Efficacy of 3 Techniques in Removing Root Canal Filling Material

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ABSTRACT

Objective: Retreatment of a root canal in the case of infection requires complete removal of previous filling material. This study evaluated the efficacy of 3 techniques in removing laterally compacted Resilon/Epiphany and gutta-percha/AH Plus from straight and curved canals during retreatment.

Materials and Methods: Extracted human teeth (90 maxillary anterior teeth with single, straight root canals and 90 mandibular molars with mesial canal root curvatures of 20° to 35°) were divided into 6 groups each consisting of 15 straight and 15 curved root canals. Three groups were obturated using gutta-percha/AH Plus and 3 were obturated with Resilon/Epiphany. After 3 weeks storage at 37°C and 100% humidity, all root canal fillings were removed using a Gates Glidden drill, a Gates Glidden drill plus chloroform or a System B device.

Results: For all removal techniques, specimens obturated with gutta-percha/AH Plus showed significantly more remnants of obturation material than specimens filled with Resilon/Epiphany for both straight and curved canals ($p < 0.05$). Removal time was shorter for Resilon/Epiphany than gutta-percha/AH Plus filling for all techniques and for both curved and straight canals. The Gates Glidden drill and Gates Glidden drill plus chloroform removal techniques were significantly faster than the System B technique for both straight and curved canals. The Gates Glidden drill technique was best for straight canals, whereas the Gates Glidden drill plus chloroform was the best technique for curved canals when removing Resilon/Epiphany sealer.

Conclusions: Removal of Resilon/Epiphany filling resulted in fewer remnants and was faster than gutta-percha/AH Plus removal using a Gates Glidden drill with or without chloroform in both straight and curved canals.

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After a root canal procedure, a tooth may require retreatment because of a persistent infection or reinfection of the root canal. Retreatment requires complete removal of the root canal filling material, followed by further shaping, cleaning and reobturation.[1–3] Many of these cases can be managed successfully and the tooth saved by careful endodontic retreatment.

Although numerous materials have been prescribed for obturation of root canals, gutta-percha in combination with a sealer is most frequently used. Various methods are used to remove the filling material: thermal, mechanical, chemical and a combination of the 3.[4] Methods for using gutta-percha and its solvents have been well researched.[5–8]

Table 1 Experimental groups showing the various combinations of obturation material and removal techniques examined in this study

Group	Obturation material	Removal technique	No. specimens	
			Straight canal	Curved canal
1	Gutta-percha/AH Plus	Gates Glidden drill	15	15
2	Resilon/Epiphany	Gates Glidden drill	15	15
3	Gutta-percha/AH Plus	Gates Glidden drill + chloroform	15	15
4	Resilon/Epiphany	Gates Glidden drill + chloroform	15	15
5	Gutta-percha/AH Plus	System B device	15	15
6	Resilon/Epiphany	System B device	15	15

Resilon is a new material (Resilon/Epiphany, Pentron Clinical Technologies, Wallingford, Conn.) that has recently been developed as an alternative to gutta-percha and traditional sealers for root canal obturation. Resilon is a thermoplastic synthetic polyester polymer-based root canal core material that contains bioactive glass, bismuth oxychloride and barium sulfate. The filler content is approximately 65% by weight. Resilon cones come in a range of sizes similar to gutta-percha cones. Epiphany sealer is a dual-curable, resin-based composite sealer. The Resilon bonding agent is a self-etching primer that contains sulfonic-acid terminated functional monomer, HEMA, water and a polymerization initiator.

There is little available information about the removal of Resilon/Epiphany sealer. Thus, in this study, we assessed and compared gutta-percha/AH Plus (Dentsply, GmbH, Konstanz, Germany) with Resilon/Epiphany in terms of remaining filling material and working time using several techniques to remove these materials from extracted teeth.

Materials and Methods

In this study, 180 extracted human teeth were used: 90 maxillary anterior teeth with single, straight root canals and 90 mandibular molars with mesial canal root curvatures of 20° to 35°. Roots with open apices, cracks or resorptive defects were excluded. Teeth were cleaned carefully with a curette to remove soft tissue remnants and stored in a saline solution before instrumentation.

Root Canal Preparation and Obturation

To avoid anatomical variation and to standardize the measurements in this study, crowns of the teeth were sectioned at the cementoenamel junction using water-cooled diamond discs. Canal lengths were established visually by placing a size 15 K-type file (Kerr, Romulus, Mich.) into each root canal until the tip of the file was visible at the tip of the apical foramen. The working length was established at 1 mm short of the apex. The canal systems were instrumented to the working length with a size 35 K-file using a step-back technique. The coronal third of the roots was flared using a size 2–4 Gates Glidden drill (Dentsply, Maillefer, Switzerland; ISO size 70–150) with a low-speed handpiece. During preparation, root canals were irrigated with 10 mL of 5.25% NaOCl after each depth assessment. The smear layer was removed by rinsing with 10 mL of 17% EDTA (Canal+, Septodont, France) for 60 seconds, followed by 10 mL of 5.25% NaOCl. Finally, the root canals were flushed with 3 mL saline solution, then dried with paper points.

Experimental Groups

The 180 teeth were divided into 6 groups each consisting of 15 straight and 15 curved root canals (**Table 1**).

In groups 1, 3 and 5, the roots were filled with gutta-percha/AH Plus using cold lateral compaction. A size-30 master cone and root canal sealer were placed in the canal. Lateral condensation was accomplished using finger spreaders and gutta-percha accessory points with sealer until the canal was completely filled. The obturation was judged to be complete when a spreader could not penetrate more than 3 mm into the gutta-percha mass.

In groups 2, 4 and 6, the roots were filled using Resilon/Epiphany sealer. A self-etching primer (Epiphany Primer, Pentron Clinical Technologies) was inserted into the canal with a thin needle. Excess primer was removed with paper points. The canals were obturated by cold lateral compaction using a size-30 master Resilon cone and Epiphany sealer. The obturation process was similiar to that used for the gutta-percha/AH Plus groups.

After the quality of the obturation was assessed radiographically, root canal entrances were sealed with temporary filling material (Cavit, ESPE Dental, Medizin, Germany) and specimens were stored at 37°C and 100% humidity for 3 weeks.

Table 2 Comparison of times needed to remove canal filling material according to filling material and removal technique

Specimen type	Removal technique	Removal time (min ± 95% CI)		*p* value
		Resilon/ Epiphany filling	Gutta-percha/ AH Plus filling	
Straight canal	GG	2.89 ± 0.337	3.06 ± 0.269	0.081
	GG + C	3.01 ± 0.420	3.32 ± 0.456	0.045
	SysB	3.49 ± 0.542	3.58 ± 0.404	0.653
Curved canal	GG	4.59 ± 0.343	4.86 ± 0.337	0.006
	GG + C	4.86 ± 0.375	5.20 ± 0.460	0.006
	SysB	5.37 ± 0.525	5.59 ± 0.467	0.436

Note: CI = confidence interval, GG = Gates Glidden drill, GG + C = Gates Glidden drill + chloroform, SysB = System B device.

Removal of Root Canal Fillings

All roots were mounted on plastic tubes with acrylic resin, and temporary fillings were removed using round burs. Root canal fillings in both obturation groups were then removed using 1 of the following 3 techniques:

- *Gates Glidden drills:* Gates Glidden drills (size 4) were used to remove two-thirds of the root canal material. Hedström files (size 30) were then used in a reaming motion to reach the working length.
- *Gates Glidden drills plus chloroform:* Chloroform (0.5 mL per tooth; Merck, Darmstadt, BRD, Germany) and Gates Glidden drills (size 4) were used to remove two-thirds of the root canal material and create a reservoir for the solvent. Stainless steel hand K-files (size 30) plus Hedström files (size 30) were then used in a reaming motion to reach the working length.
- *System B:* A Buchanan 0.06-taper fine-tip plugger attached to the System B Heat Source (Analytic, Richmond, Va.) was heated to 200°C and taken to a depth of 3 mm short of the working length. The tip was allowed to cool for 15 seconds, then a single burst of heat was applied for 1 second and the tip was removed. Hedström files (size 30) were then used to reach the working length.

Root canal filling material was removed until the canal walls were smooth and the initial working length was reached. The time required to remove the obstructive material was recorded when the clinician was certain that no root canal filling remnants remained attached to the files. No additional instrumentation was required, as the aim was simply to determine the effect of removing the obstruction.

The teeth were removed from the acrylic resin with a diamond wheel, split longitudinally and examined at 4× magnification in a stereomicroscope. The specimens were scored for remaining root canal filling material using the following scale, according to Hulsmann and Stotz[9]:

I No root canal filling material
II One to 3 small isles (< 2 mm long) of root canal filling material
III More than 3 small isles (< 2 mm long) of root canal filling material
IV One large piece (> 2 mm long) of root canal filling material
V Root canal filling material > 5 mm long
VI Several isles of root canal filling material > 2 mm long

Evaluation was performed by a clinician who was blind to the experiment. The degree of removal of sealer was not assessed in this study.

The main purpose of this study was to determine the best removal technique based on removal time and material left in root canals. The affect of 3 factors on these parameters was assessed: the type of canal (straight or curved), the root filling material (Resilon/Epiphany or gutta-percha) and removal technique (Gates Glidden, Gates Glidden plus chloroform or System B). However, this study did not yield enough data for each combination to allow statistical analysis. Also, removal time is not normally distributed. Thus, the Mann–Whitney U test was used for 2 independent group comparisons, and the Kruskal-Wallis *H* test was used to compare 3 independent groups and for pair-wise comparisons. For the evaluation of material left in canals, the score values were used and cross tables were presented.

Results

Removal Time

Table 2 shows the time needed to remove the root canal filling material. Resilon/Epiphany required less time to remove than gutta-percha/AH Plus for all techniques and in both curved and straight canals. The Gates Glidden and Gates Glidden plus chloroform techniques were significantly faster than the System B technique

Table 3 Effectiveness of removal of gutta-percha/AH Plus (groups 1, 3 and 5) and Resilon/Epiphany (groups 2, 4 and 6) filling material from straight and curved canals[a]

Group	Removal technique	No. straight canals						No. curved canals					
		I	II	III	IV	V	VI	I	II	III	IV	V	VI
1	GG	10	3	2				6	3	2	2	1	1
2	GG	13	2					9	3	2	1		
3	GG + C	9	1	3	1	1		6	3	2		2	2
4	GG + C	11	2	1	1			7	3	3	2		
5	SysB	6	3	1	2	2	1	5	2	2	2	2	2
6	SysB	8	3	2	1	1		6	3	2	2	1	1

Note: GG = Gates Glidden drill, GG + C = Gates Glidden drill + chloroform, SysB = System B device.
[a]Scoring is based on the scale developed by Hulsmann and Stotz,[9] which ranges from I indicating no remaining filling to VI indicating significant remaining filling material.

for both straight and curved canals ($p < 0.05$) and for both gutta-percha/AH Plus and Resilon/Epiphany filling material.

Cleanliness of Root Canal Walls

Table 3 shows the root canal wall cleanliness scores for all groups. All removal techniques left more remnants of filling material in curved canals than in straight canals. For all removal techniques, specimens obturated with gutta-percha/AH Plus (groups 1, 3 and 5) retained significantly more obturation material than specimens filled with Resilon/Epiphany (groups 2, 4 and 6) in both straight and curved canals ($p < 0.05$).

The Gates Glidden technique worked best for straight canals. In contrast, the Gates Glidden plus chloroform worked best for curved canals. However, there appeared to be no statistical difference in degree of removal of material among all removal techniques ($p > 0.05$). The degree of removal for the 2 groups subjected to the System B technique was lowest compared with the other 2 techniques for both straight and curved canals.

Discussion

The goal in retreatment of endodontically treated teeth is complete removal of the root canal filling material, followed by cleaning and shaping of the root canal for final obturation.[4] Thus, several techniques were investigated to find an effective, easy method of removing root canal filling material. None of the techniques evaluated in this study was able to remove all filling material from the root canals, a result that was consistent with previous reports.[5–8,10]

Chloroform was used in this study because it is known to be more efficient than other chemicals in dissolving root canal filling material.[11–13] Chloroform can be used safely in clinical endodontics provided caution is exercised[14]; however, possible adverse health effects from exposure to chloroform should not be overlooked.[11,12] Hülsmann and Stolz[9] found rotary instruments to be more effective than chloroform for removing root canal fillings, and Wilcox and others[8] found that hand files clean dentin walls better than chloroform. In our study, although the use of Gates Glidden drills plus chloroform was more time consuming than the Gates Glidden technique alone for both tested materials in curved canals, it was also more effective.

Although there were no statistically significant differences in efficiency of the removal techniques, significant differences in time for retreatment were observed. Time could be reduced by using Gates Glidden instruments compared with System B. This reduction may be explained by the fact that the faster rotation of the Gates Glidden drill plasticizes the root canal filling material more quickly, particularly in the coronal and middle thirds of the roots. Although the efficiency of the Gates Glidden removal technique decreases in curved canals, the addition of a solvent compensated for the decrease. The decreased efficiency of the Gates Glidden technique in curved canals may be explained by the fact that the Gates Glidden drill remains centred within the root canal during rotation and tends to form round preparations in curved canals, which are mainly oval.[15]

In contrast, the heat conductivity of System B in the apical section affected both the Resilon/Epiphany material and gutta-percha causing the softened materials to adhere to the root canal walls. Thus, remnants were difficult to remove with endodontic files. In addition, System B instrumentation could not penetrate far enough into curved and narrow canals. For this reason, the Gates Glidden plus chloroform technique was superior to System B in curved canals.

The use of a Gates Glidden drill is the most effective technique for removing root canal fillings from the coronal and middle part of the root canal system.[9,16] However, this drill cannot be used in the apical third due to its size, lack of flexibility and potential for breakage, especially in curved canals.[17] In this study, the amount of remaining filling material was greater in curved than in

straight canals, consistent with the results of Wilcox and others[8] and Sae-Lim and others.[18] Furthermore, remnants of the filling material were observed in the apical section of both straight canals and, particularly, curved canals. The presence of gutta-percha and sealer in deep grooves and depressions on dentin walls in the apical third may indicate less original instrumentation of this region. Complete removal of debris from the apical section is often difficult to achieve during retreatment. However, as this section is most likely to be infected, it is important to shape and clean it carefully, removing any existing filling material. Effective removal should be carried out using a mechanical instrumentation technique with an endodontic irrigant.

Although gutta-percha/AH Plus does not adhere to canal walls as well as Resilon/Epiphany sealer, removal of Resilon/Epiphany leaves significantly less filling material. This may be explained by the strong adhesion between Resilon and Epiphany sealer.[19,20] Epiphany sealer is more easily removed as it is bound to the core material. On the other hand, it can be difficult to achieve complete coating of the canal walls with the Resilon bonding agent; thus, the connection between Resilon and dentin may be inadequate. Conversely, with gutta-percha, there is no chemical attachment between the core material and the sealer. Therefore, the amount of remaining material is higher as the sealer that is brushed on the canal wall is not completely removed because of its inadequate connection with the gutta-percha. These factors may account for the easier removal of Resilon/Epiphany sealer from the root canal system in terms of both effectiveness and time.

In a study by de Oliveira and others,[21] comparing remaining filling material and working time when removing gutta-percha/AH 26 and Resilon/Epiphany from straight canals using chloroform and 2 rotary systems, the authors found that Resilon/Epiphany was effectively removed with the rotary files. Ezzie and others[22] demonstrated that, compared with heat, chloroform combined with rotary files was more efficient in material removal. These studies also found that Resilon/Epiphany was removed more quickly than gutta-percha/resinous sealers. Schirrmeister and others[23] claimed that vertically compacted Resilon/Epiphany sealer was removed more effectively than gutta-percha/AH Plus sealer in straight canals. Our results agree with those of these other studies.

Conclusions

In this study, the removal of Resilon/Epiphany filling material was faster and resulted in fewer remnants than removal of gutta-percha/AH Plus filling using a Gates Glidden drill and a Gates Glidden drill plus chloroform in both straight and curved canals.

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