Change in Periapical Lesion and Adjacent Mucosal Thickening Dimensions One Year after Endodontic Treatment: Volumetric Cone-beam Computed Tomography Assessment

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Abstract

Introduction: Changes in periapical lesion dimensions along with mucosal thickening after endodontic treatment have not been studied yet. Therefore, the objectives of this study were (1) to obtain linear and volumetric measurements of lesion dimensions in maxillary first molars with periapical pathology and (2) to measure maxillary sinus mucosal thickening in the vicinity of periapical lesions before and 1 year after endodontic treatment by using cone-beam computed tomography (CBCT). **Methods:** Twenty-one maxillary first molar teeth of 21 patients (14 female and 7 male) with periapical lesion that had local mucosal thickening in the vicinity of the periapical lesion were endodontically treated. A total of 21 maxillary first molar roots (8 mesiobuccal roots, 6 distobuccal roots, and 7 palatal roots), each one from different patients, was included. Pretreatment and 1-year post-treatment CBCT images of each tooth were obtained by using Kodak CS 9300 3D CBCT unit. Width, height, surface area, and volume measurements of periapical lesions and mucosal thickening of the maxillary sinus mucosa in the vicinity of the periapical lesion were measured before and 1 year after endodontic treatment. General linear model (analysis of variance) was used for the comparisons between measurements, and significance was set at $P < .05$. Regression analysis was also used to test the correlation between different measurements. **Results:** We found statistically significant differences between mean pretreatment and mean post-treatment measurements conducted by using CBCT images (width, $P = .002$; height, $P < .001$; maximum mucosal thickening, $P < .001$; medium mucosal thickening, $P < .001$; minimum mucosal thickening, $P < .001$; surface area, $P = .032$; and volume, $P = .034$). Considering gender, age, and root-type variables, no significant differences were found for all the measurements conducted ($P > .05$). There were 36%, 41%, 53%, 54%, 53%, 73%, and 75% mean reductions in lesion width, lesion height, maximum sinus mucosal thickness, medium sinus mucosal thickness, minimum sinus mucosal thickness, lesion surface area, and lesion volume, respectively, before and 1 year after endodontic treatment. Regression analysis of pretreatment lesion volume versus percentage of post-treatment lesion volume change revealed a low regression coefficient (R^2 = 16.7%, $P > .05$), showing a weak linear relationship. **Conclusions:** CBCT assessment of changes in periapical lesion and mucosal thickening dimensions may reveal useful information regarding endodontic treatment success. *(J Endod 2017;43:218–224)*

Key Words

CBCT, mucosal thickening, periapical lesion

Significance

Three-dimensional radiologic quantitative assessment of periapical lesion dimensions can provide useful information for the diagnosis, differentiation, and treatment of periapical pathology. By using CBCT, this study provided useful information regarding measurements of lesion dimensions in maxillary first molars with periapical pathology and maxillary sinus mucosal thickening in the vicinity of periapical lesions before and 1 year after endodontic treatment.

Radiologic detection of periapical pathology is clinically important in enabling the endodontist to provide immediate and appropriate dental treatment (1). In addition, radiologic quantitative assessment of periapical lesion dimensions can provide useful information for the diagnosis, differentiation, treatment plan, and revision of periapical disease (2). The prognosis of the endodontic treatment is affected by the presence, true size, location, and duration of pathology along with the ability of the material used to fill in the root canals (2). When measured by radiographic criteria, success is higher when teeth are endodontically treated before radiographic signs of periapical disease are detected (2). Two-dimensional intraoral periapical radiography is able to provide only limited information regarding the origin, size, and location of periapical lesions especially in maxillary molars because of super-

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imposition of adjacent structures such as the palatal root or the zygomatic bone (3–5). Therefore, periapical radiographs are incapable of detecting early stages of periapical lesions, and the actual size of lesions is generally larger than their appearance in periapical radiographic images (4, 5). Periapical lesions may eventually lead to bone and tooth loss, making it essential to find more effective and objective methods to quantify periapical pathology for diagnosis, treatment, and follow-up (1, 2).

The use of cone-beam computed tomography (CBCT) in endodontics is increasing rapidly owing to the high demand for a three-dimensional technique that can better address a variety of specific dental tasks with the advantages of lower effective radiation dose and cost, easier dental image acquisition, and higher-definition tooth images when compared with medical computed tomography (6). Units with small fields of view (FOVs) offering high-resolution images of teeth and related structures were specifically recommended in the diagnosis of dental periapical pathosis in patients who present with contradictory or nonspecific clinical signs and symptoms, in those who have poorly localized symptoms associated with an untreated or previously endodontically treated tooth with no evidence of pathosis identified by conventional imaging, and in cases where anatomic superimposition of roots or areas of the maxillofacial skeleton are required to perform task-specific procedures (3). CBCT has the ability to detect periapical pathosis before it is apparent on periapical radiography, with the advantage of three-dimensional assessment (3, 7). In addition, CBCT imaging provided highly accurate and reproducible measurements of periapical lesions (2).

Unlike the other paranasal sinuses, the maxillary sinuses are often present on CBCT images, even when a small FOV is used for maxillary posterior image capture, and their assessment can be detrimental for diagnosis and treatment planning. Maxillary sinus inflammation may also have a dental focus, and these can be radiographically diagnosed and treated as well (8). No mucosal thickening detected on CBCT images or uniform thickening less than 2 mm is considered as normal sinus. It is also well-known and accepted that a tooth with periapical pathology may cause mucosal thickening of maxillary sinus that is limited to the area of the tooth in question. The tooth most frequently associated with odontogenic sinusitis is the first molar, and the most frequently associated root is the first molar palatal root (9). It has been proven that mucosal thickening in the vicinity of teeth with periapical pathology is more pronounced than that of teeth without periapical pathology (10).

To the best of our knowledge, changes in periapical lesion and adjacent mucosal thickening dimensions after endodontic treatment have not been studied yet. Therefore, the purpose of this study was 2-fold:

1. To obtain linear and volumetric measurements of lesion dimensions in maxillary first molars with periapical pathology and
2. To measure maxillary sinus mucosal thickening in the vicinity of periapical lesions before and 1 year after endodontic treatment by using CBCT.

Materials and Methods

Ethical approval for the present study was obtained through Başkent University Ethical Committee, Ankara, Turkey (D-KA15/9). Patients were asked to sign an informed consent before the treatment.

Twenty-one maxillary first molar teeth (11 left and 10 right molars) of 21 patients (14 female and 7 male) with periapical lesion that had local mucosal thickening $\geq$ 2 mm (defined by Maillet et al [9]) in the vicinity of the affected root and without prior endodontic treatment were treated by an experienced endodontist (10 years of clinical experience). A total of 21 maxillary first molar roots (8 mesiobuccal roots, 6 distobuccal roots, and 7 palatal roots), each one from different patients, was included in the present study. The mean age of patients was 34.05 years (women, 33.79 years; range, 25–46; men: 34.57 years; range, 18–52). Patients with sinonasal disease and who had operation from the maxillary sinus region were not included in the study. All teeth presented negative responses to cold test and electric pulp tester.

During endodontic treatment, antiseptic conditions were provided. Tooth, clamp, and surrounding parts of the rubber dam were cleaned with 30% hydrogen peroxide. After proper coronal access, working length was determined by using apex locator Root ZX (J. Morita Corp, Kyoto, Japan). Tooth was prepared following the technique recommended by the manufacturer: SX files in the cervical third of the root canal and S1, S2, F1, and F2 files up to the working length. The canals were instrumented with 2.5% sodium hypochlorite and irrigated with 2 mL of the same solution each time after the 3 pecking motions until reaching the working length. The final irrigation was performed with 1 mL 17% EDTA for 1 minute and a final rinse with 2 mL 2.5% sodium hypochlorite with a 30-gauge NaviTip needle (Ultradent Products Inc, South Jordan, UT). Root canals were dried with absorbent paper points, and then they were dressed with $(CaOH)_2$ medicament. After 2 weeks when all symptoms disappeared, root canals were finally obturated with single cone gutta-percha (ProTaper) and AH Plus sealer (Dentsply, Maillefer, York, PA). Finally, coronal restorations were performed by using composite restorative materials.

Pretreatment and 1-year post-treatment CBCT images of each tooth were obtained by using CMOS flat panel detector with small FOV (50 mm $\times$ 50 mm) Kodak CS 9300 3D (Carestream Health Co, Rochester, NY) unit. The imaging parameters were set at 80 kVp, 8 mA, 12 seconds, and 0.09 mm voxel size with 628 mGy.cm^2 dose area product value. Images were viewed by an experienced dentomaxillofacial radiology specialist (16 years of experience) in a dimly lit room on a 15.6-inch laptop monitor (F75 5-3D350, Qosmio; Toshiba, Tokyo, Japan) at a screen resolution of 1920 $\times$ 1080 and 32-bit color depth. A separate calibration session that used images of 1 patient who was not included in the study was performed before all measurements. By using inbuilt software (Kodak Imaging Software CS 3D Imaging V 3.5.7; Carestream Health Inc), linear dimensions of periapical lesions along with neighboring maxillary sinus mucosal thickening were recorded in millimeters before endodontic treatment and 1 year after endodontic treatment. Maximum width and height measurements of periapical lesions in the axis of roots on multi-planar reformatted sagittal CBCT images were measured twice, and an average was calculated. In addition, on the same sagittal sections, mucosal thickening of the maxillary sinus mucosa in the vicinity of the periapical lesion was measured from the most mesial part of the periapical lesion to the most distal part of the periapical lesion on 3 points (most mesial, most distal, and at the center of these 2 points). Maximum, medium, and minimum values of these 3 measurements were recorded. Measurements were performed twice, and an average was taken at each point. Maximum, medium, and minimum sinus thickening values were measured and recorded perpendicular to the sagittal width of the periapical lesion (Fig. 1). Figure 1 shows representative linear measurements of width and height of periapical lesion along with sinus mucosal thickening by using dedicated software (Kodak Imaging Software CS 3D Imaging V 3.5.7; Carestream Health Inc) on sagittal CBCT image.

For volumetric and surface area measurements, axial CBCT images of 21 teeth were exported as DICOM images into vector-based segmentation technology software (3D DOCTOR; Able Software Corp, Lexington, MA). This ensured detailed slice-by-slice segmentation of the