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A comparative study of cone-beam computed tomography and conventional panoramic radiography in assessing the topographic relationship between the mandibular canal and impacted third molars

Weeraya Tantanapornkul, DDS,[a] Kiyoshi Okouchi, DDS, PhD,[b] Yoshikuni Fujiwara, DDS,[c] Masashi Yamashiro, DDS, PhD,[d] Yutaka Maruoka, DDS, PhD,[e] Naoto Ohbayashi, DDS, PhD,[f] and Tohru Kurabayashi, DDS, PhD,[g] Tokyo, Japan
TOKYO MEDICAL AND DENTAL UNIVERSITY

Objective. To evaluate the diagnostic accuracy of cone-beam CT compared with panoramic images in predicting neurovascular bundle exposure during extraction of impacted mandibular third molars.
Study design. Cone-beam CT and panoramic images of 142 impacted mandibular third molars were prospectively evaluated to assess tooth relationship to the mandibular canal. These interpretations were then correlated with intraoperative findings. The sensitivity and specificity of the 2 modalities in predicting neurovascular bundle exposure at extraction were calculated and compared. The diagnostic criterion for panoramic images was defined using multivariate logistic regression analysis.
Results. In predicting the exposure, the sensitivity and specificity were 93% and 77% for cone-beam CT, and 70% and 63% for panoramic images, respectively. Cone-beam CT was significantly superior to panoramic images in both sensitivity and specificity.
Conclusion. Cone-beam CT was significantly superior to panoramic images in predicting neurovascular bundle exposure during extraction of impacted mandibular third molar teeth. **(Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2007;103:253-9)**

The extraction of impacted mandibular third molars may cause dysesthesia due to damage to the inferior alveolar nerve. Several factors are considered to be associated with nerve dysesthesia.[1-3] It is known that the risk dramatically increases when there is direct contact between the nerve and the tooth root.[3,4] Thus, it is important to evaluate the topographic relationship between the mandibular canal and impacted third molars preoperatively. Panoramic radiographs are most commonly used for this purpose, and many researchers have reported imaging features suggestive of an intimate relationship between the 2 structures. Sedaghatfar et al.[5] recently reported a retrospective study that showed the following 4 panoramic features were significantly associated with inferior alveolar nerve exposure following third molar extraction: darkening of the root, interruption of the white line of the mandibular canal wall, diversion of the mandibular canal, and narrowing of the root. When the panoramic image is suggestive of an intimate relationship between the impacted tooth and the mandibular canal, medical CT is

[a]Postgraduate Student, Oral and Maxillofacial Radiology, Graduate School, Tokyo Medical and Dental University.
[b]Assistant Professor, Oral and Maxillofacial Radiology, Graduate School, Tokyo Medical and Dental University.
[c]Instructor, Oral and Maxillofacial Radiology, Graduate School, Tokyo Medical and Dental University.
[d]Lecturer, Maxillofacial Surgery, Graduate School, Tokyo Medical and Dental University.
[e]Lecturer, Oral Surgery, Graduate School, Tokyo Medical and Dental University.
[f]Lecturer, Oral and Maxillofacial Radiology, Graduate School, Tokyo Medical and Dental University.
[g]Professor and Chairman, Oral and Maxillofacial Radiology, Graduate School, Tokyo Medical and Dental University.
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recommended for further investigation to demonstrate the three-dimensional relationship between the 2 structures.[4,6-8] However, one obvious drawback of medical CT is the much higher radiation dose that the patient receives compared with panoramic radiography.[4,6-9] Other drawbacks are access to the modality and the higher financial costs of the procedure.

Due to the recent introduction of maxillofacial cone-beam CT, three-dimensional images are becoming more readily available for use in dental applications. The major advantages of cone-beam CT include high spatial resolution and low radiation dose. Applications such as dental implantology, endodontics, and minor oral surgical procedure have been reported.[10-14] However, the modality is relatively new and still requires systematic assessment to confirm its clinical usefulness.

The authors performed a prospective study to confirm the reliability of cone-beam CT in assessing the topographic relationship between the mandibular canal and impacted third molars. This study evaluated the diagnostic accuracy of cone-beam CT in predicting neurovascular bundle exposure following impacted mandibular third molar extraction and compared it with that of conventional panoramic images.

METHODS

The study was approved by our institutional review board, and written informed consent was obtained from all subjects.

Patients and data collection

All patients who consulted in the Oral Surgery Department of our dental hospital for extraction of impacted mandibular third molars between October 2004 and September 2005 underwent preoperative panoramic radiography. Among them, 135 patients (161 impacted teeth), of which 50 were males and 85 were females (mean age 33 years; range, 18-74 years), who underwent additional examination by cone-beam CT because of panoramic features suggesting a close relationship of the tooth root to the mandibular canal were included in this prospective study.

Before extraction, the authors explained the objectives of the study to each surgeon and asked the surgeons to report the presence or absence of neurovascular bundle exposure at the time of extraction. Surgeons were requested to carefully examine all extraction sites after irrigating, under direct vision using a headlight. Those cases in which careful investigation was impossible because of severe bleeding were recorded as "unknown" and excluded from subsequent analysis. At the appointment for suture removal approximately 7 days after extraction, all patients were asked about sensation in the chin and lip to investigate the occurrence of postoperative dysesthesia, and this outcome was recorded. The correlation between neurovascular bundle exposure at extraction and postoperative dysesthesia was assessed using the Fisher exact test.

Imaging

Digital panoramic radiographs were made using a Super Veraviewepocs (Morita Corp.) operated at 60-80 kVp and 5-10 mA with a photo-stimulate phosphor plate (ST III; Fuji Film Medical Co. Ltd., Tokyo, Japan). The plates were processed with an FCR 7000 system (Fuji Film Medical Co. Ltd.) The panoramic images were printed on a dry imaging film (DI-AL; Fuji Film Medical Co. Ltd.) with a laser imager (DRYPIX printer; Fuji Film Medical Co. Ltd.) and used for the evaluation.

As a cone-beam CT apparatus, 3DX multi-image micro CT (3DX; Morita Corp.) developed by Arai et al.[15] was used. The imaging area of 3DX is a cylinder with a height of 29 mm (240 voxels) and a diameter of 38 mm (320 voxels), providing isotropic cubic voxels with sides approximating 0.12 mm. The impacted third molars were imaged at a tube voltage of 80 kV, a tube current of 2 mA, and exposure cycle of 17 seconds. After scanning, contiguous sectional images in 3 directions, that is, parallel section (parallel to the dental arch), cross section (perpendicular to the dental arch), and horizontal section images were reconstructed from the projection data with a slice width of 1 mm. Scrolling the contiguous sectional images using dedicated 3DX software (Morita Corp.), the observers evaluated the images in each section on a CRT monitor. When necessary, the window setting was adjusted to optimize the images for evaluation.

Evaluation of images

Two oral radiologists (K.O., T.K.) evaluated the panoramic and cone-beam CT images independently for the topographic relationship between the impacted third molar and the mandibular canal. One hundred sixty-one cases were divided into 2 groups. In each group, panoramic images were first evaluated, and after 2 weeks, cone-beam CT images were evaluated. Cone-beam CT images were presented to the observers in randomized order so that they could not refer to the panoramic features. When disagreement existed between the assessments of the 2 observers, consensus was reached by discussion. Interobserver agreement was evaluated using kappa statistics.

For cone-beam CT, the presence or absence of direct contact between the tooth root and the canal contents was three-dimensionally evaluated, which was used as the diagnostic criterion in predicting neurovascular bundle exposure. It was considered that direct contact