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Contemporary Endodontic Retreatments: An Analysis based on Clinical Treatment Findings

Michael M. Hoen, DDS, and Frank E. Pink, DDS, MS

A prospective in vivo investigation was conducted to determine radiographic and clinical factors associated with contemporary nonsurgical endodontic retreatments. Approximately 1100 failing endodontically treated teeth were screened to determine an appropriate treatment plan. Using magnification, 337 consecutive retreatment cases were evaluated and treated. The vast majority of the retreated cases involved multiple factors. Eighty-five percent of the cases presented with periradicular radiolucencies. Sixty-five percent of the cases demonstrated poor radiographic obturation quality. Associated pain was noted 51% of the time. Forty-two percent of the teeth had untreated canal space. It was statistically significant (Chi-square, $p \leq 0.05$) that additional canal space was located and treated in 89% of the cases that had previous radiographic asymmetrical obturations. Evidence of coronal leakage was noted in 13% of the retreated teeth. Tooth number, obturation materials, overfills, and previous surgical retrofillings were also recorded. Recommendations were made that might improve the rate of clinical success.

An evaluation of the endodontic literature reveals that there is a significant percentage of root-canal-treated teeth that do not respond to treatment in a manner consistent with clinical or radiographic success (1, 2). Reported nonsurgical endodontic success rates vary considerably. One of the more extensive classical studies, which was conducted at the University of Washington, revealed an almost 9% failure rate 2 yr after treatment (1). This analysis is certainly a reasonable benchmark on which to base optimistic clinical expectations. There are certainly differences of opinion as to what constitutes success and failure. However, most clinicians would agree that after appropriate restoration, the patient should ideally return to comfortable mastication, exhibit clinical lack of pathosis, and eventually have radiographic evidence of normal healed periradicular osseous structures. These endodontic treatment goals are usually obtainable by the competent clinician. However, even the most experienced clinician will have occasional endodontic failures. When endodontic failure or continued endodontic disease is evident, additional nonsurgical or surgical treatment options should be considered.

The presence of infection and/or varying degrees of inflammation is assumed to usually be present when the desired endodontic treatment results are not achieved. Numerous factors are associated with failing nonsurgical endodontic treatment. The cause of the endodontic failure is often multivariant. Causes of failure include: incomplete obturation, root perforation, external root resorption, coexistent periodontal-periradicular lesions, grossly overfilled or overextended canals, canals left unfilled, developing apical cysts, adjacent pulpless teeth, inadvertently removed silver points, broken instruments, unfilled accessory canals, constant trauma, and nasal floor perforation (1). Recent literature has additionally suggested coronal leakage of bacteria or endotoxin as potential causes of endodontic treatment failure (3–5). The clinical significance of this leakage is debatable (6–8).

The purpose of this investigation was to prospectively identify radiographic and clinical factors associated with teeth that receive contemporary nonsurgical endodontic retreatment. It was anticipated that an evaluation of why the retreatments were necessary would lead to recommendations that might improve the rate of clinical success.

MATERIALS AND METHODS

All patients referred for management of failing endodontically treated teeth were initially examined to determine a diagnosis and decide upon the appropriate course of treatment. Informed consent was routinely obtained from each patient before examination or treatment. Approximately 1100 failing endodontically treated teeth were screened. A significant number of "endodontic failures" were subsequently extracted due to the patients desire, extensive recurrent caries, severe periodontal disease, vertical root fractures, extensive resorption, or nonrepairable iatrogenic misadventures. Although these extracted teeth were endodontically treated, the cause of failure was not necessarily directly related to the endodontic treatment. Teeth that the author did not feel could be improved by additional nonsurgical endodontic treatment were scheduled for surgical endodontic treatment. Endodontic failures that were extracted or surgically treated were not included in this evaluation, because all pertinent data could not be obtained. The remaining 337 consecutive nonsurgical retreatment cases involving 822 canals were the basis for the data included in this investigation. In most instances it was not possible to accurately determine the length of time since the preceding endodontic treatment

was completed. The author (M.H.) under magnification of at least 3.25 power completed all clinical evaluation and retreatment. During the examination and subsequent treatment, 12 factors were evaluated. The patient was questioned and the tooth was tested to determine whether there was associated pain. The tooth number was recorded. The tooth was radiographically evaluated for evidence of caries, resorption, fracture, periradicular pathosis, poor obturation quality, additional untreated canal space, overextension of filling material, type of filling material, and evidence of adequate coronal restoration. During the clinical retreatment of the first 100 cases, the author observed an apparent correlation of the asymmetric position of the previous obturation material and subsequent ability to locate untreated canal space. Starting with case #101, all additional cases were observed to objectively evaluate for the presence of an asymmetrical obturation. The clinical treatment provided additional insights as to the evidence of coronal leakage, additional untreated canals, type of filling material, instrument fragments, perforations, fractures, canal patency, and periodontal condition.

The presence of pain was determined subjectively by questioning the patient. No distinction was made as to frequency, duration, cause, or intensity. The presence of pain was determined objectively by noting clinical responses to palpation of the periradicular tissues, percussion, bite testing, and when indicated, thermal testing of the tooth. Objective or subjective painful responses were the basis for the tooth being included in the painful category.

The presence of a periradicular radiographic lesion was determined by visually inspecting the digital or film image with magnification. Widening of the periodontal ligament space by 1 mm or more on at least one root was necessary to categorize the tooth as having a periradicular radiographic lesion. When sufficient radiographs were available, the obvious enlargement of a previous radiographic lesion was additionally noted. Poor obturation quality was defined radiographically as filling material that was more than 2-mm short of the radiographic root apex or that had evidence of obvious voids within or adjacent to the root canal filling material. Obturation material that extended 2 mm or more beyond the radiographic root apex was noted as an excessive overfill. The type of filling material was categorized as paste, silver cone, gutta-percha with carrier, a combination of materials, or only gutta-percha. No effort was made to determine the presence or type of sealer that was utilized in the obturation process. The radiographic presence of a surgically placed retrofilling was also noted when present. Caries that communicated with the root canal filling or loss of the coronal restoration were considered radiographic evidence of coronal leakage. After the first 100 cases, the radiographic position of the root canal filling material relative to the external surface of the root was measured to determine whether the filling was symmetrically located within the root. The measurements were typically made in the middle third of the root, along a horizontal line perpendicular to the long axis of the filling material. The distances from the edge of the filling material to the periodontal ligament were noted. These measurements were made directly on the film using a hand-held ruler or on the digital images using the appropriate digital software measurement tool. Instances of asymmetry were recorded when differences of more than 0.5 mm were measured (Fig. 1).

During the clinical nonsurgical retreatment, instances of previously untreated canals were noted. Clinical treatment also confirmed the type of filling material and further identified instances of coronal leakage. Clinical evidence of coronal leakage was considered present when restorations were missing, fractured, or unserviceable. Additionally, clinical evidence of coronal leakage was noted when there was staining of caries or fractures within the pulp chamber or obvious corrosion of root canal sealer. Dector (DenMat, Santa Maria, CA, U.S.A.), Seek, and Sable Seek (Ultradent, South Jordan, UT, U.S.A.) were the stains utilized.

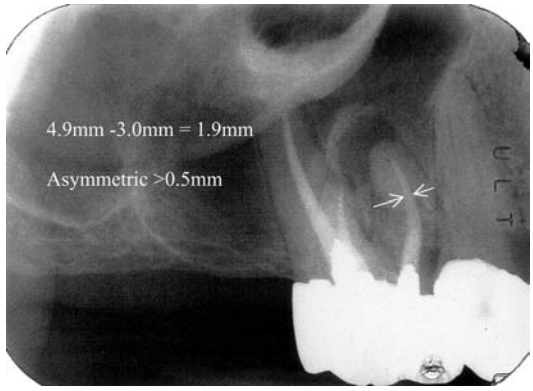

FIG 1. Periapical radiograph, demonstrating obturating material not centered within the mesial buccal root of tooth #3. Horizontal measurements from periodontal ligament to the gutta-percha differ by 1.9 mm. Asymmetric study criteria was a difference of at least 0.5 mm.

TABLE 1. Number of retreatments

Maxilla		Mandible	
Tooth	Count	Tooth	Count
1	0	17	1
2	9	18	15
3	41	19	38
4	18	20	10
5	10	21	5
6	3	22	3
7	8	23	2
8	9	24	7
9	14	25	4
10	8	26	2
11	5	27	2
12	7	28	7
13	9	29	7
14	37	30	29
15	11	31	16
16	0	32	0

RESULTS

The distribution of retreated teeth is listed in Table 1. The tooth most often retreated in this investigation was the maxillary right first molar, #3. As a group, more maxillary teeth (189; 56%) were retreated than mandibular teeth (148; 44%). Molar teeth (197; 58%) were more commonly retreated than the combination of bicuspids (73; 22%) and anteriors (67; 20%). Pain was noted in 172 cases (51%). There were 284 instances of the presence or enlargement of a radiographic periradicular lesion (84%). Two hundred nineteen of the cases demonstrated poor radiographic obturation quality (65%). Missed canals were noted in 143 cases (42%). Excessive overfills were noted in only 11 cases (3%). Evidence of radiographic or clinical coronal leakage was noted in 42 cases (13%). Silver point obturation was noted in 77 cases (23%). Paste fillings were noted in 33 instances (9%). Gutta-percha with metal or plastic core carriers were noted in eight teeth (2%). There were 53 cases in which the previous obturation material was not symmetrically located within the root (22% of the cases measured). In 47 of 53 cases with an asymmetrical obturation, an additional canal

was located during the clinical nonsurgical retreatment (89%). The association of asymmetric obturations and clinically locating additional canal space was statistically significant (Chi-square, $p \leq 0.05$). Excessive overfills were noted in 10 cases (3%). Previous surgical retrofillings were present in three cases (1%).

DISCUSSION

Although there is no direct correlation with classic success/failure literature, it is interesting to note that there were several areas of findings agreement. Certainly the factors associated with failures and retreatments are multivariant. Overfilling the canal space seems significantly less of a problem than incomplete or poor obturation quality. Excessive overfills were noted in 3% of teeth in this investigation, 4% of Washington study failures, and 12% of the teeth evaluated by Petersson et al. (1,2). It can be argued that there is relatively more clinical importance to thorough removal of the canal system contents and subsequent complete obturation than the amount of filling material excess. Incomplete obturation in the Washington study (59%), in the Petersson study (50%), and poor obturation quality noted in this investigation (65%) were all high percentage negative influencing factors. Inadequate obturation is likely associated with difficulty in or incomplete instrumentation of the canal system. The lack of appropriate canal shaping only increases the clinical difficulty of subsequent cleaning and obturation procedures. Fifteen percent of the teeth retreated in the current investigation did not have an associated periradicular lesion, whereas much of the classic failure literature includes only teeth with radiographic evidence of periradicular pathosis.

As an educator and clinician, the author was disturbed by the 42% incidence of missed roots or canals discovered in this investigation. Unlike the 3% unfilled canal Washington Study cause of failure, this much higher incidence seems indicative of a lack of clinical thoroughness during the initial endodontic treatment. The routine use of magnification and stains certainly aids in the visualization of anatomic structures and may improve clinical treatment quality. In this investigation poor obturation quality was the factor under the clinician control that was most often associated with the teeth that were nonsurgically endodontically retreated. Certainly there has been no significant dental anatomical change in the past 30 yr. The relatively controlled academic environment of the Washington study may account for the majority of the laudable thoroughness. It is the authors' contention that efficiency rather than effectiveness may have been an underlying treatment consideration during the initial nonsurgical endodontic treatment of the failing teeth evaluated in the current investigation.

Symmetry of the root canal filling material within the radiographic root outline seems reasonable to expect. As early as 1925, Hess noted the consistent association of the canal space shape relative to the external surface of the root (9). Although this association is assumed, the authors were unable to locate scientific evidence of this relationship. During this investigation, the author was able to clinically locate and treat additional canal space in 89% of cases that had radiographic evidence of a previous asymmetric canal filling. A similar number of additional canals were located in retreated teeth that were classified as symmetrical. This may have been partially due to the relatively stringent investigation asymmetry criteria or the lack of consistency in radiographic technique. There was no numerical consistency to the amount of horizontal angulation change in obtaining the multiple initial radiographic views. The statistically significant high degree or correlation between an asymmetric obturation and the clinical ability to locate additional canal space seems clinically relevant. It seems reasonable and prudent to include the objective evaluation of obturation symmetry as simple part of an endodontic failure evaluation. The authors recommend that the decision process in determining the appropriate surgical versus nonsurgical treatment of an endodontic failure should include the expectation of unfilled canal space in cases with asymmetric obturations. Subsequent nonsurgical treatment of the unfilled canal space to eliminate disease is more thorough than the surgical attempt to apically seal the involved root and entomb remaining bacteria and their by-products.

Coronal leakage does seem to be a common factor associated with teeth requiring nonsurgical retreatment. Clinical evidence of leakage was noted in 13% of the retreated teeth. It was not possible to determine a time interval associated with the existence of the noted leakage. There was no clinical attempt made to determine the extent or character of the microleakage present. It is reasonable to assume that considerably more microleakage was present than the leakage that was clinically evident. Although microleakage is undeniably important, the degree of clinical significance associated with the occurrence of coronal leakage remains uncertain. Clinical judgment remains necessary in making the decision to retreat a tooth based solely on the evidence of coronal leakage. The fact that a tooth is asymptomatic may not be sufficient to preclude the need for retreatment.

Successful endodontic treatment should never be guaranteed, although a consistently high degree of success should be expected. The authors contend that the clinical application of a thorough knowledge of canal anatomy and meticulous attention to treatment detail are essential to minimizing failure and the need for subsequent endodontic retreatment.

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Dr. Hoen is associate professor and director, Graduate Endodontic Program, University of Detroit Mercy; his clinical practice is with Endodontic Associates in Bloomfield Hills, MI. Dr. Pink is professor and associate dean of Graduate Education and Research, Course Director Biostatistics & Research Design, University of Detroit Mercy School of Dentistry, Detroit, MI. Address requests for reprints to Dr. Michael Hoen, University of Detroit Mercy School of Dentistry, Endodontic Department, 8200 West Outer Drive, P.O. Box 19900, Detroit, MI 48219-0900.

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