

Changes of Root Length and Root-to-Crown Ratio after Apical Surgery: An Analysis by Using Cone-beam Computed Tomography

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Abstract

Introduction: Apical surgery is an important treatment option for teeth with post-treatment periodontitis. Although apical surgery involves root-end resection, no morphometric data are yet available about root-end resection and its impact on the root-to-crown ratio (RCR). The present study assessed the length of apicectomy and calculated the loss of root length and changes of RCR after apical surgery. **Methods:** In a prospective clinical study, cone-beam computed tomography scans were taken preoperatively and postoperatively. From these images, the crown and root lengths of 61 roots (54 teeth in 47 patients) were measured before and after apical surgery. Data were collected relative to the cemento-enamel junction (CEJ) as well as to the crestal bone level (CBL). One observer took all measurements twice (to calculate the intraobserver variability), and the means were used for further analysis. The following parameters were assessed for all treated teeth as well as for specific tooth groups: length of root-end resection and percentage change of root length, preoperative and postoperative RCRs, and percentage change of RCR after apical surgery. **Results:** The mean length of root-end resection was 3.58 ± 1.43 mm (relative to the CBL). This amounted to a loss of 33.2% of clinical and 26% of anatomic root length. There was an overall significant difference between the tooth groups ($P < .05$). There was also a statistically significant difference comparing mandibular and maxillary teeth ($P < .05$), but not for incisors/canines versus premolars/molars ($P = .125$). The mean preoperative and postoperative RCRs (relative to CEJ) were 1.83 and 1.35, respectively ($P < .001$). With regard to the CBL reference, the mean preoperative and postoperative RCRs were 1.08 and 0.71 (CBL), respectively ($P < .001$). The calculated changes of RCR after apical surgery were 24.8% relative to CEJ and 33.3% relative to CBL

($P < .001$). Across the different tooth groups, the mean RCR was not significantly different ($P = .244$ for CEJ and 0.114 for CBL). **Conclusions:** This CBCT-based study demonstrated that the RCR is significantly changed after root-end resection in apical surgery irrespective of the clinical (CBL) or anatomic (CEJ) reference levels. The lowest, and thus clinically most critical, postoperative RCR was observed in maxillary incisors. Future clinical studies need to show the impact of resection length and RCR changes on the outcome of apical surgery. (*J Endod* 2015;41:1424–1429)

Key Words

Apical surgery, cone beam computed tomography, root-end resection, root length, root-to-crown ratio

Apical surgery is a treatment option to maintain teeth with recurrent periapical pathology. The development of microsurgical principles has revolutionized the technique of apical surgery and has contributed to higher success rates of the modern technique compared with the traditional technique (1–3). Although the main objective of apical surgery is to control bacterial reinfection from the root canal system and/or to remove extraradicular pathogens and altered tissues (4–6), other factors may jeopardize the prognosis of apical surgery. One important aspect of apical surgery is the removal of the root tip by resection. The goal of cutting the root end is to eliminate the complex apical ramifications of the root canal system. Root-end resection also creates a flat surface for root-end inspection and management. Furthermore, apicectomy simplifies the debridement of the pathologic tissue, in particular at the lingual aspect of the root end, thus allowing for a better control of hemostasis and improving visibility.

An anatomic study of the root apex suggested that at least 3 mm of the root end must be removed to reduce 98% of the apical ramifications and 93% of the lateral canals (7). Teeth with long posts or screw-retained cores or short roots requiring surgery or re-surgery may necessitate alteration to the length of root-end resection.

As a consequence of root-end resection, the root-to-crown ratio (RCR) or crown-to-root ratio (CRR), respectively, is altered. Both ratios are used in the literature; studies about the anatomic root length preferably use the term *RCR*, whereas prosthodontic articles mostly refer to the term *CRR*. The CRR is one of the primary variables in the evaluation of the suitability of a tooth as an abutment for a fixed or removable partial denture (8). In a clinical study evaluating 100 treated periodontal patients under maintenance care for 5 years, an unsatisfactory CRR resulted in a worse initial prognosis (9).

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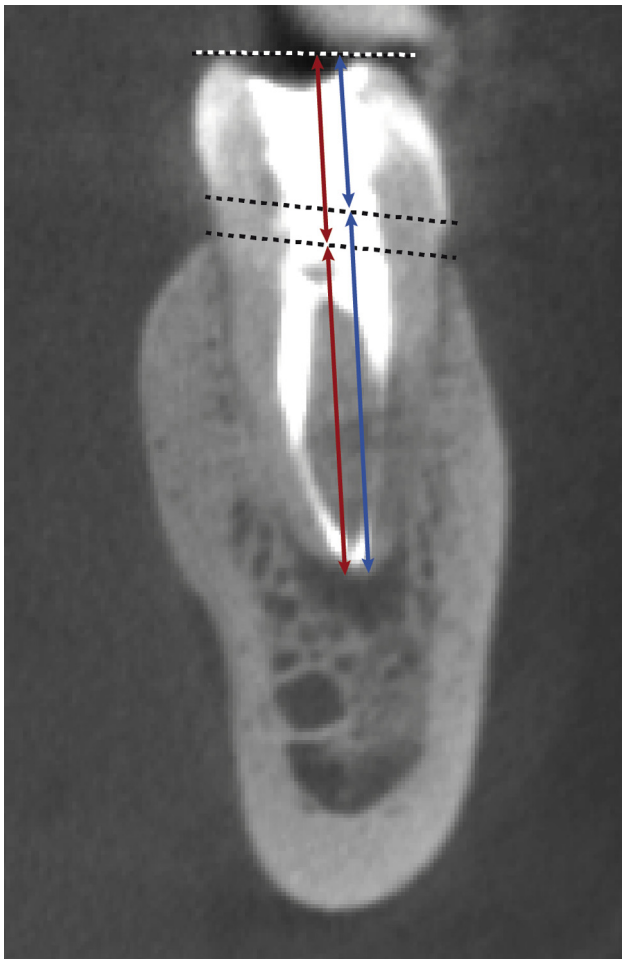


Figure 1. CBCT scan (coronal plane) showing preoperative measurements of CLs and RLs in mesial root of mandibular first molar. *Dotted lines* represent the reference lines. *Blue arrows* indicate CL and RL to level of CEJ. *Red arrows* indicate CL and RL to CBL.

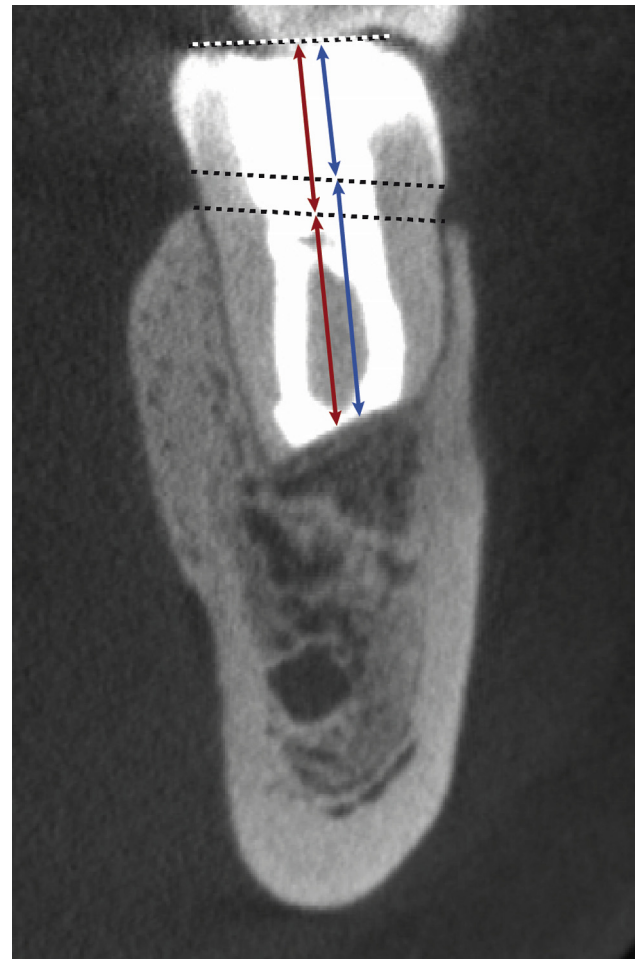


Figure 2. CBCT scan (coronal plane) taken 1 year after apical surgery showing postoperative measurements of CLs and RLs in the same root (as in Fig. 1). *Dotted lines* represent the reference lines. *Blue arrows* indicate CL and RL to level of CEJ. *Red arrows* indicate CL and RL to CBL.

In teeth with periodontal destruction and loss of marginal bone support, root-end resection may also compromise the periodontal support of such teeth. However, a recent review article has pointed to the fact that apical attachment loss after apical surgery is minimal because of the root configuration and cannot be compared directly with the clinical importance of attachment loss in the crestal area (10). A finite element analysis has evaluated the influence of root-end resection on the biomechanical response of a single-rooted tooth (11). The study reported that apical root resection did not significantly alter stress distribution and tooth displacement until it reached 6 mm. The authors concluded that 3 mm of apical root resection appeared to be mechanically acceptable. However, no clinical or radiographic studies have determined the length of root-end resection and its possible role for the prognosis of apical surgery.

The objective of the present study was to evaluate the length of root-end resection and to calculate the change of RCRs after apical surgery by using preoperative and postsurgical cone-beam computed tomography (CBCT).

Materials and Methods

Sixty-two consecutively treated patients with first-time apical surgery were enrolled in this prospective clinical study that had been approved by the Institutional Review Board (Ethic Committee of Canton

Bern/Switzerland, approval number KEK-BE 098/11) (12). Patients had been fully informed about the procedure including imaging methods, treatment alternatives, and follow-up appointments according to the Declaration of Helsinki. They signed consent forms before inclusion into the study. Patients had the right to withdraw from the study at any time.

At the initial appointment, the tooth to be treated was clinically and radiographically examined including periapical radiography and CBCT imaging with a dentoalveolar field of view (FOV) (13).

TABLE 1. Reasons for Patient Dropouts (*n* = 15)

Study population	<i>n</i>	<i>N</i>
Initial cohort		62
Resurgery cases	4	
No CBCT taken after 1 y	8	
Patient denied CBCT after 1 y	3	
Patient pregnant, no CBCT taken after 1 y	1	
Patient could not be contacted for 1-y examination	1	
Patient did not want to come for 1-y examination	2	
Patient had died before 1-y examination	1	
Insufficient image quality for measuring	3	
Subtotal (dropouts)	15	
Final cohort		47

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