

The Effect of the Dental Operating Microscope on the Outcome of Nonsurgical Root Canal Treatment: A Retrospective Case-control Study

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Abstract

Introduction: The aim of the current investigation was to assess the effect of the use of a dental operating microscope on the outcome of nonsurgical root canal treatment (NS RCT) while treating the mesiobuccal (MB) root of the maxillary first molar. **Methods:** This retrospective investigation included endodontically treated maxillary first molars (ETMs) with apparent adequate previous NS RCT and restorations referred for endodontic retreatment at the endodontic graduate clinic. Inclusion criteria were ETMs that were diagnosed with irreversible pulpitis and normal periapical tissues before the initial NS RCT and ETMs that presented with a minimum of 1 identifiable periapical lesion (PAR) at 1 of the roots at the time of retreatment. One hundred ninety-five ETMs were included and divided into 2 groups: (1) the initial NS RCT had been performed using a microscope ($n = 83$) and (2) NS RCT had been performed without the use of a microscope ($n = 112$). Data extracted were whether the second MB (MB2) canal was located initially and the presence of an MB PAR at the time of retreatment. Data were statistically analyzed using binary logistic regression ($\alpha = 0.05$). **Results:** The MB root was 3 times more likely to present with a PAR at the time of retreatment if the initial NS RCT was performed without the use of a microscope ($P < .05$, odds ratio = 3.1). There was a significant association between a missed MB2 canal and an MB PAR in the group in which the initial NS RCT was performed without the use of a microscope ($P < .05$, odds ratio = 5.1). However, in cases in which the initial NS RCT was performed using a microscope, a missed MB2 canal was not associated with the presence of an MB PAR. **Conclusions:** With proper education, dentists can gain further insight into recognizing limitations in treating cases that require advanced training and advanced optics such as a microscope. Based on this strategy, it would appear that the outcome of NS RCT can be improved. (*J Endod* 2017; ■ :1–5)

An inability to locate and treat all the root canal systems (RCSs) is one of the factors that may lead to a nonhealing outcome after nonsurgical endodontic treatment (1).

The use of a dental operating microscope allows the detection of canals that have normally been difficult to recognize and treat in the absence of enhanced magnification (2, 3). The American Association of Endodontics suggests that all endodontists learn about the benefits of microscopes and incorporate the use of those devices in their practice (4).

Maxillary molars are the most endodontically treated posterior teeth and possess a complex root canal system (5). In *Colleagues for Excellence* (6) published by the American Association of Endodontics, the authors stated “as most maxillary first molars have two canals in the mesiobuccal (MB) root, case referral to endodontists for microscope-supported treatment should be considered.” However, a recent Cochrane systematic review reported that no study has investigated the effect of the microscope on the healing outcome of nonsurgical root canal treatment (NS RCT) (7).

Cross-sectional studies (8, 9) have reported that molars treated by endodontists using a microscope have significantly higher survival rates than molars treated by nonendodontists who did not use a microscope after 10 years. Also, Wolcott et al (10) suggested that a significant difference in the incidence of treated second MB (MB2) canals between initial NS RCT and any required retreatment may indicate that failure to find and treat existing MB2 RCSs will result in poorer healing outcomes. However, because of the use of nonpairwise comparison in the aforementioned studies, there were other confounding variables such as preoperative pulpal/periapical diagnoses, quality of the NS RCT, timing and quality of the postoperative restoration, and the presence of any systemic disease that could affect the outcome of NS RCT (11, 12). Therefore, the results of these studies (8–10) may not be representative of the effect of the use of a microscope or the presence of a missed MB2 canal on the healing outcome of NS RCT. If these conditions could be controlled, then an investigation could be performed to determine the difference in treatment outcomes performing NS RCT using a microscope.

To the best of our knowledge, no study has investigated the effect of the use of a microscope on the healing outcome of NS RCT (7). Therefore, the purpose of the present study was to assess the effect of the use of a microscope on the NS RCT healing outcome on the MB root of maxillary first molars.

Significance

With proper education, dentists can gain further insight into recognizing limitations in treating cases that require advanced training and advanced optics such as a dental operating microscope.

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Materials and Methods

The protocol of the present case-control study was approved by the Committee on Research Involving Human Subjects, Case Western Reserve University (CWRU), Cleveland, OH. Study data were collected and managed using General Systems Design Group academic data capture tools (Cedar Rapids, IA) hosted at CWRU.

Existing patients' electronic records based on the American Dental Association Code on Dental Procedures and Nomenclature identified all endodontically treated maxillary first molars (ETMs) with completely formed apices that exhibited nonhealing outcomes after the initial NS RCT and were referred for nonsurgical root canal retreatment at the graduate endodontic department between January 1, 2007, and January 1, 2016. A nonhealing outcome was defined as the presence of a minimum of 1 identifiable periapical lesion (PAR) on at least 1 of the roots (MB, distobuccal [DB], or palatal [P]) at the time of retreatment. This initial search resulted in 1045 ETMs from 1021 patients.

Patients' records, radiographs, and computerized databases were examined to identify samples that matched the inclusion criteria in the present study. Inclusion data for the ETMs were as follows:

1. Patients between 18 and 75 years of age in good health (American Society of Anesthesiologists classification I or II)
2. ETMs with an acceptable quality of the initial NS RCT according to the criteria suggested by Tronstad et al (13) and Farzaneh et al (14) (Table 1)
3. ETMs with preoperative digital radiographs before the initial NS RCT, preoperative radiographs before retreatment, and complete records with American Dental Association Code on Dental Procedures and Nomenclature treatment codes
4. ETMs with a pulpal diagnosis of irreversible pulpitis and normal apical tissues before the initial NS RCT
5. ETMs that received an adequate crown after the initial NS RCT that was confirmed by the absence of open/defective margins using a clinical and radiographic examination
6. Cases with a recorded date of the initial NS RCT and a time lapse between the initial NS RCT and referral for retreatment
7. Periodontally sound teeth or probing depths <5 mm with no bleeding
8. Teeth with no detectable crack(s); the presence or absence of a crown crack was confirmed during retreatment (all retreatments were performed under the microscope)
9. ETMs that presented with a minimum of 1 identifiable PAR associated with at least 1 of the roots (MB, DB, or P) at the time of retreatment
10. Restorable teeth with at least 2 mm of ferrule effect and at least 1 mm of dentinal thickness

TABLE 1. Suggested Criteria for Evaluating the Quality of Nonsurgical Root Canal Treatment

Radiographic parameter	Definition
Root canal obturation length	Adequate obturation: 0–2 mm short of the radiographic apex Short obturation: >2 mm from the radiographic apex Overextended obturation: beyond the radiographic apex
Void	Adequate: no voids present in obturation Root filling with visible voids

Based on Tronstad et al¹³ and Farzaneh et al¹⁴ with permission.

Teeth with no preoperative radiographs before the initial NS RCT, periodontally compromised teeth with a questionable prognosis, and cases with suspected vertical root fracture (15) were excluded. Also, ETMs with any operative mishaps such as a perforation and/or a separated file were excluded. ETMs that were obturated with a material other than gutta-percha were excluded.

Two independent reviewers (N.K. and J.W.) who were blind regarding whether the initial NS RCT was performed using a microscope or not evaluated the radiographs of the ETMs, which were taken before retreatment. The periapical status was assessed according to Lopez-Lopez et al's study (16) using the periapical index (PAI) described by Orstavik et al (17). Based on the scoring system, PAI ≥ 3 was considered to be a sign of periapical pathology. Before evaluation, the observers were calibrated regarding the PAI system. These patients were randomly selected. The interobserver agreement test on the PAI scores on the 50 patients produced a Cohen kappa of 0.82.

Screening of the ETMs that met the inclusion criteria yielded 195 ETMs, from which 195 patients were included in the final analysis to avoid clustering effects. This considered a PAR at a single level as an independent entity, which reduced the effect of patients as a risk factor (18). The following data were collected from the included patients' records by 2 blinded reviewers (N.K. and J.W.) regarding whether the initial NS RCT was performed using a microscope or not:

1. Patient-related factors: age and sex
2. Whether the MB2 canal was identified and treated during the initial NS RCT. This was later confirmed using a microscope during retreatment. This variable was dichotomized as present or absent for each sample for statistical analysis.
3. The presence of a PAR on the MB root was assessed and dichotomized as present or absent and used as the dependent variable. Also, the presence of a PAR on the DB and P roots was assessed.

After data collection, included ETMs were then divided into 2 groups:

1. Patients who received the initial NS RCT at the endodontic department using a microscope and referred back for the retreatment (microscope group, $n = 83$)
2. Patients who received the initial NS RCT without the use of a microscope by general dentists at a dental clinic and were referred for retreatment (nonmicroscope group, $n = 112$)

TABLE 2. Distribution and Characteristics of Included Endodontically Treated Maxillary First Molars

Characteristics	DOM group, $n = 83$ (43%)	Non-DOM group, $n = 112$ (57%)	<i>P</i> value (chi-square and <i>t</i> test)
Age	54	43	.75
Sex, n (%)			
Male	48 (58)	66 (59)	.11
Female	35 (42)	46 (41)	
Time lapse between the initial NS RCT and retreatment (y)	5.5	2.6	.02*
Identified MB2 canal in the initial NS RCT, n (%)	51 (62)	21 (19)	.02*
MB root lesion at the time of retreatment, n (%)	21 (26)	82 (73)	.01*

DOM, dental operating microscope; MB, mesiobuccal; MB2, second mesiobuccal; NS RCT, nonsurgical root canal treatment.

*The significance level is $P = .05$.

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