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Restorative outcomes for endodontically treated teeth in the Practitioners Engaged in Applied Research and Learning Network

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Abstract

Background—The authors aimed to determine the outcome of and factors associated with success and failure of restorations in endodontically treated teeth in patients in practices participating in the Practitioners Engaged in Applied Research and Learning (PEARL) Network.

Methods—Practitioner-investigators (P-Is) invited the enrollment of all patients seeking care at participating practices who had undergone primary endodontic therapy and restoration in a permanent tooth three to five years earlier. P-Is classified endodontically reated teeth as restorative failures if the restoration was replaced, the restoration needed replacement or the tooth was cracked or fractured.

Results—P-Is from 64 practices enrolled in the study 1,298 eligible patients who had endodontically treated teeth that had been restored. The mean (standard deviation) time to follow-up was 3.9 (0.6) years. Of the 1,298 enrolled teeth, P-Is classified 181 (13.9 percent; 95 percent confidence interval [CI], 12.1–15.8 percent) as restorative failures: 44 (3.4 percent) due to cracks or fractures, 57 (4.4 percent) due to replacement of the original restoration for reasons other than fracture and 80 (6.2 percent) due to need for a new restoration. When analyzing the results by means of multivariate logistic regression, the authors found a greater risk of restorative failure to be associated with canines or incisors and premolars ($P = .04$), intracoronal restorations ($P < .01$), lack of preoperative proximal contacts ($P < .01$), presence of periodontal connective-tissue attachment loss ($P < .01$), younger age ($P = .01$), Hispanic/Latino ethnicity ($P = .04$) and endodontic therapy not having been performed by a specialist ($P = .04$).

Conclusions—These results suggest that molars (as opposed to other types of teeth), full-coverage restorations, preoperative proximal contacts, good periodontal health, non-Hispanic/Latino ethnicity, endodontic therapy performed by a specialist and older patient age are associated with restorative success for endodontically treated teeth in general practice.

Clinical Implications—These results contribute to the clinical evidence base to help guide practitioners when planning the restoration of endodontically treated teeth.

Keywords

Practice-based research networks; restorative outcomes; endodontic therapy; root canal

The objective of endodontic therapy is the removal of irreversibly inflamed or necrotic pulp tissue and the bacterial biofilm and biofilm products from the root canal and the dentinal tubules that line the root canal system. The root canal then is sealed (obturated) with a biologically compatible filling material to promote and maintain the periapical health of the endodontically treated tooth. The placement of a definitive restoration returns the tooth to function, seals the obturated root canal against oral contamination and reinfection, and helps maintain the integrity of the patient's occlusion.

The clinician uses mechanical instrumentation of the root canal walls, which may be complicated by anatomical variation in root canal shape and size, to facilitate the debridement of necrotic pulp tissue and the bacterial biofilm from the root canal system.[1] Because it is impossible to debride the dentinal tubules completely by means of mechanical instrumentation alone, investigators have proposed several chemically active agents to facilitate removal of necrotic tissue and bacterial biofilm.[2] This has led to the recommendation that root canals be widened on the basis of the need for mechanical debridement and to facilitate the delivery of chemically active agents to the apical aspects of the root canal.[3] However, enlargement of the root canal system and the use of chemically active agents can result in excessive removal of the supporting dentin matrix, a situation that may compromise the structural integrity of the endodontically treated tooth and its long-term prognosis.[4] These conflicting treatment objectives present the clinician with a dilemma of how to balance the biological need for debridement to maintain periapical health with the need to maintain the structural integrity of the tooth to ensure its long-term function.[1] As a result, at the completion of endodontic therapy, the restorative dentist must determine how to restore to function a nonvital tooth that may be structurally compromised. The question therefore arises: How best to restore the endodontically treated tooth?

In 2005, the National Institute of Dental and Craniofacial Research established three regional dental practice-based research networks (PBRNs) to address these types of clinically significant questions through studies conducted in actual private dental practices.[5] One of the PBRNs, the Practitioners Engaged in Applied Research and Learning (PEARL) Network, conducted a retrospective study of the three- to five-year outcomes of primary endodontic therapy and restoration in general dental private practices. We[6] previously published a report regarding the outcomes of more than 1,300 primary endodontic therapies and factors associated with endodontic success and failure. Our objective in this article is to present the outcome of the definitive restoration placed after the completion of endodontic therapy. We addressed the following questions:

- What are the restorative outcomes for endodontically treated teeth in general practice?
- What are the most prevalent modes of restorative failure in these teeth?
- What factors are associated with restorative success and failure in endodontically treated teeth?

METHODS

Study design and inclusion criteria

We[6] have published details of the study design. In brief, practitioner-investigators (P-Is) in participating PEARL Network practices invited the study enrollment of patients in those practices who had undergone primary endodontic therapy and subsequent restoration in a permanent tooth three to five years previously. In addition, we required that patients be 70 years or younger at the time the endodontic therapy was completed. We required that the restoration have been placed by the general dentist, but allowed the endodontic therapy to have been performed by a specialist. If a patient had several endodontically treated teeth, the P-I selected as the index (study) tooth the one that had been treated earliest in the three- to five-year period. We excluded teeth with incomplete apexes, teeth that served as abutments for removable partial dentures or overdentures, third molars and teeth undergoing active orthodontic treatment. The New York University School of Medicine Institutional Review Board, New York City, reviewed and approved the study protocol.

Study protocol and data collection

After each participant provided written informed consent, the P-I completed a demographic form documenting the participant's age, sex and ethnicity and race. In addition, the P-I recorded the presence or absence of the index tooth and, if it was absent, the reason for its extraction.

If the index tooth was present, the clinical data recorded included pain on percussion; whether the restoration had been or needed to be replaced and, if so, the reason for replacement; the number of proximal contacts; the presence of cracks or fracture of the crown or root; the presence of primary or secondary caries; and the presence of periodontitis as measured according to clinical attachment level. If a periapical radiograph of the index tooth had not been obtained within the preceding seven months, the P-I obtained a new one and examined it for periapical pathosis, widening of the periodontal ligament space and radiographic suggestion of root fracture. The participant also completed a tooth sensitivity assessment and an oral health inventory questionnaire (the Oral Health Impact Profile[7]).

For each index tooth, the P-I recorded whether the tooth was vital or nonvital or had periapical pathosis before endodontic therapy began; whether a general dentist or specialist had performed the endodontic therapy; whether a post (dowel) had been placed and, if so, the type of post; the type of coronal restoration placed; the date of placement of the definitive restoration; and whether the restoration was replaced and, if so, the reason for its replacement. The participating practice sent a duplicate periapical radiograph of the index tooth at follow-up to the PEARL Network administrative center. A board-certified periodontist (R.G.C.) and an endodontist made the determination of periapical pathosis if they clearly observed a lesion that corresponded to a score of 3 or higher on a periapical index developed by Ørstavik and colleagues.[8] Both reviewers were masked as to practitioner-reported outcome before undertaking the evaluation.

Statistical analysis

Our specific aim in this study was to determine the outcome of the definitive restoration three to five years after completion of primary endodontic therapy in general practice. We used logistic regression to evaluate the relationship between the primary dependent variable, restorative failure and the independent variables listed below. We defined restorative failure as a crack or fracture, extraction of the tooth owing to restoration or root fracture, replacement of the restoration or a determination by the dentist that the restoration needed replacement. The categories of restorative failure were mutually exclusive, and the order of definition was “tooth cracked or fractured,” “restoration replaced” and “restoration needs replacement.” The independent variables were the patient’s demographic data (age, sex, race, ethnicity); tooth type; any connective-tissue attachment loss; number of existing proximal contacts; initial pulpal diagnosis, as assessed retrospectively by the dentist; presence of periapical disease; whether a general dentist or a specialist performed the endodontic therapy; restoration type (full-coverage crown versus intracoronal restoration); placement of a post, including the type of post used; the number of visits required to complete endodontic therapy; and time to coronal restoration in months. The study was powered assuming a 95 percent restorative failure rate to detect a 75 percent increase in risk associated with binary, relatively nonskewed covariates. We included factors significant at the $P = .10$ level in the univariate setting in the multivariate model with backward elimination at the $P = .05$ significance level for variable selection. In the case of correlated factors, we included only one of the factors in the multivariate model.

RESULTS

P-Is from 64 PEARL Network practices enrolled 1,323 patients. Twelve of these failed to meet the eligibility requirements, and 13 of them had not received a definitive restoration; this left 1,298 eligible patients with restored primary endodontically treated teeth for analysis. The mean (standard deviation) time from completion of endodontic therapy to follow-up was 3.9 (0.6) years. The median enrollment per practice was 11 patients, with a range of one to 100 patients. The median patient age at enrollment was 52 years (range, 14–74 years), and 58 percent were female. Patient-reported race was 86 percent white, 4 percent African American, 5 percent Asian, 0.5 percent Hawaiian/Pacific Islander, 0.4 percent Alaska Native or American Indian and 3 percent unknown. Patient-reported ethnicity was 7 percent Hispanic/Latino, 89 percent not Hispanic/Latino and 4 percent unknown. The distribution of enrolling sites was 69 percent suburban, 19 percent urban and 12 percent rural. The median number of years in practice for enrolling dentists was 23, with a range of two to 35 years.

Table 1 presents the restorative outcomes of endodontically treated teeth three to five years after the completion of endodontic therapy. Of the 1,298 eligible restored teeth, 181 (13.9 percent) were classified as restorative failures: 80 (6.2 percent) needed a new restoration as determined by the examining dentist, 57 (4.4 percent) had undergone replacement of the original restoration and 44 (3.4 percent) had fractures detected by means of clinical or radiographic examination. Tooth fractures led to replacement of the restoration in 38 (58

percent), secondary caries in 20 (30 percent), mobility (unseating of restoration) in four (6 percent) and other outcomes in four (6 percent) of the teeth.

Table 2 presents the distribution of patient and clinical variables with the number and percentage of restorative failures, and Table 3 presents a univariate analysis of factors potentially associated with restorative failure of endodontically treated teeth. We found a greater percentage of restorative failures in participants with Hispanic (28.1 percent) versus non-Hispanic (12.9 percent) ethnicity ($P < .01$); in incisors and canines (20 percent) and premolars (15.1 percent) versus molars (11.7 percent) ($P < .01$); in teeth with periodontal connective-tissue attachment loss (20.5 percent) versus teeth that were periodontally healthy (11.5 percent) ($P < .01$); in teeth without proximal contacts (26.2 percent) compared with teeth with the preoperative presence of one (13.3 percent) or two (11.5 percent) proximal contacts ($P = .02$); in teeth in which a general practitioner (15.7 percent) rather than a specialist (10.2 percent) ($P < .01$) had performed the endodontic therapy; and in teeth with intracoronal (26.4 percent) versus full-coverage (8.3 percent) restorations ($P < .01$). Younger patient age also was associated with restorative failure ($P < .01$). Teeth without posts or with fiber posts experienced more restorative failures than did teeth restored with metal posts ($P < .01$).

Table 4 (page 751) presents the distribution and types of posts placed in endodontically treated teeth. A similar percentage of teeth with a single root canal versus multiple root canals and molars versus nonmolars received posts in this study. The majority of posts placed were metal (80 percent), with cemented preformed metal posts composing the majority. Twenty percent of the posts placed were fiber; preformed fiber and composite posts constituted the majority of those.

We constructed a multivariate logistic regression model by using factors significant at the $P = .10$ level in the univariate analysis (Table 5). Variables included in the model found to be significantly associated with restorative failure were tooth type, with incisors and canines and premolars being more at risk than were molars ($P = .04$); intra-coronal versus full-coverage restorations ($P < .01$); the number of preoperative proximal contacts, with teeth without proximal contacts being at greater risk than those with one or two proximal contacts ($P < .01$); Hispanic/Latino ethnicity compared with non-Hispanic/Latino ethnicity ($P = .04$); presence of periodontal connective-tissue attachment loss ($P < .01$); endodontic therapy performed by the general practitioner versus the specialist ($P = .04$); and younger patient age ($P = .01$).

DISCUSSION

The restoration of endodontically treated teeth presents unique challenges when compared with the restoration of teeth with vital pulps. Extensive caries or trauma culminating in the need for endodontic therapy frequently results in limited remaining coronal tooth structure and therefore may require the placement of a post and core before the tooth is restored. However, the presence of a post can place the tooth at a greater risk of experiencing root fracture[9] or the development of periapical radiolucencies.[10–12] In addition, the presence of a temporary or inadequately sealed coronal restoration may permit leakage with resultant

reinfection of the root canal. Therefore, several authors have suggested that the newly obturated root canal be sealed quickly and effectively via the placement of a definitive restoration to maintain periapical health.[9,13–20] Finally, debridement of the root canal system by mechanical or chemical means (or both) can remove excessive amounts of dentin, which may compromise the tooth structurally. This concern has led to the recommendation that endodontically treated teeth receive full-coverage coronal restorations that encompass and protect the remaining coronal tooth structure.[16,20] Collectively, these concerns provide the basis for the observation that restored endodontically treated teeth are extracted at a higher rate than are comparably restored teeth that are not endodontically treated.[9]

Owing to the restorative challenges presented by endodontically treated teeth, we conducted this study to determine the restorative outcomes and factors associated with restorative success and failure in endodontically treated teeth in general practice. The intent of the study was to provide a clinical evidence base, derived from actual experience in general dental practices, to help guide the practitioner in planning the restorative phase of treatment. Criteria for restorative failure in this three- to five-year retrospective study were replacement of the restoration as determined by review of the patient's chart, need for the restoration to be replaced at the practitioner's decision or coronal or root fracture as suggested by clinical or radiographic findings. Given these criteria, we classified 181 of the 1,298 restored teeth enrolled in this study as restorative failures with 6.2 percent needing a new restoration, 4.4 percent undergoing replacement of the original restoration and 3.4 percent having cracks or fractures, for a combined failure rate of 13.9 percent. The authors of a 2009 review of the relative survival of cast metal, porcelain-fused-to-metal and full-coverage ceramic crowns, placed on both vital and endodontically treated teeth, found that 90 percent of crowns did not require catastrophic treatment within five years of placement, with full-coverage ceramic crowns placed on posterior teeth having the lowest survival rate.[21] The results of our study are in general agreement with those of this comprehensive review, especially in view of the more stringent criteria we used to define restorative success.

However, the 13.9 percent restorative failure rate reported here, when combined with the 19.1 percent endodontic failure rate for primary endodontic therapy we[6] reported earlier, underscore the need for the practitioner to give careful consideration to all treatment options when planning treatment for teeth with an irreversible pulpitis or a necrotic pulp. To this end, we sent "benchmarking" reports to PEARL Network P-Is who participated in this study so they could see the outcome of endodontic and restorative treatment in their offices compared with the average across all participating practices.

To facilitate clinical treatment planning decisions, we also identified several factors associated with restorative success and failure for endodontically treated teeth. Strongly associated with restorative failure, in both univariate and multivariate analyses, were teeth restored with intracoronal restorations. Investigators in previous studies have reported that full-coverage restorations result in a greater survival rate than do intracoronal restorations for endodontically treated teeth,[13,16,20,22] especially in posterior teeth.[15,23] The advantages suggested for full-coverage restorations for endodontically treated teeth include the generation of a cervical ferrule that may seal the obturated root canal against oral contamination more effectively, increased retention of the restoration attributable to the

cervical ferrule, and the provision of greater protection for remaining natural tooth structure that may have been structurally compromised by endodontic therapy.[12,13,15,16,18–20,22,24] However, not all study findings have showed differences in outcome for coronal versus intracoronal restorations for endodontically treated teeth.[18,25] The investigators in one study suggested that teeth with a favorable endodontic prognosis at the completion of endodontic therapy (that is, vital preoperative pulpal diagnosis, lack of periapical pathology and a root canal filling within 2 millimeters of the apex) tend to receive full-coverage restorations rather than intracoronal restorations. Teeth with a guarded endodontic prognosis tend to receive less expensive intra-coronal restorations, which may include a resin-based composite or amalgam restoration. Therefore, the practitioner's perception of the long-term endodontic prognosis creates a bias regarding subsequent restorative treatment.[26]

We also found tooth type to be associated with restorative failure in our study. Incisors, canines and premolars were at significantly greater risk of experiencing restorative failure than were molars. This finding may result from the interaction of several factors. Anterior teeth received a greater proportion of intracoronal restorations, a variable we found to be associated with restorative failure in this study. Specialists were more likely to perform endodontic therapy in posterior teeth, which may have resulted in a greater amount of tooth structure remaining for restoration. Our finding of increased restorative failure in anterior teeth does not support the results of earlier research showing that full-coverage restorations increase the overall prognosis of posterior, but not anterior, endodontically treated teeth.[23] Instead, the results of this study tend to support the use of full-coverage restorations for both anterior and posterior endodontically treated teeth.

We also found the number of preoperative proximal contacts to be associated with restorative failure. Endodontically treated teeth without preoperative proximal contacts were at greater risk of experiencing restorative failure than were teeth with one or two preoperative proximal contacts. This finding is in agreement with those of several reports that endodontically treated teeth without proximal contacts are at greater risk of experiencing endodontic and restorative failure than are such teeth with proximal contacts.[1,22,27] It is possible that the lack of proximal contact exposes the restored tooth to greater and more varied occlusal loading forces. In addition, endodontically treated teeth without proximal contacts are more likely to serve as abutments for fixed partial dentures, which investigators have reported to have a higher failure rate.[1,12,28]

According to literature, the decision to place a post and core after endodontic therapy is based not on the need to reinforce the tooth against root fracture but on the amount of remaining coronal tooth structure available to retain a restoration.[12,15,23] Investigators in other studies have reported decreased long-term endodontic, but not restorative, success with post placement.[10–12,27] It is possible that post placement adds to an already structurally compromised tooth an additional restorative element that may fail, or that the preparation of the root canal before post placement further decreases the amount of remaining dentin, or that post preparation may compromise the apical seal of the root canal.[10,14] In univariate analysis only, we found an increased risk of restorative failure in teeth without posts and in teeth with fiber posts when compared with teeth in which metal posts had been placed (Table 3). Placement of a post and core allows optimal preparation contours to retain the

restoration, which is independent of the remaining coronal tooth structure. In addition, placement of a post and core is followed by the fabrication of a full-coverage restoration, which was highly associated with restorative success in our study.

Our finding of decreased restorative success with fiber posts versus metallic posts may reflect the small number of fiber versus metal posts in this study (Table 4). Researchers in several studies have reported that preformed posts of either metal or fiber and composite to have more favorable endodontic and restorative outcomes when compared with cast metal,[19,28–30] and the authors of a related Cochrane Review reported fewer clinical failures with nonmetal posts.[19] Our finding of increased restorative failure rates in younger patients and patients of Hispanic/Latino ethnicity was unexpected. Investigators in one study reported decreased survival rates of endodontically treated and restored teeth with older patient age, although this study involved patients in a dental school.[25] In our study, patients receiving full-coverage restorations were significantly older than those who did not, and crowns (as opposed to intra-coronal restorations) were significantly associated with restorative success. The finding of increased restorative failure in Hispanic/Latino patients is more difficult to explain, especially because Hispanic/Latino patients composed only 7 percent of the study population. However, of the 22 participating practices that enrolled the 89 Hispanic/Latino patients in this study, one site enrolled 37 patients and had an overall rate of restorative failure higher than that of the other sites. The maximum enrollment of Hispanic/Latino patients at any other site was eight patients, suggesting that the finding of increased restorative failure in Hispanic/Latino patients may be due to a site effect. Alternatively, the effects of both age and ethnicity may be due to residual confounding variables for which we did not account in our analysis or to racial or ethnic characteristics in this population.

Study limitations

Several aspects of this study should be considered when one is interpreting the results. A retrospective study design was used that evaluated the three- to five-year outcome of primary endodontic therapy and restoration. To be enrolled in the study, we required that patients have remained in the practice in which they received the restoration of the endodontically treated tooth and be in active therapy or on a recall and maintenance schedule; we considered patients who had left the practice for any reason to be lost to follow-up. Therefore, our exclusion of patients lost to follow-up may constitute a source of bias. A prospective study design would have followed a cohort of patients across time, allowing for an analysis of patients who were lost to follow-up and, thereby, providing a more accurate measurement of endodontic and restorative outcomes. We are investigating the loss of patients to follow-up as a potential source of bias in a secondary study. In selected practices in which P-Is enrolled patients in this study, we are comparing the loss to follow-up of patients undergoing prophylaxis with the loss of those who received a full-coverage crown restoration (without endodontic therapy), and with the loss of those who received the combination of endodontic therapy and restoration. These results will be reported elsewhere.

In addition, the demographics of the 64 practices that participated in this study and the 1,298 patients enrolled in it reflect the demographics of suburban private practices located in the greater northeastern United States. Therefore, the results of this study may not be generalizable to the U.S. population at large. We also acknowledge the possibility of patient selection bias by the P-Is in the participating practices in that they may have tended to enroll patients who were likely to have favorable outcomes. However, the 19.1 percent endodontic failure rate reported earlier,[6] coupled with the 13.9 percent restorative failure rate reported here, tends not to support the possibility of gross patient selection bias. Finally, we should acknowledge that the study was conducted in a PBRN by general practitioners who volunteered to participate and who enrolled patients actively treated in their practices. The PEARL Network researchers made no attempt to influence how endodontic or restorative care was delivered, only to record its outcome accurately. Therefore, these practitioners, in view of their voluntary participation and interest in conducting clinical effectiveness research in their own practices, may not reflect the dental profession at large.

Study strengths

The strengths of our study include the relatively large patient population (1,298) enrolled across many (64) private practices. Therefore, the study results tend to reflect restorative outcomes one would expect in private dental practice, in contrast to those of outcome studies conducted in dental school or specialty settings. In addition, the unit of analysis in this study was the tooth, because a single restored endodontically treated tooth was enrolled per patient. This prevented inclusion of patient-associated factors from the enrollment of multiple teeth per patient. We also used formal data quality assurance procedures, including the use of clinical research associates and formal site closeout procedures, which we[6] detailed in our earlier report.

CONCLUSIONS

The restorative outcome of 1,298 endodontically treated teeth three to five years after the completion of endodontic therapy was determined in 64 general practices of a dental PBRN. The overall rate of restorative failure was 13.9 percent. Factors associated with restorative success for endodontically treated teeth were molars (as opposed to other tooth types), full-coverage restorations, preoperative presence of proximal contacts, good periodontal health, endodontic treatment having been performed by a specialist, ethnicity other than Hispanic/Latino and younger patient age. The results of this study, derived from private practices, contribute to the clinical evidence base to help guide practitioners when planning the restoration of endodontically treated teeth.

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Dental Practice-Based Research Network, which is headquartered at the University of Alabama at Birmingham School of Dentistry.

ABBREVIATION KEY

PBRN	Practice-based research network
PEARL	Practitioners Engaged in Applied Research and Learning
P-I	Practitioner-investigator

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TABLE 1

Restorative failures for primary endodontically treated teeth three to five years after completion of treatment (N = 1,298).

TYPE OF RESTORATION FAILURE*	NO. OF FAILURES	PERCENTAGE FAILED, MEAN (95 PERCENT CI†)
Tooth Cracked or Fractured	44	3.4 (2.4–4.4)
Restoration Replaced	57	4.4 (3.3–5.5)
Restoration Needs Replacement	80	6.2 (4.9–7.5)
Total No. of Restoration Failures	181	13.9 (12.1–15.8)

*The subcategories of restorative failure are mutually exclusive; a tooth was allowed to be counted as a restorative failure only once, in the sequence of outcomes as presented in the first column.

†CI: Confidence interval.

TABLE 2

Association of participant and clinical variables with restorative failure.

VARIABLE AND CATEGORY	NO. OF TEETH	NO. OF FAILURES	PERCENTAGE OF FAILURES
Sex			
Male	547	80	14.6
Female	751	101	13.4
Race			
White	1,118	156	14.0
Nonwhite or unknown	180	25	13.9
Ethnicity			
Hispanic	89	25	28.1
Not Hispanic or unknown	1,209	156	12.9
Tooth Type			
Molar	721	84	11.7
Premolar	372	56	15.1
Incisor or canine	205	41	20.0
Connective-Tissue Attachment Loss			
Yes	127	26	20.5
No	1,130	130	11.5
No. of Existing Proximal Contacts			
Zero	42	11	26.2
One	301	40	13.3
Two	913	105	11.5
Initial Pulpal Diagnosis			
Nonvital pulp	519	73	14.1
Irreversible pulpitis	778	108	13.9
Clinician Who Performed Endodontic Treatment			
General practitioner	885	139	15.7
Specialist	413	42	10.2
Restoration Type			
Full-coverage crown	892	74	8.3
Other	406	107	26.4
Post Placement			
Metal	576	61	10.6
Fiber	147	23	15.6
Not placed	574	97	16.9

VARIABLE AND CATEGORY	NO. OF TEETH	NO. OF FAILURES	PERCENTAGE OF FAILURES
No. of Visits Required to Complete Endodontic Therapy			
One	657	93	14.2
Two	495	69	13.9
Three or more	146	19	13.0

TABLE 3

Univariate analysis of risk factors for restorative failure in endodontically treated teeth.

RISK FACTOR	ODDS RATIO	95% CI*	*P* VALUE	OVERALL *P* VALUE
Age in Years	0.98	(0.97–1.00)	< .01	< .01
Sex				
Female	1.00			.55
Male	0.91	(0.66–1.24)	.55	
Race				
White	1.00			.98
Nonwhite or unknown	0.99	(0.63–1.57)	.98	
Ethnicity				
Not Hispanic or Latino	1.00			< .01
Hispanic or Latino	2.64	(1.61–4.31)	< .01	
Tooth Type				
Molar	1.00			
Premolar	1.34	(0.93–1.93)	.11	< .01
Incisor or canine	1.90	(1.26–2.86)	< .01	
Connective-Tissue Attachment Loss				
No	1.00			< .01
Yes	1.98	(1.24–3.16)	< .01	
Number of Existing Proximal Contacts				
Zero	1.00			
One	0.43	(0.20–0.93)	.03	.02
Two	0.37	(0.18–0.75)	< .01	
Initial Pulpal Diagnosis				
Irreversible pulpitis	1.00			.93
Nonvital tooth	1.02	(0.74–1.40)	.93	
Periapical Disease				
No	1.00			.22
Yes	1.22	(0.89–1.68)	.22	
Clinician Who Performed Endodontic Treatment				
General practitioner	1.00			< .01
Specialist	0.61	(0.42–0.88)	< .01	
Restoration Type				
Full-coverage crown	1.00			< .01
Intracoronal	3.96	(2.86–5.47)	< .01	

RISK FACTOR	ODDS RATIO	95% CI*	*P* VALUE	OVERALL *P* VALUE
Post Placement				
Not placed	1.00			
Metal	0.58	(0.41–0.82)	< .01	< .01
Fiber	0.91	(0.56–1.50)	.72	
No. of Visits Required to Complete Endodontic Therapy				
One	1.00			
Two	0.98	(0.70–1.37)	.92	.94
Three or more	0.91	(0.53–1.54)	.72	
Time to Restoration in Months	0.99	(0.97–1.01)	.38	.38

* CI: Confidence interval.

TABLE 4

Distribution and types of posts placed.

VARIABLE	FREQUENCY (%)
Number of Canals	
Single (n = 401)	230 (57.4)
Multiple (n = 897)	494 (55.1)
Tooth Type	
Molar (n = 721)	369 (51.2)
Other (n = 577)	355 (61.5)
Type of Post (n = 724)	
Cast metal	75 (10)
Preformed metal (mechanical retention)	77 (11)
Preformed metal (cemented)	424 (59)
Preformed fiber and composite	145 (20)
Custom fiber	2 (< 1)
Cast metal and preformed fiber	1 (< 1)

TABLE 5

Multivariate logistic regression model of risk factors for restorative failure.

RISK FACTOR	ODDS RATIO (95% CI*)	*P* VALUE	OVERALL *P* VALUE
Restoration Type			
Full-coverage crown	1.00		< .01
Intracoronal	4.04 (2.79–5.86)	< .01	
Number of Existing Contacts			
Zero	1.00		
One	0.42 (0.19–0.96)	.04	< .01
Two	0.27 (0.12–0.59)	< .01	
Connective-Tissue Attachment Loss			
No	1.00		< .01
Yes	2.10 (1.27–3.49)	< .01	
Patient Age	0.98 (0.97–1.00)	.01	.01
Tooth Type			
Molar	1.00		
Premolar	1.69 (1.10–2.60)	.01	.04
Canine or incisor	1.50 (0.93–2.42)	.10	
Ethnicity			
Not Hispanic or unknown	1.00		.04
Hispanic	1.81 (1.02–3.22)	.04	
Clinician Who Performed Endodontic Treatment			
General practitioner	1.00		.04
Specialist	0.63 (0.41–0.99)	.04	

*CI: Confidence interval.