Apical Quality and Adaptation of Resilon, EndoREZ, and Guttaflow Root Canal Fillings in Combination with a Noncompaction Technique

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Abstract

The objective of this study was to compare the quality of Guttaflow (Coltene/Whaledent, Langenau, Germany), Resilon/Epiphany (Jeneric/Pentron, Kusterdingen, Germany), and EndoREZ (Ultradent Products, Inc, South Jordan, UT) root canal fillings. Thirty single-rooted teeth were randomly assigned to three groups: Resilon/Epiphany, EndoREZ, and Guttaflow. After radiography of the root canal fillings, the roots were sectioned horizontally at the level of 2 mm and 4 mm from the apex. The area of voids and adaptation to canal walls and points were evaluated using light microscopy and calculated through a computer program. The radiographs showed no significant differences between the materials ($p > 0.05$, Mann-Whitney *U* test). Evaluation of cross-sections revealed sealer adaptation >99% to the root canals and >98% to the points. Resilon/Epiphany had significantly higher values at 98.8% (standard deviation [SD] = 3.9%) than EndoREZ at 98.7% (SD = 1.1%), and Guttaflow at 98.5 (SD = 2.1%) ($p < 0.05$, Mann-Whitney *U* test). The absolute difference compared with Resilon/Epiphany was at 0.84% (0.44%–1.76%) for EndoREZ and at 1.08% for Guttaflow (0.00%–2.08%) (95% confidence interval, Hodges-Lehman). This outcome indicated an effective apical obturation using any of the three materials in combination with a noncompaction technique. *(J Endod 2009;35: 261–264)*

Key Words

Cross-sections, EndoREZ, Guttaflow, noncompaction technique, radiographic quality, Resilon/Epiphany, root canal–filling materials

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Although gutta-percha is still the most commonly used root canal obturation material to date, it appears to be a weak point in endodontic therapy (1–3). Therefore, many techniques and materials have been developed with the objective to offer a higher sealing ability than gutta-percha (4–6). Leakage tests are widely used to evaluate sealing ability. Unfortunately, leakage methods display large discrepancies and oftentimes produce converse results (7, 8) making it difficult to determine the real quantity of leakage (9, 10). Another method of assessing the quality of root canal fillings is microscopy. In numerous studies, the evaluation of voids and distribution of the root canal–filling components was performed by examining cross-sections under stereomicroscope (11–17). In the case of EndoREZ (Ultradent Products, Inc, South Jordan, UT) and Resilon (Jeneric/Pentron, Kusterdingen, Germany), two strategies were used to circumvent the problem of chemical union between the polyisoprene component of gutta-percha and methacrylate-based resins (18). With the intention of reducing the disadvantages of warm gutta-percha techniques, Guttaflow (Coltene/Whaledent, Langenau, Germany), a cold flowable silicon-based sealer was introduced (10, 16, 19).

The objective of the present study was to assess and compare the quality of Guttaflow, Resilon/Epiphany (Jeneric/Pentron), and EndoREZ in combination with a noncompaction technique by evaluation of the root canal fillings on radiographs and cross-sections at 2 mm and 4 mm from the apex.

Materials and Methods

Thirty extracted single-rooted human teeth with straight roots were used in this study. Immediately after extraction, these teeth were stored in 10% formalin. They were watered and cleaned, the access cavities were prepared, and the root canal lengths were measured by passing a #10 K-file until the tip was just visible at the apical foramen. Subsequently, 1 mm was subtracted from this measurement to determine the working length.

The root canals were shaped and filled by one operator under 10× magnification. Profile (Dentsply Maillefer, Ballaigues, Switzerland) and M_{two} (VDW, Munich, Germany) nickel-titanium rotary instruments were used in a hybrid technique to prepare the root canals. Final preparation was performed by using an M_{two} file .04/35. Only such root canals were allowed when a passively introduced # 30 K-file could not reach the apical foramen before instrumentation. The root canal lengths ranged from 16 mm to 18 mm. The canals were irrigated with 5 mL of 2.5% NaOCl after every change of file. After instrumentation, the root canals were rinsed with 2 mL of EDTA (17%) and flushed again with 5 mL of 2.5% NaOCl. Finally, the canals were rinsed with 3 mL of sterile water and dried with paper points. The 30 teeth were randomly assigned to one of three root canal–filling materials in groups of 10 teeth each. All materials were used according to the manufacturers' instructions.

Resilon/Epiphany

The primer was applied to the working length with paper points. Paper points were also used to remove the excess primer. Subsequently, the sealer was inserted to a distance 3 mm short of the working length using a lentulo spiral. The rotating lentulo was removed slowly out of the canal, and in the same manner the procedure was repeated to an even shorter length. A .04/30 master cone was coated with sealer and

slowly inserted to the working length. Two accessory smaller .02/25 cones were placed passively, and the sealer was light cured for 40 seconds. After trimming the Resilon points with a hot instrument, the sealer self-cured in 30 minutes.

EndoREZ

A skinny syringe with Navi Tip (Ultradent Products) was inserted 3 mm from the apex, and EndoREZ was withdrawn slowly while distributing it into the canal space. The EndoREZ mastercone and the two accessory .02/25 cones were placed passively and light cured at the orifice for 40 seconds. The excess of the EndoREZ points was trimmed with a hot instrument.

Guttaflow

The activated capsule was mixed for 30 seconds in a triturator. The tip of the Guttaflow device was introduced into the root canal 3 mm short of the working length, and Guttaflow was inserted. The master gutta-percha cone was coated with Guttaflow and inserted. Two accessory 02/25 cones were pushed forward until first resistance was reached. The gutta-percha master point was seared off with a heated hand instrument. The setting time was 10 minutes. The access cavities were filled with Dyract extra (Dentsply De Trey, Konstanz, Germany), and the teeth were radiographed in buccolingual and mesiodistal directions.

Radiographic Quality of Obturation

The quality of the root canal filling was scored on the following modified three-point scale (20): (1) a good, homogenous filling that obturated the entire prepared root canal and was well adapted to the canal wall with only a few minor areas of relative radiolucency (<0.25 mm in diameter), (2) imperfect filling with irregularities of <1 mm and where the filling might be a bit shorter (0.5 mm or less) than the working length, and (3) inadequately filled canal with irregularities of more than 1 mm in diameter and where the filling might be more than 0.5 mm shorter than the working length.

Evaluations were performed simultaneously by two trained evaluators. Observer reliability was assessed by re-evaluation of all specimens on a separate occasion. In case of disagreement, the ultimate decision was reached by consensus.

Cross-sections

The teeth were decoronated, dehydrated with alcohol, and embedded in methacrylate resin (Technovit 7200 VLC; Heraeus Kulzer, Wehrheim, Germany). Two horizontal root cross-sections were cut at 4.05 mm and at 2.05 mm on each end using a microtome saw (Exakt Apparatebau, Norderstedt, Germany), applying a cutting grinding technique (21). Then, the samples were infiltrated with Technovit 7200 VLC to prevent the occurrence of artifacts during the sawing. Afterwards, they were polished with abrasive papers K 4000 (Diaplus, Oststeinbek, Germany) and sawed again to the exact length of 4 mm and 2 mm. The sections were digitally photographed at 100× magnification using a stereomicroscope (DM 1000; Leica, Wetzlar, Germany) (Fig. 1). The area of voids in sealer and the location of voids along the root canal walls as well as along the points were measured and calculated by using an architecture software (ArchiCAD 8.0; Graphisoft, Munich, Germany) (Fig. 1*B*).

Statistical analysis was performed by using SPSS (2003) (SPSS Inc, Chicago, IL). The level of significance was set at $p = 0.05$.

Results

Radiographs

Resilon/Epiphany obtained the best radiographic values in the buccolingual and mesiodistal projection (Table 1). The differences

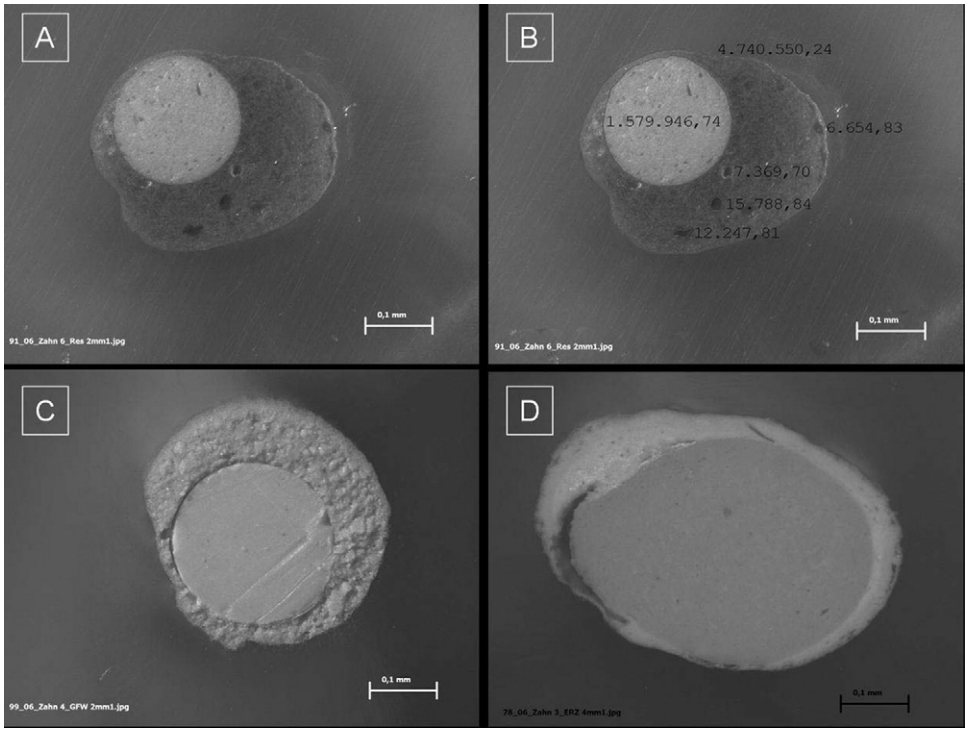

Figure 1. (*A*) Digitally photographed cross-section 2 mm from the root end (Resilon, 100× original magnification). (*B*) The calculated area with architectural software of voids (deficiencies) in sealer, sealer along the root canal wall, and along the points; numbers are the special software code of the area of root canal–filling components (Resilon, 2-mm section, 100× original magnification). (*C*) Guttaflow, granular structure (100× original magnification). (*D*) Deformation of the EndoREZ point, the gap between the point and sealer.

TABLE 1. Results of the Radiographic Evaluation of the Root Canal Fillings

	Radiographic Results						Cross-sections – Mean Values in % and SD			
	Buccolingual			Mesiodistal			Adaptation to Root Canal Walls	Adaptation of Sealer to Points	Deficiencies in Sealer	Deficiencies in Total
	1	2	3	1	2	3				
Resilon (n = 20)	10	0	0	10	0	0	99.54 ± 1.03	98.75 ± 3.90[a]	1.13 ± 1.63	1.73 ± 2.33
EndoREZ (n = 20)	10	0	0	6	1	3	99.93 ± 0.18	98.74 ± 1.11[b]	2.97 ± 6.03	1.92 ± 2.05
Guttaflow (n = 20)	8	2	0	6	4	0	99.01 ± 2.38	98.53 ± 2.08[b]	0.94 ± 2.52	2.20 ± 2.55

Different superscript letters[a,b] indicate significant differences in adaptation to points ($p < 0.05$). Evaluation of the cross-sections (2 mm + 4 mm). Mean values (%) and standard deviation of adaptation to root canal walls or points and deficiencies in sealers and in total per root canal filling system (n = 20).

between the three materials were not statistically significant ($p > 0.05$, Mann-Whitney *U* test).

Cross-sections

The average values revealed an adaptation of the materials to the root canal walls >99% and to the points >98%. The adaptation of Resilon/Epiphany to the points at the 2-mm and 4-mm levels added was significantly higher compared with EndoREZ and Guttaflow ($p < 0.05$, Mann-Whitney *U* test) (Table 1). The absolute difference compared with Resilon/Epiphany was 0.84% (0.44%–1.76%) for EndoREZ and 1.08% (0.00%–2.08% for GFW) (95% confidence interval, Hodges-Lehman). The materials differed statistically but are comparable in total because the interval regions of contrasts to Resilon/Epiphany were below a 5% difference.

No significant differences between the materials were found in the added 2-mm and 4-mm sections regarding the defect areas in the different sealers. No significant differences occurred between the materials regarding the total of defect areas ($p > 0.05$, Mann-Whitney *U* test). In the 2-mm cross-sections, Guttaflow (Fig. 1*C*) revealed significantly less sealer deficiencies 0.00% (standard deviation [SD] = 0.00%) compared with Resilon/Epiphany (0.86% [SD = 1.49%]) and EndoREZ (0.44% [SD = 0.66%]) ($p = 0.01$, Mann-Whitney *U* test). The 95% confidence interval calculations revealed a difference compared with Guttaflow of 0.26% (0.00%–1.01%) for Resilon/Epiphany and 0.14% (0.00%–0.57%) for EndoREZ (Hodges-Lehman). The contrast measures were below 5%. Deformations of the EndoREZ masterpoints without contact to the canal wall were observed in 5 cross-sections (Fig. 1*D*). Accessory cones occurred in two cross-sections at the level of 4 mm.

Discussion

Leakage tests were performed frequently to examine the quality of root canal fillings (2, 4, 22–24). Leakage evaluations show great variations in studies (7), and the results are often contrasting (8). To avoid the disadvantages of leakage evaluations, in the present study, the quality of the root canal fillings was assessed through a histological method.

A cross-section height of 2 mm and 4 mm from the apex was also selected by other investigators (12, 13, 15). Because the most critical area of the root canal preparation occurs in the last 2 mm from the apex (25), the cross-sections of the present study were performed in this part of the roots. In the 4-mm cross-section, the sealing quality was performed at a greater canal diameter. In order to avoid overfilling and to allow more volume for the sealers to evaluate the quality in the cross-sections, a master cone .04/30 was used, although the final instrument was larger (.04/35).

In former investigations, most sections were evaluated by 40× magnification (11, 15, 17, 26). However, voids can be too small to be detected (27) at this level of magnification. In the present study, the photographs were taken by 100× microscope magnification for detailed evaluation using architectural software.

There is a great risk that sectioning of the filled canal may result in tearing of the material (24) or smearing of the gutta-percha. To avoid these problems, the cutting-grinding technique was applied (21). To prevent pulling out and to protect the root canal fillings when sawing, the cross-sections were reinfiltrated with further resin material, then polished, and sawed to the exact lengths of 2 mm and 4 mm.

Resilon achieved significantly better values in adaptation to the points than EndoREZ and Guttaflow, but adaptation to the canal walls revealed no significant differences. However, the significance should not be overestimated because the interval regions for the contrasts to Resilon/Epiphany were below a 5% difference and may therefore not be relevant in the clinical situation.

Guttaflow exhibited the least percentage of voids in sealer in comparison to lateral and vertical compaction (16). This is in agreement with the results of the present study. Guttaflow showed the most homogeneous sealer composition with no deficiencies compared with EndoREZ and Resilon in the 2-mm cross-sections. Guttaflow was probably condensed better by the pressure of the master point in the small apical area between the master point and canal wall. This might be caused by the highly viscous composition resulting in homogeneous distribution of the sealer without any voids. It has to be taken into consideration that because of its granular structure (Fig. 1*C*) the evaluation of Guttaflow was more difficult than the assessment of the other materials and the interpretation of defects and structures may be limited.

Resilon/Epiphany showed significantly better adaptation to the points than EndoREZ and Guttaflow. The reason for this might be the chemical bond between the sealer and the Resilon points (4). In some cross-sections of the EndoREZ specimens, it could be observed that the points were deformed despite no previous compaction (Fig. 1*D*). This might be an effect of the polymerization shrinkage (28) of EndoREZ and the interaction between the methacrylate surface of the points resulting in deformations to the points.

Radiographs play an important role in assessing the quality of root canal fillings concerning homogeneity and complete obturation (20, 29). In vitro it is possible to take radiographs in two different directions and to compare them to accomplish better assessment of the qualities of the root fillings (30). The results of the present study do not show significant differences between Resilon/Epiphany, EndoREZ, and Guttaflow, both in buccolingual and mesiodistal projection. The buccolingual radiographs show better results. This is in agreement with other studies (20, 30, 31) because the root canals are usually more extensive in a vestibular-lingual projection.

The single-cone technique is easy to perform, and the possibility of improvement and revival is still under discussion (32). With the introduction of greater taper master points, the single-cone filling methods were revived (16, 17, 33), and the advent of contemporary root canal filling systems may support the use of a single-cone obturation technique (24).

Conclusions

All three tested contemporary root canal–filling systems used in combination with a noncompaction technique indicate an effective obturation in the critical apical area.

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