Influence of Size and Volume of Periapical Lesions on the Outcome of Endodontic Microsurgery: 3-Dimensional Analysis Using Cone-beam Computed Tomography

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Abstract

Introduction: The purpose of this study was to examine the size, volume, and other parameters of preoperative periapical lesions measured from cone-beam computed tomographic (CBCT) images as potential prognostic factors in endodontic microsurgery. **Methods:** A clinical database was searched for patients who had received endodontic microsurgery with preoperative CBCT examination between March 2010 and December 2014. The CBCT images were analyzed with the OnDemand3D software program (Cybermed, Seoul, South Korea). The mesiodistal (L_x), apicocoronal (L_y), and buccolingual (L_z) diameter and the volume (V) of the periapical lesions, destruction of the cortical bone, and height of the buccal bone plate (L_b) were measured independently by 2 examiners. The outcome was classified as a success or failure based on the clinical and radiographic evaluation at least 1 year after the operation. Univariate analyses using the chi-square or Fisher exact test were performed to show the correlation of the outcomes with variables to identify the potential predisposing factors. Multivariate analysis using a logistic regression model was performed with the associated variables. **Results:** Ninety-five cases were evaluated after a period of at least 1 year, and 2 were extracted before the 1-year follow-up. The interexaminer agreements were excellent for the linear and volume measurement of the preoperative periapical lesion. A lesion volume above 50 mm^3 was found to be a significant negative predictor in the univariate analysis (P = .028) and the logistic regression model (P = .038). **Conclusions:** Within the limitations of this study, the volume of the preoperative periapical lesion had a significant effect on the outcome of endodontic microsurgery. It is suggested that further studies on endodontic microsurgery should be performed and that quantitative measurements using CBCT imaging may be useful for the analyses. *(J Endod 2016;42:1196–1201)*

Key Words

3-Dimensional analysis, cone-beam computed tomography, endodontic microsurgery, outcome, periapical lesion, prognostic factor, quantitative measurement, volume of lesion

Significance

Quantitative linear and volumetric measurements of the preoperative periapical lesions were performed using CBCT images. Within the limitations of this study, the volume of the lesion had a significant effect on the outcome of endodontic microsurgery; periapical lesions with a volume above 50 mm^3 were significantly associated with failures. With regard to the treatment of large periapical lesions, the use of graft materials could be considered.

In recent years, endodontic microsurgery including the use of high-power illumination and magnification, ultrasonic root-end cavity preparation, and biocompatible root-end filling material has presented favorable outcomes with a success rate of approximately 90% (1, 2). There have been several studies investigating prognostic factors affecting the outcome of endodontic microsurgery, and a considerable number of studies included the size of the preoperative periapical lesion as a variable. Theoretically, in large periapical lesions, proliferation of fibroblasts from the periosteum into the bone defect may result in scar tissue formation instead of osseous regeneration after the surgery (3), leading to a lower chance of healing. However, this process is not yet fully understood because several other cellular and molecular factors are related to wound healing (4). In a few studies, better outcomes were reported with smaller lesions; however, the differences were not statistically significant (5–7). In other studies, the outcome was not correlated with the size of the periapical lesion (8–10). Widening the scope to traditional apical surgery, some authors noted that the size of the lesion was related to the outcome (11, 12); however, opposite results were reported as well (13, 14).

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0099-2399/$ - see front matter

http://dx.doi.org/10.1016/j.joen.2016.05.006

TABLE 1. Exposure Parameters of Cone-beam Computed Tomographic Units Used for Preoperative Examinations

Machine type	Mode	Voxel size (mm^3)	Voltage, current, and exposure time	Field of view (mm^2)	Dimension (mm^3)
Alphard*	D	0.1	80 kV, 8 mA, 17 s	51 × 51	512 × 512 × 512
	I	0.2	80 kV, 8 mA, 17 s	102 × 102	512 × 512 × 512
	P	0.3	80 kV, 5 mA, 17 s	154 × 154	512 × 512 × 512
Rayscan Symphony†		0.278	80 kV, 10 mA, 19.5 s	142 × 97	512 × 512 × 108
		0.38	90 kV, 10 mA, 19.5 s	142 × 97	376 × 376 × 256

*Alphard 3030; Asahi Roentgen Ind Ltd, Kyoto, Japan.
†Rayscan Symphony; Ray Ind Ltd, Suwon, Korea.

Periapical radiographs have been commonly used to evaluate the size of periapical lesions. However, periapical radiographs have the following limitations because the information is rendered in only 2 dimensions: a periapical lesion can only be detected in the radiograph when the mineral loss of bone reaches 30%–50%, the buccolingual extension of the lesion cannot be determined with radiographs, and it is difficult to interpret the radiograph when the lesion overlaps with neighboring anatomic structures or the background pattern is complex (15). Some investigators have made efforts to measure the exact dimensions of bone defects during surgical procedures (16, 17); they could gauge the bone defect directly without any disturbance. However, the measurement indicated the postoperative size of the lesion—not the preoperative value—because the measurement was performed after the osteotomy and apical root resection. A postoperative lesion would be larger than a preoperative one, and the postoperative dimension of the bone defect could be affected by the operator's surgical technique. Therefore, the measurements were not necessarily representative of the size of the original periapical lesions.

Currently, cone-beam computed tomographic (CBCT) imaging is often used for diagnosis and treatment planning in surgical endodontics. Studies indicate that CBCT images can provide clinically relevant information not found in periapical radiographs such as the relationship of the root apex to neighboring anatomic structures; root morphology; bony topography; the number of root canals; and the true size, location, and extent of the periapical lesion (18, 19). In the studies that compare the abilities of periapical radiography and CBCT imaging in detecting periapical lesions, it was found that CBCT imaging could identify more periapical lesions than periapical radiographs *in vitro* (20, 21) as well as *in vivo* (22, 23).

Despite the previously described advantages of CBCT imaging, the correlation between 3-dimensional measurements of the periapical lesion and the outcome of endodontic microsurgery has not been sufficiently addressed. Therefore, the purpose of this study was to examine the size, volume, and other parameters of preoperative periapical lesions measured from CBCT images as potential prognostic factors in endodontic microsurgery.

Materials and Methods

This study was approved by the Yonsei University Committee for Research on Human Subjects (2-2015-0065) and carried out in the Microscope Center of the Department of Conservative Dentistry, Yonsei University College of Dentistry and Dental Hospital, Seoul, South Korea. A clinical database was searched for patients who had received endodontic microsurgery between March 2010 and December 2014 performed by a single operator (E.K.). All surgeries were performed in an operating room using an operating microscope (OPMI pico; Carl Zeiss, Göttingen, Germany) as described in a previous study (24). The root-end cavity was filled with calcium silicate cement. The records of each patient were reviewed, and the eligibility for this retrospective study was assessed on the basis of the inclusion and exclusion criteria.

The inclusion criteria were as follows:

1. Endodontic microsurgery cases with preoperative CBCT images
2. Roots with isolated lesions
3. Lesions without apicomarginal communications

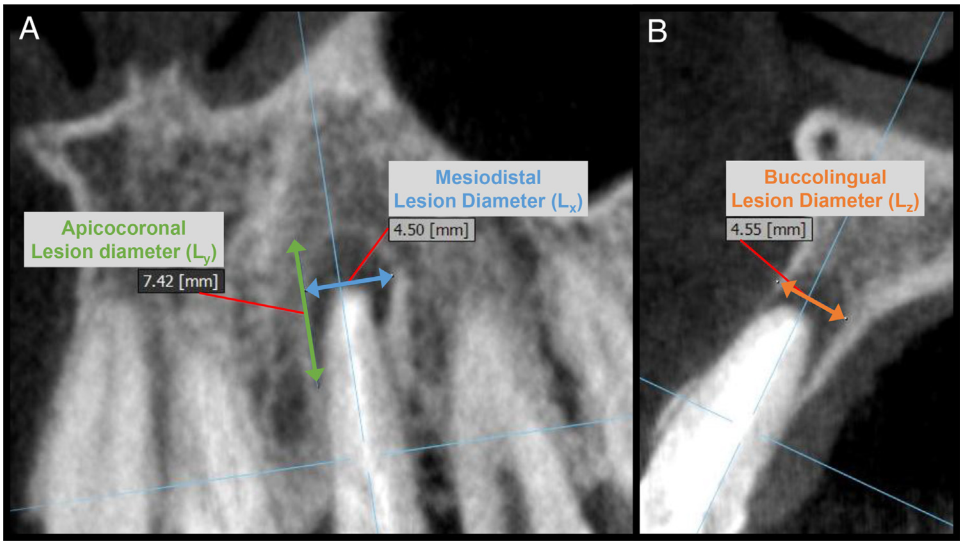

Figure 1. (*A* and *B*) Measurement of the diameter of the lesion.