Reliability and Reproducibility of Manual and Automated Volumetric Measurements of Periapical Lesions

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Abstract

Introduction: The present study aimed to test the reliability and reproducibility of 2 methods: manual and automated segmentation (using a threshold-based region growing algorithm) for measuring the volume of periapical lesions. **Methods:** A total of 43 cone-beam computed tomographic scans (14 men and 29 women, mean age of 54.6 ± 8.5 years) were analyzed by 3 observers. Intraobserver reproducibility and interobserver reliability were assessed using the intraclass correlation coefficient. Parametric correlation between manual and automated volumetric measurements was performed. In addition, the Student *t* test was also used to compare the mean time required for manual and automated volumetric measurements. **Results:** Automated segmentation showed slightly higher intraclass correlation coefficient values for all observers. A strong significant correlation was found between manual and automated volumetric measurements performed by the 3 observers. A significant difference in the mean procedure time was also found between both methods ($P = .001$). **Conclusions:** Within the limitations of this study, the present results suggest that automated segmentation with a region growing algorithm is faster and slightly more reliable to calculate the volume of periapical lesions. *(J Endod 2015;41:1555–1559)*

Key Words

Cone-beam computed tomography, periapical lesions, region growing, segmentation, volumetric measurements

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Epidemiologic assessments reveal that more than 30% of endodontically treated teeth present periapical lesions (PLs) (1). Radiographic follow-up is essential to assess lesion size progression and may indicate success or failure of endodontic treatment (2, 3). In this regard, volumetric measurements of the lesion volume (namely segmentation) assessed with cone-beam computed tomographic (CBCT) imaging are more reliable in detecting PLs than periapical radiographs (4–6) because the CBCT method provides multiplanar reconstruction, thus eliminating the superimposition of structures.

The accuracy of CBCT imaging in measuring osteolytic lesion volume was assessed in several studies (6–9). Ahlowalia et al (7) compared the accuracy of CBCT imaging with micro–computed tomographic imaging in measuring irregular-shaped cavities created in bovine bone. They concluded that CBCT imaging is an accurate method, comparable with micro–computed tomographic imaging, to evaluate artificially created bone cavities and suggested that it may be a valuable tool in conducting endodontic follow-up. Liang et al (6) found a strong correlation between the real volume (obtained by a silicone impression) of artificially created bone defects and CBCT volume measurements.

Therefore, the ability to measure the volume of a lesion intraosseously has an important application in endodontics because it can provide stronger evidence about volume changes and, indirectly, about the healing rate. Furthermore, recent medical articles have evaluated automatic and semiautomatic segmentation methods performed by thresholding algorithms, which could expedite the diagnostic procedure (10–12). However, the application of this method for osteolytic lesions of the jaw could not be found in the literature.

Despite some studies showing the accuracy of CBCT volume measurements, to our knowledge, little is known regarding differences in precision and accuracy between manual and automated segmentation methods. Thus, the aim of this study was to test the reliability and reproducibility of measuring the volume of PLs with manual and automated segmentation.

Materials and Methods

Approval was obtained from the ethics committee of the University of São Paulo, São Paulo, Brazil. All patients willing to participate in this study signed an informed consent form. The guidelines of the Helsinki Declaration were followed in this investigation.

Inclusion and Exclusion Criteria

This retrospective study was conducted on CBCT scans collected from the archives of the dental clinic of this study. Indications for taking CBCT examinations include planning future oral surgeries, diagnosing pathologic conditions, and assessing 3-dimensional (3D) information on bone-grafted areas or alveolar bone defects. All patients included had at least 1 PL. All CBCT examinations were taken between February 2010 and June 2013.

The presence of large beam-hardening artifacts caused by dental implant bodies and metallic crowns around the teeth with PLs were considered exclusion criteria.

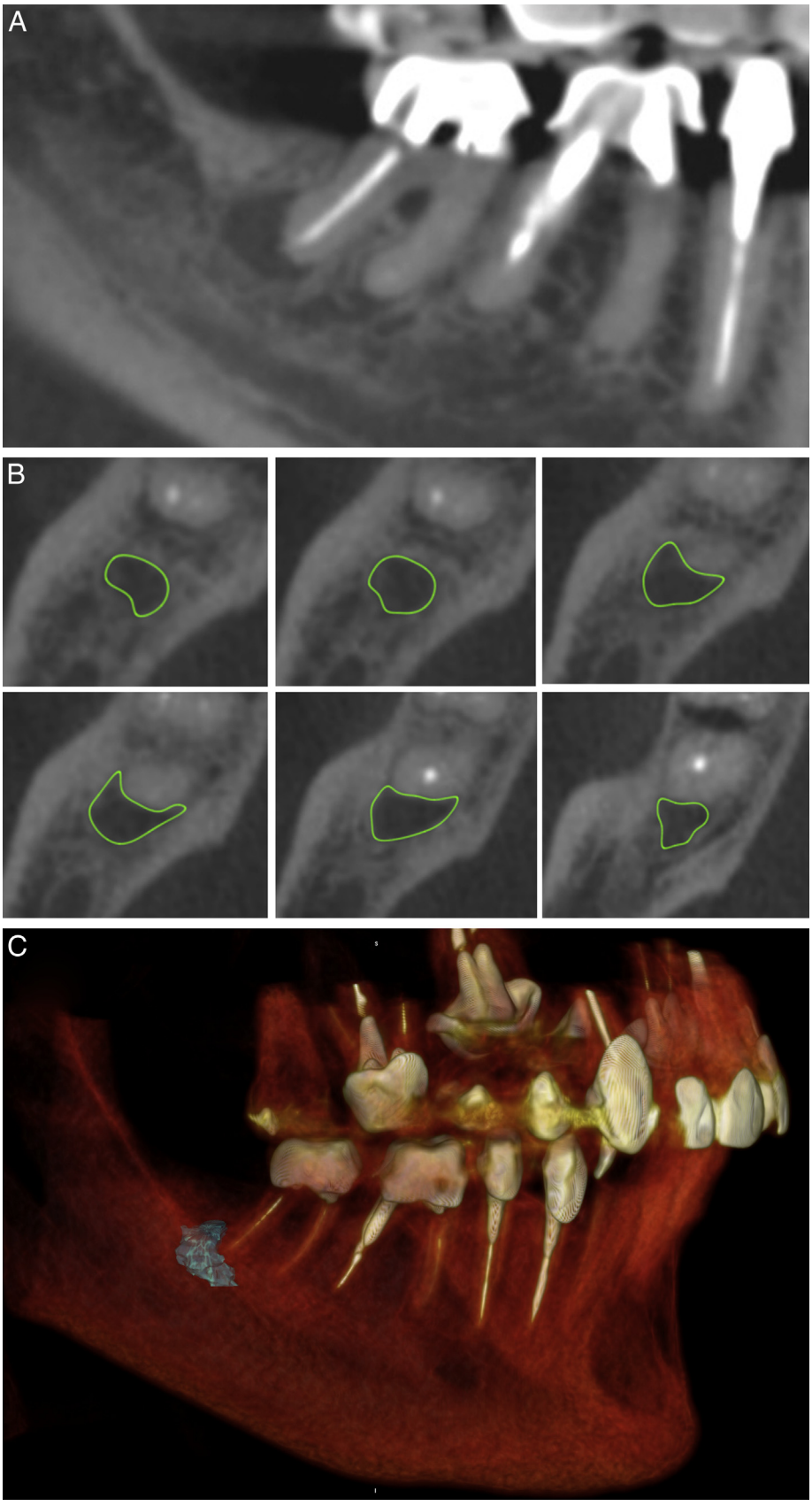

Figure 1. Manual segmentation method. (*A*) A coronal panoramic view of a PL in the distal root of the right lower molar. (*B*) A PL outlined in the axial CBCT cuts. (*C*) Volume calculation output.