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Endodontic Retreatment: Evaluation of Gutta-percha and Sealer Removal and Canal Reinstrumentation

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To examine the appearance of root canal walls after retreatment, 80 extracted teeth were chemomechanically prepared using a stepback flare technique and obturated with gutta-percha and either Roth's 801 or AH26 sealers. Four techniques were used to remove gutta-percha and sealer: method 1—heat and files; method 2—heat, files, and Cavi-Endo; method 3—chloroform and files; and method 4—chloroform, files, and Cavi-Endo. The teeth were sectioned longitudinally and the amount of debris remaining was quantitated. The results showed that no technique removed all debris. When AH26 was the sealer, method 4 was significantly less effective. When Roth's 801 was the sealer, method 1 was significantly less effective. Teeth obturated using Roth's 801 sealer were significantly cleaner after reinstrumentation.

The problem of failure following root canal therapy faces all dental practitioners who reevaluate their endodontic patients.

Several explanations for failure of root canal treatment have been proposed, including apical percolation, root perforation, unfilled canals, coexisting periodontal lesions, and gross over- and underextension of filling materials (1, 2). Coronal leakage due to loss of a restoration or recurrent decay may also contribute to endodontic failure (3). Most of these causes for failure, for instance, incomplete obturation, under- and overextension of filling materials, and coronal leakage, may be amenable to intracanal retreatment.

If conventional retreatment is not possible, a surgical procedure may have to be performed to maintain the tooth. Usually, however, the option of retreating the tooth through the root canal system is possible. The prognosis would be improved following better debridement and canal obturation and apical surgery may be avoided.

Bergenholtz et al. (4) examined 660 teeth which previously had root canal treatment and were to be retreated for either technical reasons, i.e. short fillings and voids, or for the presence of periapical radiolucencies. All of the teeth were retreated through the root canal system, the patients were recalled for examination 2 yr later, and the teeth were evaluated radiographically. In the "technical indication" group the technical quality of the root canal was improved. Ninety-four percent of the group was judged to have been successfully retreated. In the group with periapical radiolucencies, 48% of the teeth healed completely and 30% showed a decrease in the size of the lesion. Twenty-two percent of the teeth were unchanged or had worsened.

In a more detailed analysis of the same material, Bergenholtz et al. (5) reported that when teeth with periapical lesions had either overextension of instruments or materials during retreatment, success was markedly less than when they were confined to the canal space.

These studies suggest that intracanal retreatment can be effective in eliminating the clinical and radiographic signs of pathosis and may result in improved technical quality of the obturated root canal. More importantly, from the patient's point of view, the necessity for a surgical intervention may be eliminated.

PURPOSE

The purpose of this study was to evaluate one major aspect in the retreatment of root canal failures, i.e. the removal of gutta-percha and sealer from the canal and reinstrumentation of the canal space. The main objective was to examine the appearance of the root canal walls after gutta-percha and either AH26 or Roth's 801 sealer were removed by various methods. No previous studies of this type have been published.

MATERIALS AND METHODS

Eighty extracted single-rooted human teeth were obtained and stored in distilled water containing 1% thymol until use. Access openings were made into the pulp chamber using a #557 bur and water spray. A #10 file (K-Flex; Kerr/Sybron, Romulus, MI) was placed into the canal until it was visible at the apical foramen and the working length was established at 1 mm short of that length. The apical preparation was completed using small master apical files. A stepback flare tech-

nique (6) was used to complete the canal preparation. A 2.5% sodium hypochlorite irrigation was used during cleaning and shaping the canals. Preparation was deemed complete when there were clean dentin filings and when a Luks "B" finger spreader could be inserted to within 1 mm of working length. The canals were dried and apically cleared of debris using files one or two sizes larger than the master apical file.

By using a table of random numbers, teeth were assigned to one of eight groups of 10 teeth each and mounted in acrylic blocks. One half of the teeth was obturated using Roth's 801 (Roth's Root Canal) and one half with AH26 (DeTrey, Zurich, Switzerland).

Commercially obtained sealers used were mixed according to the manufacturer's instructions. Roth's 801 was mixed until it could be raised 1 inch off a glass slab. AH26 was mixed until a thick consistency without graininess was obtained. The teeth to be obturated were selected at random. A fine gutta-percha cone (Kerr/Sybron) was trimmed to fit the apical preparation and the correct length was verified radiographically. The canal was obturated using lateral condensation. Following placement of cotton in the pulp chambers and temporization with Cavit (Premier, Norristown, PA), the teeth were radiographed and stored in a humidor at 37°C for 2 wk.

Four retreatment techniques were used to remove the gutta-percha and sealer from the canals. In all cases the criteria for completion of reinstrumentation were the presence of clean filings, no additional gutta-percha or sealer present on the files, and smooth canal walls.

The four techniques were:

Method 1—Heat and files (HF). A red hot 5/7 heater plugger was used to remove gutta-percha and sealer from the canal, and the canals were reinstrumented to the original working length with the same or larger sized file.

Method 2—Heat, files, and Cavi-Endo (Dentsply, York, PA) (HFC). A red hot 5/7 heater plugger was used to remove gutta-percha and sealer from the canals and then they were reinstrumented to the original working lengths with K-Flex files. Using 1.25% sodium hypochlorite as an irrigant, a #15 file in the Cavi-Endo was then activated within the canal for 2 min, during which time a gentle, peripheral filing motion was used.

Method 3—Chloroform and files (CF). The gutta-percha was softened with chloroform and removed with barbed broaches and the canals were reinstrumented to the original working length with K-Flex files.

Method 4—Chloroform, files, and Cavi-Endo (CFC). The gutta-percha was softened with chloroform, removed with barbed broaches, and the canals were reinstrumented to the original working length with K-Flex files. Using 1.25% sodium hypochlorite as an irrigant, a #15 file in the Cavi-Endo was activated within the canal for 2 min, during which time a gentle, peripheral filing motion was used.

After the final instrumentation, all canals were copiously irrigated with sodium hypochlorite, dried with paper points, and apically cleared of debris.

ANALYSIS

The teeth were removed from the acrylic blocks, grooved on the buccal and lingual surfaces, and fractured longitudinally in a vise. For those teeth that did not split evenly, only the section with the canal was used for analysis. All samples were photographed under uniform conditions using Kodachrome 25 film. The slides were coded, randomly mixed, and then measured in sequence to avoid operator bias.

Tracings of the root canal space, sealer, gutta-percha and unknown debris were then made for each sample at a magnification of ×12 by projecting the slides onto a piece of white paper (Fig. 1). Gutta-percha was identified by its pink color, AH26 was seen as coherent areas of greenish gray material, and Roth's 801 as white or grayish plaques. Substances within the instrumented portion of the canal which could not be identified as either sealer or gutta-percha were labeled as unknown material.

The tracings were measured on a SAC Sonic Digitizer (model GP-30; Science Accessories Corp., Southport, CT) to quantitate the outlined areas. In order to test the reliability of this instrument, 10 area measurements (controls) on each of five randomly selected tracings were done. They showed an individual variation of less than 1%, which was considered acceptable for this experiment.

Each tracing was divided into thirds from the cementoenamel junction to the terminus of the apical preparation. Each third was measured separately. The total canal area and areas of sealer, gutta-percha, and unknown material in each of the three regions were also measured for each half of the split tooth. An analysis of variance and Duncan's multiple range test were used to determine whether significant differences existed among groups and for the presence of possible interactions.

RESULTS

Of the original 80 teeth, 74 remained for analysis. Two fractured during obturation, one fractured during gutta-percha removal, and two Gates Glidden drills and one finger spreader separated in the canals.

All of the teeth examined had some debris remaining in the canals (Fig. 2). The few teeth with almost no debris had usually been obturated with Roth's 801 sealer. Several teeth, all of which were obturated using AH26 sealer, had large amounts of debris, especially in the apical third. The AH26 appeared to adhere to the gutta-percha. In the apical area of several teeth, one half of the canal wall appeared to be completely clean

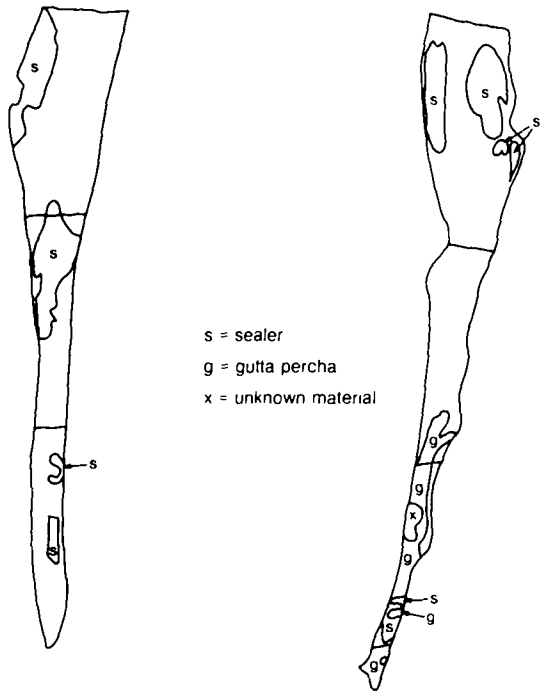

FIG 1. Tracing of canal outline and content after reinstrumentation. Sealer makes up the majority of debris overall. The gutta-percha is primarily in the apical portion of the canal.

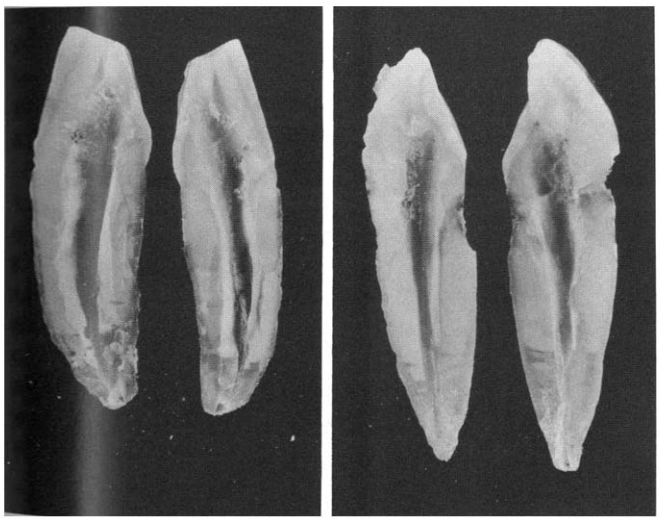

FIG 2. The tooth on the *left* shows a relatively large amount of debris remaining in the right half of the tooth and very little debris in the left half. AH26 was the original sealer and method 2 was the removal technique. The tooth on the *right* is relatively clean, except for some coronal sealer. Roth's 801 was the original sealer and method 2 was the removal technique.

while the opposite half was entirely filled with AH26 and gutta-percha (Fig. 2, *left*). In general, sealer made up the largest percentage of the debris remaining in reinstrumented canals (Table 1).

In the coronal third of the tooth, there was no significant difference between AH26 and Roth's 801 when the removal method was not considered ($p < 0.2782$). When AH26 was used, method 4 was significantly worse than the other three methods (Fig. 3*A*).

In the middle third, teeth obturated with Roth's 801 had significantly less debris than those obturated with AH26 ($p < 0.0001$). This may have been due to the large amount of debris left when method 4 was used (Fig. 3*B*).

In the apical third, teeth obturated with Roth's 801 had significantly less debris than those obturated with AH26 ($p < 0.0001$). There were no differences among methods of removal for the teeth obturated using AH26 sealer. Method 1 was less effective than methods 3 and 4 for teeth obturated using Roth's 801 (Fig. 3*C*).

Overall, teeth obturated using Roth's 801 had significantly less debris than those obturated with AH26 ($p < 0.0003$). Method 4 was significantly less effective when AH26 was the sealer and method 1 was significantly less effective when Roth's 801 was the sealer (Fig. 3*D*).

DISCUSSION

There are no techniques in the literature which adequately describe removal of gutta-percha and sealer for intracanal retreatment. In the classic article by Bergenholtz et al. (4), the technique used is briefly mentioned: "The previous root-filling was removed mechanically using root canal files. When root-filling material was difficult to remove, chloroform was used" (4). No criteria were given for what was considered a complete canal reinstrumentation.

Endodontic retreatment presents many problems, not the least of which is the decision of whether to retreat, extract, or perform surgery. If the clinician is confident that a root fracture, a ledged canal, or a perforation is not present, then retreatment is the least invasive treatment alternative. In many cases there is no apparent reason for failure, and the retreated canal may have the same radiographic appearance as it did originally. Moreover, during retreatment, the apical por-

TABLE 1. Mean percentages of sealer, gutta-percha, and unknown material by group

	Sealer and Removal Method							
	AH26 HF	R801 HF	AH26 HFC	R801 HFC	AH26 CF	R801 CF	AH26 CFC	R801 CFC
Mean % sealer	12.2	17.1	17.9	10.1	14.7	13.0	32.3	12.2
Mean % gutta-percha	8.7	1.7	2.6	0.4	3.1	1.8	3.6	2.3
Mean % unknown material	3.5	6.9	1.3	1.7	3.6	2.4	3.9	1.4

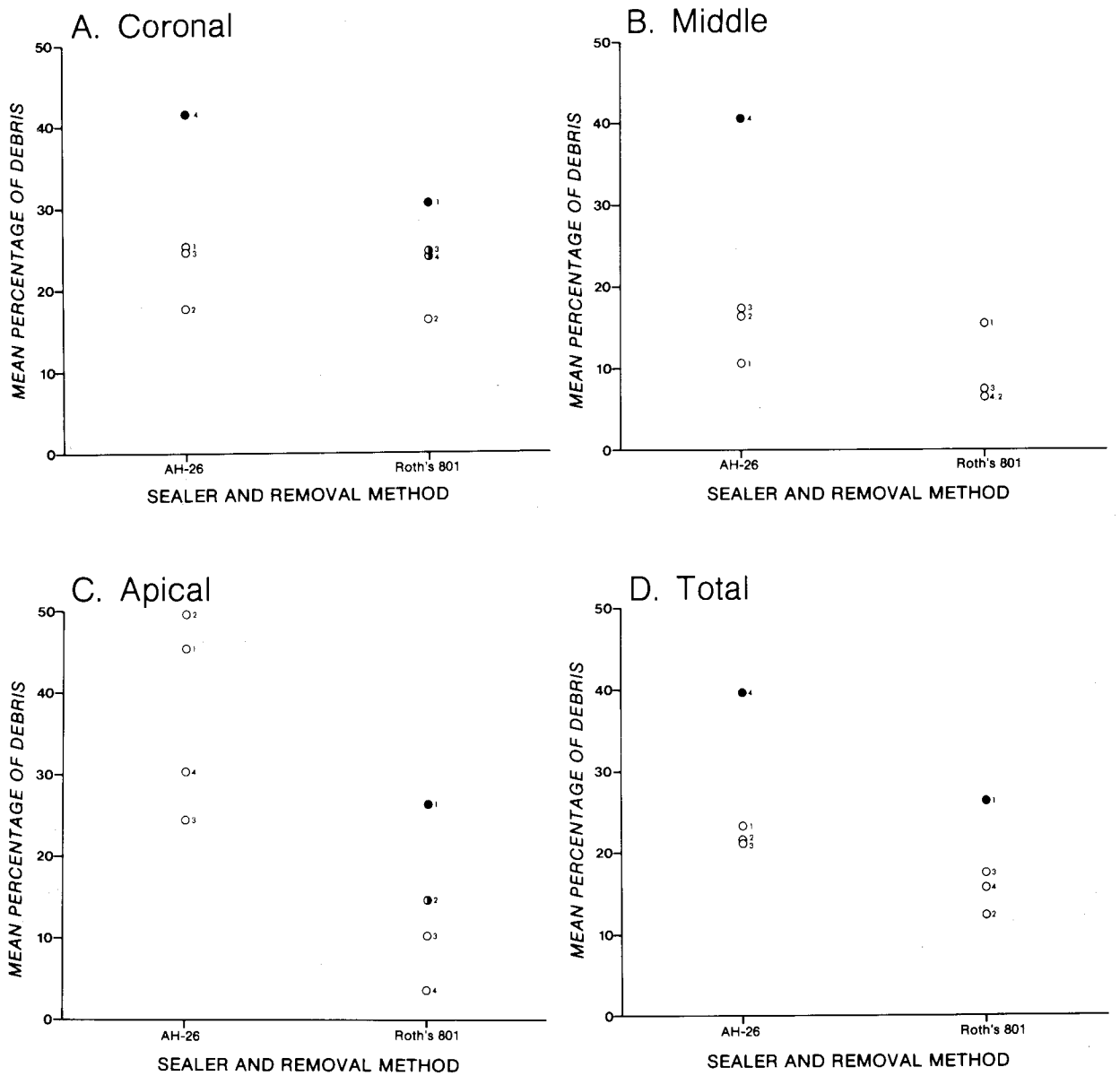

FIG 3. Results of Duncan's test for total canal and coronal, middle, and apical thirds. In each separate sealer group, the mean percentage of debris for each method is represented by a symbol. Those values with the same symbol (or half-symbol in a few cases) are not significantly different from each other. For example, in *A*, Roth's 801, group 1 is significantly different from group 2, but groups 3 and 4 are not significantly different from groups 1 or 2 or from each other. Group 1, HF; group 2, HFC; group 3, CF; group 4, CFC.

tion of the canal is often overenlarged, creating the possibility of apical perforation.

It is interesting to note that none of the reinstrumented canals were completely free of debris, even with ultrasonic instrumentation. Conflicting results have been reported on the efficacy of ultrasonic instrumentation on the debridement of the root canal system. Martin and Cunningham (7) reported that significantly more debris (pulp and predentin) is removed with ultrasonic techniques than with hand instrumentation alone. In contrast, Langeland et al. (8) reported recently that there is no difference between the two techniques in the amount of debris left in the canal. Results of the study reported here do not clarify whether ultrasonic instrumentation as a final step improved sealer and gutta-percha removal. Perhaps a different irrigant, such as chloroform, could have improved the results.

One of the difficulties encountered in this study was the removal of gutta-percha and sealer from roots obturated using AH26. AH26 is an epoxy resin sealer which polymerizes to a very hard consistency. In the roots obturated with gutta-percha and AH26, a red hot heater plugger usually could not penetrate far enough into the canal to allow a file to be inserted next to the gutta-percha to facilitate removal. Introduction of a Gates Glidden bur 1 to 2 mm into the gutta-percha was required to make space for files or chloroform. The canals obturated with AH26 were also the only ones in which the original working length could not always be achieved, despite lengthy attempts with small files. This

difficulty may account for the large amounts of sealer and gutta-percha found in the apical third of the AH26 groups.

In contrast, in the Roth's 801 groups there was no difficulty in regaining working length. In most cases large amounts of gutta-percha and sealer were removed from the canal on the first application of heat. By using chloroform as a solvent, it was common for most of the gutta-percha to be removed on the first attempt.

Clinical impressions of the differences between Roth's 801 and AH26 were substantiated in the results which showed that canals obturated using Roth's 801 were cleaner.

Future research should include investigation of apical leakage after retreatment and coronal leakage after retreatment; both for method of removal and the type of sealer. Other sealers may be tested to determine whether they are more easily removed than the two sealers tested here. Additional retreatment prognosis studies to supplement the Scandinavian studies should also be done. A histological examination of the retreated root canal spaces would provide more detail as to the types and location of debris remaining in the retreated root canal. The use of chloroform as an irrigant during ultrasonic instrumentation of retreated roots should be examined.

SUMMARY

An in vitro study using extracted human teeth was done to evaluate retreatment techniques for removal of gutta-percha and sealer from previously obturated canals. Under conditions of this study, the results showed that:

1. All methods of removal left debris in the canals.
2. Sealer accounted for the greatest percentage of debris in canals.
3. When AH26 was the sealer, removal with method 4 resulted in the most remaining debris; there was no significant difference among the other methods.
4. When Roth's 801 was the sealer, removal with method 1 resulted in the most remaining debris; there was no significant difference among the other methods.

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