Prognosis of the endodontic treatment according to the apical periodontitis lesion size: a case-control study

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Abstract

Objective: This case-control study compared the outcome of the nonsurgical root canal treatment/retreatment of teeth with small and large apical periodontitis lesions. Other factors associated with the outcome of the treatment of teeth with apical periodontitis were also assessed.
Methods: Ninety-six patients (48 cases and 48 controls) were selected from 240 treated teeth from 206 individuals, and paired for age and tooth type. An experienced operator treated all teeth over a period of 23 years. Cases were treated/retreated using irrigation with 2.5% sodium hypochlorite. The clinical and radiographic outcome was classified as healed, healing or diseased. Healed cases were considered as success and diseased cases were considered as failures. Healing cases consisted of teeth with lesions that decreased in size and were regarded as failure in a rigid criterion or as success in a lenient criterion.
Results: Overall, 62.5% of the cases were classified as healed, 28% as healing, and 9% as diseased. In the lenient criterion, the success rates in teeth with small and large lesions were 91.7% and 89.6%, respectively ($P > .05$). In the rigid criterion, the success rate was the same for both conditions (62.5%). Logistic regression analysis showed that history of a previous abscess significantly affected the outcome ($P < .05$).
Conclusions: The size of apical periodontitis lesion did not impact the outcome of the endodontic treatment when performed by the same experienced operator.

Key words: apical periodontitis; root canal treatment; outcome; case-control study

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Introduction

Apical periodontitis is caused by bacterial infection of the root canal system (Sundqvist 1976). This disease is characterized by an inflammatory response to bacteria leaving the canal via apical and lateral foramina and typically results in bone resorption around the root apex. It has been demonstrated that the larger the apical periodontitis lesions, the more complex and diverse the endodontic microbiome (Sundqvist 1976, Byström et al. 1987, Siqueira et al. 2007, Amaral et al. 2022). Bacterial biofilms have been found in higher prevalences in the apical canal of teeth with large lesions (Ricucci & Siqueira 2010). The occurrence of a complex microbiome usually organized in biofilms makes infection control more difficult in teeth with large apical periodontitis lesions. In addition, large lesions are usually cysts and there is some belief that these pathologic entities do not heal after nonsurgical treatment (Nair 1998), which has been strongly refuted by current evidence (Lin et al. 2009, Ricucci et al. 2020).

Cohort studies have showed the impact of preoperative apical periodontitis presence and size on the outcome of nonsurgical root canal treatment (Friedman et al. 1995, Weiger et al. 2000, Ng et al. 2011). These factors should be taken into account when the influence of any other factor on the treatment outcome is analyzed. There is a controversy in the literature as to whether teeth with large lesions really show a poorer outcome (Strindberg 1956, Byström et al. 1987, Sjögren et al. 1990, Farzaneh et al. 2004, Ng et al. 2011). In a recent retrospective study with a large case series, we reported on a satisfactory outcome of teeth with large and very large apical periodontitis lesions after nonsurgical root canal treatment or retreatment (Artaza et al. 2024).

The purpose of this case-control study was to evaluate the outcome of the nonsurgical root canal treatment of teeth with large apical periodontitis lesions (cases) as compared to teeth with small lesions (controls) performed by a single experienced operator. Other factors associated with the outcome of the treatment of teeth with apical periodontitis were also assessed.

Material and methods

The clinical cases that started this study comprised 206 patients (115 women and 91 men; age ranging from 9 to 85 years old), who were referred to an experienced endodontist (L.A.) in a private practice for endodontic evaluation of teeth with an apical periodontitis lesion. All patients attended consecutively over a period of 23 years, from 1999 to 2022. Many of the cases with large lesions included in this study were part of a previous case series report (Artaza et al. 2024).

Initially, selection for this case-control study was based on the following inclusion criteria: tooth with preoperative radiographic evidence of bone destruction around the root apex; tooth with necrotic pulp as confirmed by pulp vitality tests or previous root canal treatment; tooth with an indication for primary or secondary root canal treatment; tooth that was restorable and had no periodontal pockets; patients with no contributory medical history and that returned for follow-up evaluation. All patients agreed and gave consent for examination and treatment of their teeth. The approval of this retrospective study protocol was obtained by the Institutional Board Review. Sample size calculation revealed that 40 patients per group would be required for this study, based on a difference of at least 20% between groups in a 1-tailed test, with an alpha-type error set at 0.05 and power at 80%.

Clinical and radiographic data were recorded: age and gender of the patients, apical periodontitis size on periapical radiographs, root canal status, type and location of the tooth, sinus tract, swelling, symptoms, and periodontal conditions. Patients were also asked about the history of acute apical abscesses and use of antibiotics. The number of treatment visits and obturation technique were also recorded. Apical periodontitis lesion size was measured on periapical radiographs by registering the largest diameter of the lesion. Accordingly, it was categorized as small (< 5 mm) or large (> 5 mm).

Cases (large lesions) were matched with controls (small lesions) for age and tooth type. Accordingly, 48 patients were included in each group.

After initial preparation, rubber dam isolation was applied, the access cavity prepared, and the operative field disinfected with 2.5% NaOCl. Chemomechanical preparation was conducted with 2.5% sodium hypochlorite as the main irrigant. Over the years, different hand and rotary nickel-titanium (NiTi) instruments were used for instrumentation. The working length was established 1 mm short of the apical foramen on the basis of an electronic apex locator and radiographs. Most cases were treated in a single visit, excepted when the conditions were not appropriate to fill the canals after preparation. Calcium hydroxide medication was used when it was not possible to fill the root canal. Canals were obturated with gutta-percha and sealer by using either lateral compaction or a thermoplasticized technique. In cases of secondary treatment (retreatment), the filling material was removed with Gates-Glidden burs and Hedström files and in most teeth, a gutta-percha solvent (xylol) was used. Next, canals were prepared and filled as reported above. A single operator performed all cases.

Patients included in this case-control study were followed up periodically from >1 to 22 years and the treatment outcome was determined based on clinical and radiographic evaluation. Clinical data indicative of treatment success included absence of signs (swelling, sinus tract) and/or symptoms (pain, tenderness to percussion or palpation). The affected teeth were also evaluated for the presence and quality of coronal restorations at the follow-up examination. Based on radiographic evaluation at follow-up, the cases were categorized as healed (success), diseased (failure) or healing according to the periapical index system (PAI)(Orstavik et al. 1986) as follows.

1) Healed; no apical periodontitis lesion (PAI score 1 or 2).

2) Healing: the lesion size decreased, i.e., the PAI value decreased, but it was still >2.

3) Diseased: the lesion was unchanged or enlarged in size, i.e., the PAI score was 3 to 5.

Because of the uncertain outcome of healing

Table 1. Chi-Square test results for the outcome in case-control analysis

Outcome	Lesion size: Small n=48	Lesion size: Large n=48	Odds ratio (95% CI) *	*P*-value
Overall				
Healed (%)	30 (62.5)	30 (62.5)	-	.929
Healing (%)	14 (29.2)	13 (27.1)		
Failure (%)	4 (8.3)	5 (10.4)		
Rigid criterion				
Healed (%)	30 (62.5)	30 (62.5)	-	.583
Healing/Failure (%)	18 (37.5)	18 (37.5)		
Lenient criterion				
Healed/Healing (%)	44 (91.7)	43 (89.6)	1.28 (0.32 - 5.09)	.500
Failure (%)	4 (8.3)	5 (10.4)		

*Odds ratio estimated to evaluate risk factors with 95% confidence intervals (CI) cases, two criteria were used for reporting the data. In a rigid criterion, the healing cases were regarded as failure, while in a loose criterion, teeth with decreasing lesions were considered as success.

Two evaluators ranked the radiographs and disagreements were resolved by joint discussion. In multirooted teeth, the outcome was considered for the root with the worst result.

A case-control design matched to age and tooth type was used. The study group included 48 patients with large apical periodontitis lesion (largest diameter > 5 mm) (case) and 48 subjects with small lesion (largest diameter < 5 mm) (control). The chi-squared and Fisher's exact tests were used to compare the outcome of teeth with small and large lesions based on rigid and lenient criteria.

Table 2. Sample characteristics and logistic regression result in relation to the outcome

Variables (n=96)	Category	All n (%)	Healed n (%)	Healing n (%)	Failure n (%)	Rigid criterion		Lenient criterion	
						Odds ratio (95% confidence interval)	P-value*	Odds ratio (95% confidence interval)	P-value*
Mean age	**Years**	45.6 ± 15.0	45.6 ± 15.2	44.9 ± 15.5	48.1 ± 13.3	0.999 (0.972 -1.027)	.968	0.998 (0.944 - 1.034)	.599
Gender	**Male**	41 (42.7)	22 (53.7)	15 (36.6)	4 (9.8)	0.398 (0.150 -1.055)	.064	0.334 (0.447 - 20.027)	.259
	Female	55 (57.3)	38 (69.1)	12 (21.8)	5 (9.1				
Obturation technique	**Lateral compaction**	46 (47.9)	33 (71.7)	10 (21.7)	3 (6.5)	0.943 (0.564 -1.580)	.825	1.300 (0.477 – 3.549)	.608
	Thermo-plasticized obturation	50 (52.1)	27 (54)	17 (34)	6 (12)				
Previous abscess	**No**	67 (69.8)	45 (67.2)	18 (26.9)	4 (6.0)	0.350 (0.093 – 1.134)	.120	0.88 (0.10 – 0.750)	**.026**
	Yes	29 (30.2)	15 (51.7)	9 (31.0)	5 (17.2)				
Sinus tract	**No**	69 (71.9)	42 (60.9)	22 (31.9)	5 (7.2)	1.355 (0.462 – 3.976)	.581	0.409 (0.071 - 2.329)	.314
	Yes	27 (28.1)	18 (66.7)	5 (18.5)	4 (14.8)				
Intervention	**Treatment**	61 (63.5)	44 (72.1)	12 (19.7)	5 (8.2)	0.346 (0.127 -0.941)	**.038**	0.623 (0.113 - 3.422)	.586
	Retreatment	35 (36.5)	16 (45.7)	15 (42.9)	4 (11.4)				
Intracanal medication	**No**	68 (70.8)	45 (66.2)	17 (25.0)	6 (8.8)	1.935 (0.479 – 7.811)	.354	3.039 (0.368 – 25.058)	.302
	Ca(OH)2	28 (29.2)	15 (53.6)	10 (35.7)	3 (10.7)				
Coronal restoration	**Inadequate**	18 (18.8)	14 (77.8)	3 (16.7)	1 (5.6)	0.286 (0.64 – 1.284)	.102	0.604 (0.060 -6.135)	.660
	Adequate	78 (81.3)	46 (59.0)	24 (30.8)	8 (10.3)				

*Odds ratios and P-value were calculated using binary logistic regression. Rigid criterion (healed x healing/failure); Lenient criterion (healed/healing x failure). Boldface, significant P value

The influence of other variables on treatment outcome was also tested. To verify the normal distribution of the variables, the Shapiro-Wilk and Kolmogorov-Smirnov tests were used, while the Levene test was conducted to verify the homogeneity of variances. The chi-squared test followed by logistic regression analysis were used to determine the significance of differences related to the outcome (healed, healing and failure). These association analyses were carried out for both rigid and lenient outcome criteria. The raw data was entered into Excel 2016 (Microsoft Corporation, Redmond) and all analyses were conducted in an SPSS environment (Statistical Package for Social Science, v.22, IBM, Armonk). According to the established significance level, a P-value ≤.05 was considered statistically significant.

Results

Data on the treatment outcome related to the lesion size are shown in Table 1. The clinical characteristics of the 96 participants and the effects of other variables on the treatment outcome are shown in Table 2. The sample included 55 women and 41 men, with age ranging from 17 to 75 years (mean ± standard deviation: 45.6 ± 15.0 years).

Overall, 60 cases (62.5%) were classified as healed (30 with small and 30 with large lesions) (Figure 1). Twenty-seven cases (28%) were healing (14 small, 13 large) (Figure 2), and 9 cases (9%) were diseased (4 small, 5 large). Based on the lenient criterion, the success rates in teeth with small and large lesions were 91.7% and 89.6%, respectively, with only one case causing this non-significant difference (P > .05). In the rigid criterion, the success rate was the same for both conditions (62.5%).

In the logistic regression analysis, variables including age, gender, previous abscess, sinus tract, intervention type (primary or secondary treatment), interappointment medication, obturation technique, and the quality of coronal restoration were examined for their influence on the outcome. After individually eliminating clinical confounding variables (age and gender) through logistic regression analysis, only intervention type

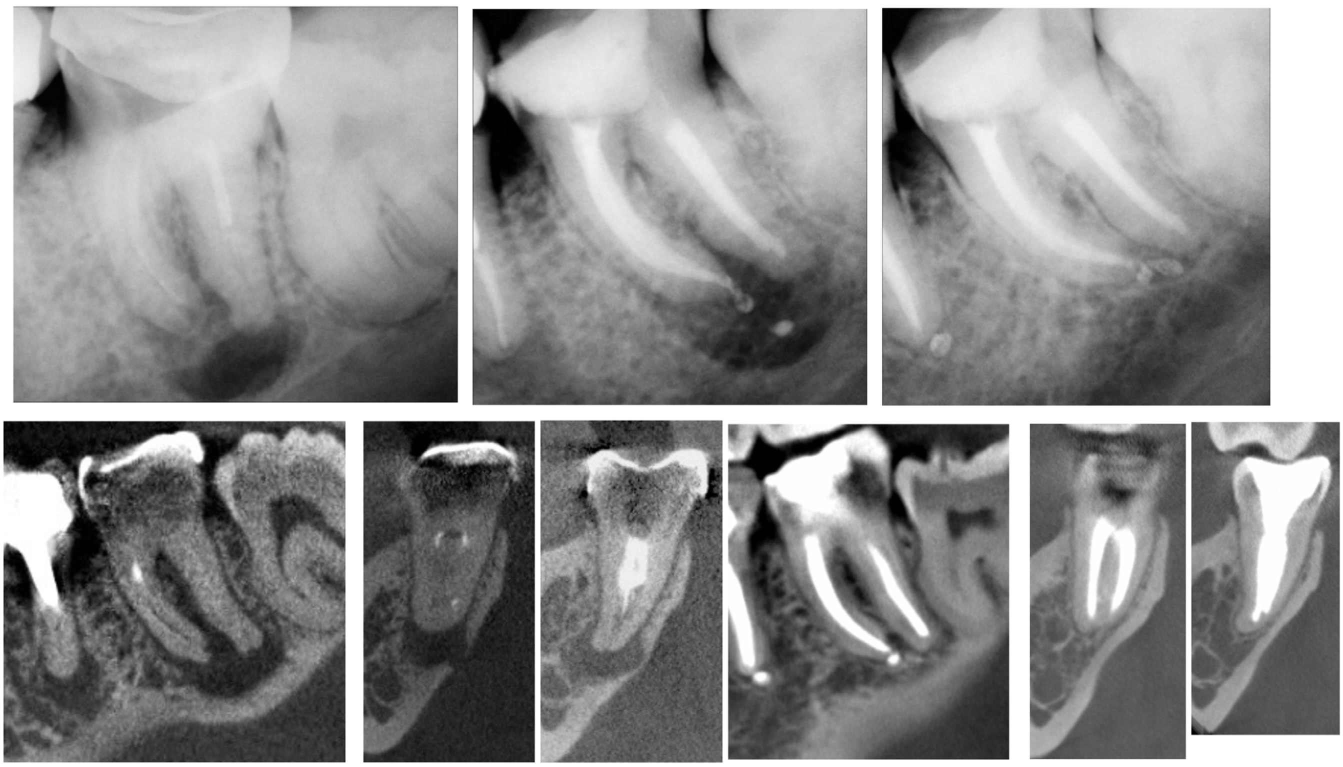

Figure 1 Postoperative and follow-up radiographic and cone-beam computed tomographic images from a representative case of a mandibular molar with large lesion, classified as healed after 2-year follow-up.

(rigid criterion) and previous abscess (lenient criterion) exhibited a statistically significant outcome (Table 2). The analyses revealed an increase in the number of individuals who achieved healing after the primary treatment, while secondary treatment was associated with more healing and diseased cases ($P < .05$). Furthermore, it was observed that individuals who had no previous abscess showed a significantly higher probability of healing compared with those who had ($P < .05$).

Discussion

This case-control study compared the success rate of the endodontic treatment in teeth with small and large apical periodontitis lesions. No significant differences were observed when using either a rigid or a lenient criterion. Data on the impact of preoperative large lesions on the treatment outcome are still inconclusive, with many cohort studies showing a lower success rate when compared to teeth with small lesions (Strindberg 1956, Friedman et al. 1995, Weiger et al. 2000, Hoskinson et al. 2002, Ng et al. 2011) and others reporting no significant difference (Byström et al. 1987, Sjögren et al. 1990, Peters & Wesselink 2002, Farzaneh et al. 2004, Artaza et al. 2021). In this case-control study, patients were matched for age and tooth type, and treated by the same operator, an experienced specialist in endodontics. Under these controlled conditions, the present findings failed to confirm that the lesion size influences the treatment outcome and are in agreement with a systematic review and meta-analysis on this subject (Baseri et al. 2023).

Apical periodontitis is an infectious disease and the associated microbiome tends to be more complex in teeth with large lesions (Sundqvist 1976, Byström et al. 1987, Siqueira et al. 2007, Amaral et al. 2022). This is highly likely to be related to the fact that large lesions are usually long-standing disease processes, and the bacterial communities involved are expected to have had sufficient time to organize themselves in protective biofilm structures and spread to areas of the canal system that may be difficult to disinfect (Ricucci & Siqueira 2010). This might be a reason for a poorer outcome in teeth with large lesions. However, when treated by an experienced clinician, aware of the infection problem, these factors could be mitigated, as focus on disinfection was given. Therefore, when

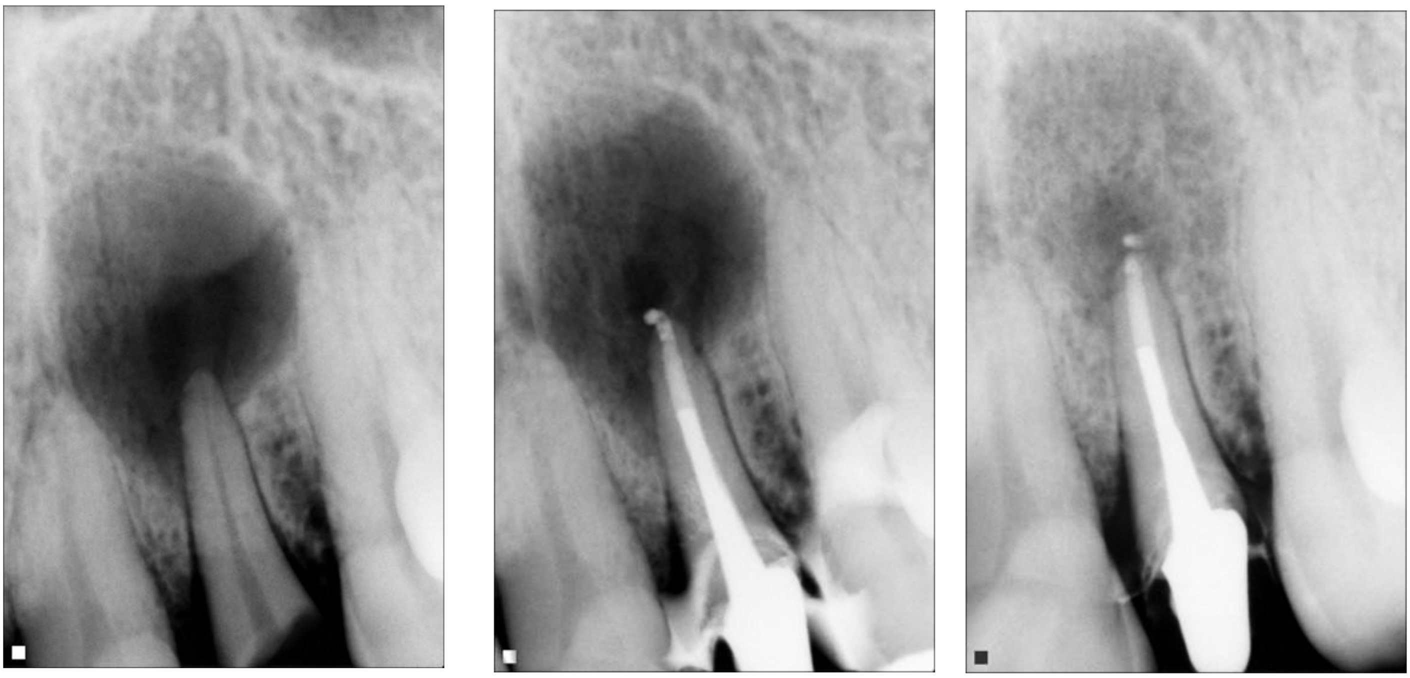

Figure 2 Postoperative and follow-up radiographs from a representative case of a maxillary lateral incisor with large lesion, classified as healing after 1.5-year follow-up.

treated by the same operator using a disinfection-oriented therapeutic protocol, the success rate was similar for teeth with small and large lesions.

The rate of diseased (non-healed) teeth was 8% for small lesions and 10% for large lesions. Posttreatment apical periodontitis in apparently well-treated teeth is usually caused by a persistent infection in the canal or a new one arising from lack of adequate coronal seal (Siqueira & Rôças 2008). An extraradicular infection cannot be discarded as a cause of posttreatment disease either (Ricucci et al. 2015).

Analyses of other factors that could influence the outcome revealed that secondary treatment (retreatment) had a significantly lower success rate in the rigid criterion. Other studies have already reported similar findings (Friedman 2017, Gulabivala & Ng 2023), which reflects the difficulties to achieve proper disinfection in previously treated teeth. A history of previous acute abscess episodes was more related to failures in the lenient criterion and may be a result of an established extraradicular infection that may have persisted and compromise healing (Ricucci et al. 2020).

One limitation of this study was that the lesion size was determined on periapical radiographs. Although this has been the most widely used method, cone-beam computed tomography (CBCT) can provide more accurate results for lesion detection and measurements (Patel et al. 2019). However, at the time some treatments were performed, CBCT was not available or recommended for follow-up examination (Patel et al. 2019). Further studies using CBCT should provide more information on this issue, preferably including 3D data such as lesion volume analysis (Zhang et al. 2021).

Although the outcome can be established as failure uniquely based on clinical symptoms before 1 year evaluation, radiographic examination of bone healing requires > 1 year follow-up (Ng et al. 2011, Azim et al. 2016). Before 4 years, lesions that decreased in size but that did not heal completely present an uncertain outcome; some may completely heal later, but other may stabilize or even regrow, characterizing a diseased state. In this study, 28% of the cases were healing in the evaluated period. For dichotomization purposes, we used two criteria to report the outcomes: one that considers healing cases as failures (rigid) and the other that considers as success (loose).

In conclusion, findings from this case-control study revealed that the size of apical periodontitis lesion did not impact the outcome of the endodontic treatment when performed by the same experienced operator.

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The authors deny any conflicts of interest.

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