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The Outcome of Endodontic Retreatment: A 2-yr Follow-up

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Retreatment is common in endodontics. The purpose of this article was to classify the different clinical situations encountered in retreatment cases and relate them to the outcome after an observation period of 24 months. A total of 425 patients (452 teeth) from 451 patients, consecutively admitted for root-canal retreatment, were monitored during a 24-month period. All teeth (254 molars, 107 premolars, and 91 single-root anterior teeth) were divided into two major categories: teeth with modified anatomy from previous endodontic treatment (root–canal-morphology altered) and teeth in which no significant anatomical changes were made by the former endodontic treatment (root–canal-morphology respected). Although the overall success was 69.03%, the success in the root–canal–morphology-respected group was 86.8% and in the root–canal–morphology-altered group 47% (Mann-Whitney *U* test $p < 0.0001$). The clinical success of an endodontic retreatment seems to depend on whether alterations in the natural course of the root canals were caused by previous root-canal treatment.

The orthograde retreatment of dental elements previously treated with the most varied techniques is a fairly common clinical practice, particularly for endodontic specialists. The need for retreatment has been frequently analyzed by using different points of view. In different European countries, epidemiological studies have shown an elevated number of teeth to be retreated resulting in periapical radiolucencies from poor root-canal therapies (1). Some authors have investigated the diagnostic process, general knowledge on retreatment procedures, and clinical behavior among dental students, general practitioners, and specialists.

The decision making process should consider the many different variables, as clearly illustrated by Reit and Dahlen (2). Some authors have reported better clinical results with surgical procedures compared with orthograde retreatment (3), although others have reported similar clinical outcomes using both techniques with slight differences related only to the time element (4).

In addition, only a few clinical trials have assessed orthograde retreatment efficacy, and most were conducted more than 10 yr ago. Bergenholtz et al. (5) reported a success rate of 78% in teeth with periapical pathologies and 94% in teeth without. Others, reviewing earlier literature on retreatment, reported a favorable outcome for greater than 66% of the study cases considered for the literature analysis (6). Allen et al. (7) obtained a favorable 65.6% outcome in a sample group of 667 subjects controlled after 6 months or more.

On the contrary, other authors related their outcomes to microbiological problems to discriminate root-canal retreatment. Sundqvist et al. (8), for example, reported an overall success rate of 74% of 50 cases examined after retreatment. They found that the success rate in bacteria-free canals was almost 80%; whereas in teeth with particular bacteria species the outcome was significantly lower (66%). In a study by Sjogren et al. (9), similar results were achieved and further considerations were made regarding the size of the lesions: the greater the lesion, the lower the success rate. Chugal et al. (10) confirmed these results.

During the diagnostic phase, only clinical signs and symptoms are available for dentists. Further information should be collected using radiographic analysis of the tooth to be retreated. Although Friedman (11) has offered a clear explanation, no attempts have been made to differentiate the many clinical situations and relate them to the final outcome. The purpose of this article was to classify the different clinical situations encountered in retreatment cases and relate them to the outcome after an observation period of 24 months.

MATERIAL AND METHODS

A total of 451 patients, whose characteristics are briefly summarized in Table 1, consecutively admitted for root-canal retreatment (RCRT), were monitored during a 24-month period.

Inclusion Criteria

After the anamnesis collection of data and an overall examination of oral status to exclude existing pathologies, the teeth needing retreatment were diagnosed. The diagnosis for retreatment was made according to the signs and symptoms reported by the patient, the preoperative radiographs showing apical radiolucency or not (taken with film holder and positioning arm), and classical clinical complaints, such as tenderness on touch, fistulas, and chewing pain on palpatory action of the buccal area.

TABLE 1. Patients enrolled in the study

	Total	Male	Female
No. patient enrolled	451	225	226
No. patient drop-out	26	14	12
No. patient controlled	425	211	214
No. of teeth	452	222	230
Mean age (yr) (SD)	40.5 (11.6)	41.5 (12.1)	39.7 (11.3)
Range (yr)	16–74	17–74	16–72

To ensure the correct diagnosis of periodontal disease with endodontic origin, a careful examination of each tooth's periodontal condition was performed before RCRT to exclude periodontal pathologies and root fractures. In patients with teeth having radiographically detectable apical lesions, no treatment was performed if acute symptoms were present at the scheduled appointment. Before treatment each patient filled out a regular, informed-consent form.

Classification Criteria

After radiographic analysis, which was occasionally performed with two different projections, the root-canal systems were classified into two large groups and nine categories, as follows. Teeth with root-canal morphology that has been respected by previous endodontic treatment, root–canal-morphology respected (RCMR), and teeth with root-canal morphology altered by previous endodontic treatment, root–canal-morphology altered (RCMA).

The first group, RCMR, included:

Calcification: natural obstacles with complete or partial obliteration of the root-canal space frequently encountered when pastes or cements were left short inside the root-canal system.

Apical stop: closure of the apical part of the canal related to the previous instrumentation.

Broken instrument: one or more stainless steel K-files or similar, or NiTi files.

Under-filled canal with gutta-percha or cement: root-canal systems insufficiently instrumented and sealed by a single-cone technique or poorly compacted lateral condensation. Both short and long levels of sealing were enclosed in this category.

The second group, RCMA, included:

Internal or external transportation: alterations toward the outer or inner parts of the curvature not leading to a perforation at the apical third.

Perforation: endodontic-periodontic communication of iatrogenic origin, either those located at the pulp chamber floor or in the lower third of the canal space.

Stripping: endodontic-periodontic communication of iatrogenic origin of the upper third extending to the middle third of the canal space.

Internal resorption: round enlargement of the canal determined by a degenerative pulpopathy left unsealed by former treatment.

Canal Retreatment Method

During retreatment the operators used loupes (3.5–5.5 magnification). All treatments were performed using the most recent crown-down techniques. An accurate cleansing of the pulp chamber and the coronal part of each tooth to be retreated was performed with rotating instruments or ultrasound tips. Ill-fitting crowns were removed and substituted by provisional ones in resin.

Various-shaped posts (cast posts, preformed screwed, or parallel posts) were carefully removed using ultrasound vibrations, by unscrewing motions or by Gonon extractor. Broken instruments were retrieved by ultrasound or, in some cases, with the Cancellieri device. In most cases of canals filled with cement or gutta-percha, a smooth action of different solvents (chloroform, xylene, or halotan) was used to synergically combine their action with ultrasound.

The root-canal system was handled with a stainless-steel K-file and NiTi engine-driven instruments under copious irrigation with warm (50°C) 5% sodium hypochlorite. The sequence of instrumentation was strictly dependent upon the root-canal morphology.

Almost all teeth were instrumented and sealed in one visit. In some cases, in which there was reduced patient compliance, an intermediate session with calcium hydroxide in the root-canal system and reinforced zinc–eugenol-provisional cement in the crown was used.

All teeth were sealed with warm gutta-percha vertical compaction, and a zinc-oxide sealer was used to create a more precise sealing action. The sealing limit was fixed within 0.5 to 1 mm from the radiographic apex, and a slight extension beyond this sealer limit was tolerated. While perforating and stripping, bases with fibrin adhesive, zinc-oxide–EBA-added cement, or amalgam were used. Perforations in the lower third of the root-canal system were repaired with warm gutta-percha.

At the end of the treatment, after 30 days, a complete adhesive reconstruction (direct or indirect), with intracanal retention if needed, was made to avoid coronal leakage. For all teeth with provisional crowns, a new one substituted the provisional one used during retreatment.

RECRUITMENT AND DROPOUT

A recall program adopted during usual specialist's practice was used to obtain radiographic checks on the teeth submitted to RCRT. Almost all patients had been recruited (425 of 451; 94.2%). The radiographs taken at 12 and 24 months (a rejection of almost 30 days was considered unimportant) were stored and forwarded to independent evaluators.

Radiograph Execution and Examination

RADIOGRAPH EXECUTION

Customized film holders and Ultra speed X-ray film (Kodak) were used throughout the study to expose radiographs using the paralleling technique. Radiographs were taken before and at the end of retreatment, and during the follow-up appointment. All lesions were measured under magnification (2×) following the longer axis and only teeth with apical lesions smaller than 5 mm were considered for the clinical trial.

RADIOGRAPH EXAMINATION

Two endodontists with at least 10 yr of clinical experience in endodontics were properly calibrated according to the scheme proposed in literature (12). All collected radiographs were independently examined twice (with intervals of almost 20 days) by each observer under 2× magnification lenses and assigned to the appropriate category at the corresponding time.

In molars, the evaluation of the treatment type was performed at the roots. Those that presented the most significant alterations were

TABLE 2. Outcome of the single type of retreatment cases

	N	*n*	Complete (%)	*n*	Incomplete (%)	*n*	Failure (%)	*n*	Success (%)	*n*	Failure (%)
RCMR											
Calcification	32	17	53.1	0	0.0	15	46.9	17	53.1	15	46.9
Apical stop	71	51	71.8	3	4.1	17	23.9	54	76.1	17	23.9
Broken instrument	61	58	95.1	1	1.6	2	3.3	59	96.7	2	3.3
Under-filled canal with gutta-percha or cement	81	81	100.0	0	0.0	0	0.0	81	100.0	0	0.0
Total	245	207	84.4	4	1.6	19	14.0	211	86.1	19	13.9
RCMA											
Internal or external transportation	90	27	30.0	5	5.6	58	64.4	32	35.6	58	64.4
Apical resorbsion	42	28	66.7	2	4.8	12	28.6	30	71.4	12	28.6
Perforation	43	22	51.2	4	9.3	17	39.5	26	60.5	17	39.5
Stripping	25	6	24.0	1	4.0	18	72.0	7	28.0	18	72.0
Internal resorb	7	5	71.4	0	0.0	2	28.6	5	71.4	2	28.6
	207	88	42.5	12	5.8	107	51.7	100	48.3	107	51.7
Total of both groups	452	295	65.3	16	3.5	126	31.2	311	69.0	126	31.0

Success cases were considered the sum of complete and incomplete cases only for teeth with periapical lesion at the beginning of the root canal retreatment.

TABLE 3. Outcome of the retreatment cases divided into groups considering the different periapical condition.

	No. teeth	Complete	Incomplete	Failure	Success		Failure	
					n	(%)	*n*	(%)
RCMR								
NO-PLEO	83	76	0	7	76	91.6	7	8.4
YES-PLEO	167	136	4	27	140	83.8	27	16.2
RCMA								
NO-PLEO	32	27	0	5	27	84.4	5	15.6
YES-PLEO	170	56	12	102	68	40.0	102	60.0

NO-PLEO = group of teeth without periapical lesion radiographically detectable; YES-PLEO = group of teeth with periapical lesion radiographically detectable.
Success cases were considered the sum of complete and incomplete cases only for teeth with periapical lesion at the beginning of the root-canal retreatment.

subsequently analyzed. In situations where two observers disagreed, the worst results were considered. All radiographs used to monitor each case's healing process were evaluated following previously reported classification to make the results more comparable to previous literature reports (4).

In this way, each tooth was classified into one of the following categories.

Complete healing: all teeth with a normal periodontal-ligament width surrounding the entire root contour at the 24-month control visit were considered. Slight extrusion of the sealer was tolerated. No clinical signs and symptoms were present at the control visit.

Incomplete healing: only considered in teeth with periapical radiolucency at the beginning of retreatment. All teeth whose radiographs showed a remarkable reduction of the periapical lesion without any associated clinical signs and symptoms were assigned to this group.

Unsatisfactory healing or failure: considered for teeth with and without periapical lesions at the beginning of the retreatment. In teeth without periapical radiological signs, but with clinical signs or symptoms at the beginning of the RCRT, the persistence of clinical signs or symptoms at the end of the RCRT or the appearance of a periapical radiolucency made them eligible for this group. All teeth with periapical radiographic signs at the beginning of the RCRT were classified in this category when the periapical radiolucency was still present, unchanged, or enlarged.

The success group was formed by the sum of completely and incompletely healed teeth, whereas the last group was considered in the failure group. All clinical records were given to the observers and the first two categories were always associated with clinical signs and symptom-free teeth.

Observers' Assessment

Intra- and interobserver analyses were performed using Kappa statistics.

RESULTS

The global results are summarized in Tables 2 and 3. As shown, the success percentage differs greatly in the two groups considered: the group having dental elements with canal and apical morphology alterations (RCMA), and groups with dental elements in which previous treatment had not determined this kind of problem (RCMR). Regarding the differences found when comparing the RCMR and RCMA groups, the evaluation performed with nonparametric Mann-Whitney tests showed a high statistical significance ($p < 0.0001$). The same significance was reported when evaluating the data subdivided by individual tooth regrouping. In single–root-canal teeth, the overall percentage result of success was 83.3% for the RCMR group and 48.7% for the RCMA group (Mann-Whitney *U* test; $p = 0.0009$). In premolars the percentage was 87.2% for RCMR and 50.3% for RCMA, and the molar group was 87.1% for RCMR and 44.1% for RCMA. In both subgroups the Mann-Whitney *U* test reported $p < 0.0001$. In the analyses,

another important variable was considered: the pretreatment presence of periapical lesions evident with radiographs (Table 3).

The presence of periapical lesions is another important element in determining the healing process. Comparing teeth with periapical lesions or not—89.5% of success in the first group and 61.7% in the latter—before the retreatment procedure, reported a statistically significant difference ($p < 0.0001$). This variable seems to be particularly relevant in the group with morphological alterations. In the RCMA group, teeth with periapical lesions compared with teeth without periapical lesions showed a significant difference ($p < 0.0001$). In the RCMR group, teeth with periapical lesions compared to teeth without periapical lesions showed a slight but not statistically significant difference ($p = 0.19$). Intra- and interobserver analyses, performed by K statistics, resulted in a good percentage, respectively $K = 0.85$ and $K = 0.88$.

DISCUSSION

The collection of retrospective and prospective literature on retreatments has revealed variable success percentages ranging between 40% and 85%. Most of these were written more than 20 yr ago and endodontic techniques today are very different from those in the past. The results that have emerged from this program have been generally very close to those previously presented (3–7, 9). In addition, with many retreatments, only dental elements from the anterior region were considered, because their anatomy is definitely less complex than teeth from the posterior regions.

Our data are not entirely comparable with previous data, because possible anatomical variations determined from preceding treatments were not considered as an independent variable—as far as we know—by other authors. The suggested classification, although personal, brings to light how different outcomes can be determined by different anatomical situations under the same clinical-treatment issue.

Therefore, this result, considering the elevated number of molars present in the sample, must be cautiously reported to other authors. Nevertheless, not having noticed significant differences between groups of dental elements, the majority of molars present in the study do not seem to have negatively influenced the final result.

As expressed many times, the variable that seems to be significantly influential is canal alteration. Comparing dental elements from the RCMR group and teeth from the RCMA group, an enormous difference in healing is noted, whatever group of teeth is considered.

In this study the microbiological component, examined in other retreatment studies, was not considered. Some authors, for example, had completed a longitudinal study without performing the analysis (4, 7). On the other hand, some authors had demonstrated that control of this variable seems to be decisive for the success of the retreatment therapy (8, 9, 13).

This study did not check the importance of failures, because a considerable part had already been handled by other researchers to explain it. Peciuliene et al. (14, 15), for example, maintains that a large part of failures was attributed to types of bacteria that are not sensitive to normal flushing.

Nair et al. (16) have demonstrated that microbiological factors are as important as technical ones. They confirmed the hypothesis according to which the microbiological component was not the only thing responsible for failure, which Siqueira also stated (17).

Probably, in cases where there are damaged morphologies, an inferior cleansing can be performed specifically aimed at the anatom-ical irregularities created by previous treatment. The low healing percentage for cases with perforations could be because of the type of material used. On the basis of the study conducted, however, partially susceptible to reevaluation with longer observation periods, the deciding criteria for procedures for an endodontic retreatment must be based on different clinical aspects. Among these, the presence or absence of visible radiographic periapical lesions might be important but does not seem to weigh on other variables. Among the others, the alterations performed on the natural course of root-canal systems by previous endodontic treatments seem to have a key role.

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