Detection of periapical lesion development by conventional radiography or computed tomography

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Objective. The aim of this study was to detect the development of experimentally induced periapical lesions using conventional radiography and computed tomography.
Study design. The root canals of dogs' teeth were exposed to the oral environment for 7 days for contamination and then sealed for 7 days (GI), 15 days (GII), 30 days (GIII), and 60 days (GIV). Immediately after each experimental period, radiographs and tomograms were taken in order to detect the occurrence of periapical bone resorption. The periapical radiographs were digitized and areas of bone resorption were measured using the VIXWIN 2000 software. Scores were assigned to the tomograms based on the progression of periapical bone resorption. The specimens were evaluated by calibrated examiners who were blinded to the groups. The radiographic results were analyzed by ANOVA and Tukey's test ($P < .05$) and the tomographic results were analyzed by Kruskal-Wallis and Dunn's tests ($P < .05$).
Results. The radiographic evaluation did not reveal periapical lesions at the 7-day control. Lesions were radiographically visible at 15 and 30 days (47.4% and 77.8% of the cases, respectively) and presented similar dimensions ($P > .05$). At 60 days, lesions were detected in all specimens, presenting larger dimensions than those of the earlier evaluation periods ($P < .05$). The tomographic evaluation detected lesions at 7 and 15 days (32.5% and 83.3% of the cases, respectively). Lesions were detected in all specimens at the 30- and 60-day periods, when the greatest values of bone resorption were observed ($P < .05$).
Conclusions. Tomography was able to detect periapical lesion development in its initial stages, even when the lesions were undetectable radiographically. **(Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2008;106:e56-e61)**

Endodontic therapy aims to allow or to stimulate apical and periapical tissue repair. The various pathological and microbiological conditions that affect the pulp tissue, the root canal system, and the periapical tissues demand different treatment protocols. Radiographic detection of periapical alterations affects the diagnosis, prognosis, and planning of root canal therapy.[1,2]

Radiographic visualization of chronic periapical lesions emphasizes the need for bacterial elimination because of their propagation into the root canal system[3-5] and possible presence of apical biofilm on root surface.[6] Endodontic treatment of teeth with periapical lesions has a lower success rate[1] due to the numerous and often correlated microbiological and pathological implications.[7]

Radiographic evaluation is the most widely used method for detection of periapical lesions. However, periapical radiographs give 2-dimensional images of 3-dimensional structures, which somewhat restricts information regarding bone thickness, root canal anatomy, and size, extension, and location of periapical lesions.[8] Although periapical radiographs provide acceptable details on the mesiodistal plane, visualization of details on the buccolingual plane is inadequate.[9] Furthermore, bone superimposition interferes with the observation of radiolucent periapical images.[10] Accordingly, Bender and Seltzer[11,12] have reported that periapical lesions can be detected radiographically only when loss of alveolar bone is accompanied by cortical bone involvement.[11] This means that it is not possible to determine radiographically the development of a periapical lesion until resorption advances and reaches the cortical bone.

Based on the limitations of conventional radiographic images, computed tomography has been used to improve the observation of 3-dimensional bone structures[13,14] and their relationship with the adjacent anatomic structures, such as the maxillary sinus and the mandibular canal.[15,16] In endodontics, tomography has been used in the evaluation of periapical lesions, aiding in surgical planning, assessment of posttreatment re-

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Received for publication Dec 30, 2007; returned for revision Feb 29, 2008; accepted for publication Mar 14, 2008.
1079-2104/$ - see front matter

doi:10.1016/j.tripleo.2008.03.020

pair, and differential diagnosis between perforations and root fractures.[17,18]

The aim of this study was to assess the dynamics of experimentally induced periapical lesion development in dogs, comparing conventional radiography and computed tomography.

MATERIALS AND METHODS

The second, third, and fourth mandibular premolars and the second and third maxillary premolars of 4 approximately 1-year-old mongrel dogs were selected for treatment, totaling 76 roots that were assigned to 4 groups. The experimental protocols were in accordance with the Institutional Animal Experimentation Committee.

The animals were anesthetized intravenously with 3% sodium thiopental (Thionembutal; Abbott Laboratórios do Brasil Ltda., Rio de Janeiro, Brazil) and periapical radiographs of the selected teeth were taken using a custom-made film holder.[19] The same anesthetic protocol was repeated for each study procedure in the dogs.

Following the proposed study design, periapical lesions were experimentally induced within different time periods.[19] The groups were established according to the period of lesion induction after the pulp tissue had been exposed to the oral cavity for 7 days for contamination. The teeth were sealed and examined after 7 days (GI), 15 days (GII), 30 days (GIII), and 60 days (GIV).

Group IV was the first to be treated, followed by groups III, II, and I. In each animal, the 4 dental quadrants were treated according to each experimental period, in such a way that all animals had teeth belonging to all groups.

Coronal access was prepared mesially and distally on the occlusal surface of the selected teeth. After removal of coronal pulp, the pulp chamber was irrigated with saline and the root canal entrance was exposed using size 25 K-files (Dentsply Maillefer S.A., Ballaigues, Switzerland). Files were inserted into the canals and advanced until reaching the apical plateau, located approximately 1.5 mm short of the apex. Radiographs were taken to determine the working length and the root pulp was extirpated using sizes 25 and 30 Hedströem files (Dentsply Maillefer S.A.). The root canals were left open for 7 days to allow contamination. Thereafter, a cotton pellet was placed in the pulp chamber and the coronal access was sealed with fast-setting zinc oxide–based cement (Pulposan, S.S.White, Rio de Janeiro, Brazil).

From every tooth, new periapical radiographs were taken, using a Heliodent x-ray unit (Siemens, Malvern, PA) set at 60 Kvp, 10 mA, and 0.4-second exposure. In order to obtain standardized radiographs, the custom-made film holder was used[19] and films were processed in an automated processor (DenTX 9000; Dent-X, Elmsford, NY).

All groups were also submitted to spiral computer tomographic analysis (Elscint Helicat II tomograph, Haifa, Israel).

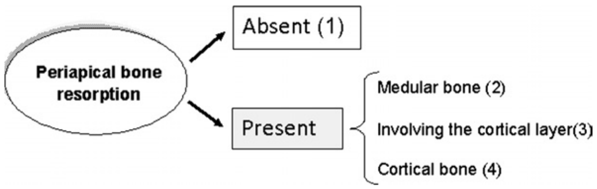

Fig. 1. Schematic representation of the evaluation method in the computed tomographic analysis.

Method of radiographic analysis

Radiographs were digitized using a scanner (Snap Scan 1236; Agfa-Gevaert N.V., Martsel, Belgium) and the images were saved as TIFF files with 600-dpi resolution using Adobe Photoshop software version 6.0 (Adobe Systems Inc., San Jose, CA). Next, the digital images were imported into the VixWin 2000 software, version 1.2 (Gendex Dental Systems, Lake Zurich, IL) and the contour of the periapical lesion, when present, was outlined on the computer monitor. The images were imported into the VixWin software and the program was calibrated with the aid of a scale of known values (in mm). Following software calibration, lesions were outlined with the cursor and the values obtained in pixels were automatically converted to square millimeters (mm^2). Images were analyzed by 3 calibrated examiners (1 radiologist and 2 endodontists) blinded to the groups. Intra- and intergroup evaluations were performed. The obtained mean values were registered.

Method of tomography evaluation

Tomographic sections (1.0-mm thick, buccolingual orientation) of the areas of interest (upper and lower bicuspids) were obtained at 90 kV and 150 mAs and observed on the monitor screen. The images were analyzed by 3 calibrated examiners (1 radiologist and 2 endodontists) blinded to the groups. Intra- and intergroup evaluations were performed.

Scores were attributed to each area, according to the extension of the bone resorption (Fig. 1): absence of periapical bone resorption (score 1); medular bone resorption (score 2); medular resorption with cortical involvement (score 3); and cortical bone resorption (score 4).