 2013. The selected files were from 50 patients, 24 women and 26 men, with ages ranging from 18 to 77 years (mean age 45.62; SD 15.61). The majority of subjects selected for this study were referred for preoperative evaluation of impacted or partially erupted inferior third molars. Others were selected by the fact that the same subject had DPI and CBCT images taken with a maximum interval of 6 months from each other for different diagnostic reasons. The selected images should show at least one inferior third molar, with at least 2/3 of the roots completely grown (Nolla's stage 8). Images that presented lesions interfering with the inferior third molar position were also excluded.

DPIs were obtained using Kodak 9000C (Eastman Kodak, Rochester, NY, EUA) panoramic X-ray unit at 70 kV and 15 mA and stored in a tagged image file format (TIFF). Each selected DPI was copied twice, enhanced using edge enhancement and invert tools, applied with Kodak Dental Image Software 6.5 (Eastman Kodak, Rochester, NY, EUA) software and codified. The CBCT images were previously obtained using i-CAT Cone Beam 3D Imaging System (Imaging Science International, Hatfield, PA, USA) with a 20 cm × 25 cm amorphous silicon flat-panel image detector. Images were obtained at 120 kVp, 5.5 mA and a voxel size of 0.2 mm, with an exposure time of 40 s. The volumetric acquisitions were exported as digital imaging and communications in medicine (DICOM) files and saved to a portable hard disk for later reconstruction.

After the enhancement of the DPIs, the total number of DPIs – original and two group enhanced – and CBCT images to be evaluated by the observers was 292 (219 DPIs – 73 originals and 146 enhanced, and 73 CBCT volumes).

2.1. Viewing sessions

Prior to all examination sessions, verbal and practical instructions and calibration tests were performed. The DPIs, with and without enhancement, were visualized using Kodak Dental Imaging Software (Kodak Dental Systems, Carestream Health, Rochester, NY, EUA), displayed in a Sony VAIO (SVS151C1SX Intelcore i7, Windows 8) laptop with a 17.3-inch color monitor placed in a quiet room with dimmed light. The observers were only allowed to use the zoom tool.

Two experienced oral radiologists assessed all DPIs. The panoramic images (original, edge enhanced and inverted) (Fig. 1) were evaluated in random order, with a minimum interval of two days between each evaluation. The number of images evaluated per day was established by the observer's choice; however they were counseled to evaluate a maximum of 25 images, since visual fatigue can impair image evaluation. A minimum interval of fifteen days between the evaluations of the same DPI was established.

To evaluate the relationship between inferior third molars and the mandibular canal, the following signs of close relationship between third inferior molar and IAC classification was used: darkening of the root; deflection of the root; narrowing of the root; superimposition of the root; bifurcation of the root over the inferior alveolar canal; diversion of the inferior alveolar canal; interruption of the cortex of inferior alveolar canal; and no radiographic findings noted (Monaco et al., 2004; Sedaghatfar et al., 2005; Flores et al., 2009).

CBCT images were assessed by the same observers using i-CAT Workstation (Imaging Sciences International, Pennsylvania, USA), displayed in a Sony VAIO (SVS151C1SX Intelcore i7, Windows 8) laptop with a 17.3-inch color monitor placed in a quiet room with dimmed light. The CBCT images were evaluated 15 days after the panoramic images. CBCT images were three-dimensionally evaluated using two-dimensional, multiplanar, reformatted slices (axial, sagittal, coronal, panoramic, and cross-sectional images) (Fig. 2).

For the CBCT images, the anatomical relationship between the third molar and the mandibular canal was classified into two types: (1) Separation – no interruption of the canal cortical bone between the third molar root and the canal wall was recognized, so the canal does not come in contact with the tooth; and (2) Contact – interruption of the of the canal cortical bone was recognized and the canal is in contact with the tooth.

To avoid differences between the observer's ratings, when disagreement existed between them, another trained observer with 15 years' experience as an oral radiologist performed a joint assessment to reach agreement.

2.2. Data analysis

Kappa coefficient (k_w) test was used to analyze the agreement for each close relationship classification viewed in DPIs with CBCT images. An exact binominal test was used to assess k_w significance levels.

Categorical data (signs of close relationship) was analyzed using Student's *t*-test and Mann–Whitney tests, when parametric tests could not be applied. Descriptive data was also used.

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