

The comparison of dentin adaptation and sealing ability of gutta-percha/AH Plus, Resilon/Epiphany SE, EndoREZ: an in-vitro study

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ABSTRACT

The aim of this study compares three different root canal filling systems (gutta-percha/AH Plus, Resilon/Epiphany SE, EndoREZ) regarding their adaptation root to dentine and their sealing ability at different horizontal sections.

One Hundred extracted single root maxillary incisors were randomly assigned into 3 groups and filled gutta-percha/AH Plus (group GA), Resilon/Epiphany SE (group RE) or EndoREZ root canal filling system (group EZ). All teeth were sectioned horizontally at 1, 3, and 5 mm from apex. Then teeth layers were examined with stereomicroscope. The ratios of the areas containing core material, sealer and/or voids to the total area were calculated and analyzed statistically.

EndoREZ had significantly more core areas/total areas ratio at 1 mm compared to the other systems. At 3 mm level, gutta-percha/AH Plus had the lowest core to total area ratio ($p < 0.05$). At 1 mm level, EndoREZ had significantly lower sealer+debris+voids ratio than other groups, while gutta-percha/AH Plus had the highest sealer+debris+void areas/total areas at 3 mm ($p < 0.05$). When core, sealer, and voids areas were examined within groups, significant differences were found in the ratios of group GA and group RE at different cut sections.

Results are consistent with the previous findings. On the other hand, there are some contradictory results as well. Conflicting findings might result from the differences in the methods of measurement. Moreover, filling materials that are away from the biological cycle may limit in vitro studies. At 1 mm there are not significantly core areas/total areas group GA and group RE. At 3 and 5 mm level group GP had significantly lower core areas/total areas

Key Words: EndoREZ, gutta-percha/AH Plus, root canal filling, Resilon/Epiphany SE

Introduction

The root canal filling materials are generally categorized into two groups: solid and semi-solid (1). For an effective root canal filling, solid materials should be used together with the semi-solid ones such as gutta-percha and Resilon (2).

The root canal obturators consist different types of polymers. During gutta-percha placement into root canal, voids can remain between the core material and dentinal wall. Lateral condensation is well known and preferred technique by the clinicians to increase the volume of gutta percha. Many researchers suggest that gutta-percha/sealer technique is not sufficient for a complete hermetic seal (3). The weaknesses of the lateral condensation technique were also reported including insufficient surface adaptation, presence of voids inside the canal filling materials, limited use of spreader, and extreme use of the sealer (4).

In the past thirty years, the development of adhesive techniques brought a revolutionary change in dentistry and the number of products

that are manufactured with adhesive technology increased on the market. Besides, these materials also became the focus of attention for clinical studies. Resilon/Epiphany, EndoREZ, and MetaSeal are some of the systems using these materials. There is no available root canal filling system, which enables a completely hermetic obturation (5). On the other hand, there are ongoing studies regarding the development of new canal filling materials.

The sealing ability of a root canal filling material between root canal filling and canal wall is, evaluated with adhesive ability of its adhesion to the dentinal wall and interfacial adaptation. In this way, hermetic sealing and impermeability of root canal filling materials are controlled as well. In the present study, gutta-percha/AH Plus root canal filling system, Resilon/Epiphany SE and EndoREZ filling system were compared for their adaptation and sealing ability at different horizontal sections.

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Materials and Methods

100 freshly extracted single-rooted maxillary incisors were used in the current study. Similar sizes of the teeth were selected. Teeth with extensive decay, root resorption, fracture or fissures were eliminated. Subsequently, teeth were separated into 3 groups (n=20). All samples were cut decoranated from cemento-enamel junction prior to the shaping procedure. Gutta-percha/AH Plus, EndoREZ, and Resilon/Epiphany SE were used for Group 1, 2 and 3, respectively.

A 10 sized K-type file was inserted into canal apically till the file visible from the foramen. Working length was established with subtracting 1 mm from this measure. The root canals were shaped with K3 (Sybron Endo, Orange, USA) rotary file system, which was mounted on a high-torque electric motor (speed: 350 rpm, contra-angle 16:1 reduction).

10 ml of 5% NaOCl (Wizard, Ankara, Turkey) solution were used to irrigate the root canals during the shaping procedure. After irrigation with NaOCl, root canals were irrigated 1 minute with 17% EDTA (Vista Dental Products, USA). After all, the canals were flushed with the physiological saline solution. In the current study, Resilon+Epiphany (Resilon Research LLC, Madison, CT, USA), gutta-percha (Dident, Dident Group International)/AH Plus (Dentsply de Trey, Konstanz-Germany), EndoREZ (Ultradent Products, South Jordan, UT) canal filling systems were used.

All teeth were incubated in an incubator at 37°C for one week. When the setting time computed, sections were prepared at the 1, 3, and 5 mm from the apex.

Each tooth was mounted in an acrylic block. The instrumentation of the blocks were performed with a Buehler-Series Diamond IsoMet Wafering Blade=15LC 1/2" (12.7 mm) under constant water-cooling. Then sections were examined with

a stereomicroscope (Leica DFC320) at 100X magnification.

Finally, (sealer+debris+voids area)/(total area), (core area)/(total area), and (voids area)/(total area) ratios were calculated and the results were analyzed statistically.

Statistical Analysis: National curriculum standards for social studies (NCSS 2007. NCSS, LLC. Kaysville, Utah, USA.) statistical software package was used for the analyses of the results. Firstly, descriptive statistics were performed (mean, standard deviation). Secondly, groups were compared with respect to cut sections (mm) and materials with Kruskal-Wallis test. Lastly, Dunn's Multiple Comparison test was conducted for subgroup comparisons. The significance level for each test was determined at $p < 0.05$.

Results

The study results revealed that there is a statistically significant difference between (core area)/(total area) ratio of group GA and the core ratios of group EZ and group RE at each cross-sections (1, 3, and 5 mm) ($p < 0.05$). At 1 and 3 mm cut sections, (core area)/(total area) of group RE was significantly different from the core ratio of group EZ ($p < 0.05$).

Group GA and group RE had significantly lower core ratio than group EZ at 1 and 3 mm. Group GA had significantly lower core ratio than group RE at 3 mm cut section. Also, group GA had significantly lower core ratio than group EZ and group RE at 5 mm (Table 1).

Group GA and group RE ($p = 0.002$, $p = 0.001$) showed significantly different core ratios at different horizontal sections (1, 3, and 5 mm). There was no difference statistically group EZ ($p = 0.811$) (Table 2). Group GA and group RE had significantly different core ratios at different sections (1, 3, and 5 mm). However, there was no significant difference between the subgroups of

Table 1. Interfaccional multi comparisons of the CORE area to the total area

CORE/Total	1 mm	3 mm	5 mm	KW	p
	Mean±SD	Mean±SD	Mean±SD		
Gutta-percha/AH Plus	0.707±0.108	0.660±0.138	0.805±0.094	12.8	0.002
EndoREZ	0.893±0.097	0.881±0.087	0.893±0.051	0.42	0.811
Resilon/Epiphany SE	0.746±0.158	0.787±0.116	0.902±0.052	14.67	0.001
KW	27.89	56.20	37.34		
p	0.0001	0.0001	0.0001		

SD, Standard deviation; KW, Kruskal-Wallis Test

the EndoREZ ($p>0.05$). Gutta-percha/AH Plus and Resilon/Epiphany SE materials did not have a significant difference between the core ratios of their subgroups at 1 mm and 3 mm ($p>0.05$); however, they showed significant differences at 5 mm cut section when compared to the sections at 1 mm and 3 mm ($p<0.05$) (Table 3).

The (sealer+debris+voids area)/(total area) examination showed that, EndoREZ group had significantly lower ratio when compared to group GA and group RE at 1 mm ($p<0.05$). There was no statistically significant difference between group GA and group RE ($p>0.05$). At 3 mm level, no significant difference was found between group EZ and group

REgroups, while group GA having the highest sealer+debris+voids ratio than other groups. Similar results were obtained in the sealer+debris+voids ratio at 3 and 5 mm cut sections (Table 4).

Group GA and group RE showed significant differences in sealer+debris+voids ratio at 1, 3 and 5 mm ($p<0.05$), but in group EZ. There was no such differences at different sections ($p>0.05$). Group GA and group RE had significantly lower sealer+debris+voids ratio at 5 mm when compared to 1 mm and 3 mm ($p<0.05$); however, they did not show a significant difference between subgroups at 1 mm and 3 mm cut sections ($p>0.05$) (Table 5).

Table 2. Comparison of the rates of the core areas of 1 mm, 3 mm and 5 mm of the same groups to the total areas in themselves

Dunn's Multi Comparison Test ¹	Gutta-percha/AH Plus	EndoREZ	Resilon/Epiphany SE
1 mm / 3 mm	0.409	0.891	0.514
1 mm / 5 mm	0.024	0.999	0.0001
3 mm / 5 mm	0.001	0.900	0.008

¹The difference between two groups are statistically significant ($p<0.05$)

Table 3. Rates of the CORE area of 1 mm, 3 mm and 5 mm of the canal filling substances to the total area in themselves

CORE/Total	1 mm	3 mm	5 mm	KW	p
Gutta-percha/AH Plus	0.707±0.108	0.66±0.138	0.805±0.094	12.80	0.002
EndoREZ	0.893±0.097	0.881±0.087	0.893±0.051	0.42	0.811
Resilon/Epiphany SE	0.746±0.158	0.787±0.116	0.902±0.052	14.67	0.001
KW	27.89	56.20	37.34		
p	0.0001	0.0001	0.0001		

KW, Kruskal-Wallis Test

Table 4. Comparison of the meaningfulness of the rates of the sealer, debris and voids areas in the incisions of 1 mm, 3 mm and 5 mm to the total incision area in double groups

Dunn's Multi Comparison Test ¹	1 mm	3 mm	5 mm
Gutta-Percha AH Plus / EndoREZ	0.0001	0.0001	0.004
Gutta-percha+AH Plus / Resilon+ Epiphany SE	0.860	0.001	0.001
EndoREZ / Resilon+Epiphany SE	0.005	0.07	0.990

¹The difference between two groups are statistically significant ($p<0.05$)

Table 5. Interfactual multi comparisons of the sealer, debris and voids areas of 1 mm, 3 mm and 5 mm to the rate of the total area

S.D.V/Total	1 mm Mean±SD	3 mm Mean±SD	5 mm Mean±SD	KW	p
Gutta-percha/AH Plus	0.293±0.108	0.340±0.138	0.195±0.094	12.8	0.002
EndoREZ	0.107±0.097	0.119±0.087	0.108±0.051	0.42	0.811
Resilon/Epiphany SE	0.253±0.157	0.206±0.111	0.096±0.052	15.27	0.0001
KW	27.94	56.95	37.46		
p	0.0001	0.0001	0.0001		

SDV, Sealer Debris Voids; SD, Standard deviation; KW, Kruskal-Wallis Test

Group GA and group RE had significantly different (sealer+debris+voids area)/(total area) ratios at 1, 3, and 5 mm cut sections ($p=0.002$; $p=0.001$). However, this significant difference was not found for the sealer +debris+voids ratio of EndoREZ subgroups ($p=0.811$) (Table 6).

Sealer+debris+voids areas/total areas ratio of group GA and group RE were found significantly lower at 5 mm cut section compared to the sections at 1 and 3 mm level ($p=0.024$, $p=0.001$; $p=0.01$, $p=0.0001$). No statistically significant difference was found between the groups at 1 and 3 mm ($p>0.05$) (Table 7).

At 1, 3 and 5 mm cut sections, no statistically significant difference was found between (voids area)/(total area) ratios of the groups. Also, there was no within group differences at different sections ($p>0.05$).

Discussion

Since teeth with wider canal diameters enable the researchers to obturate the root canals with more canal fillings, maxillary incisors were preferred in the current study. In this way, the irregularities in the root canal filling materials at horizontal sections can be easily observed.

The current study aimed to compare the sealing ability of three different canal fillings in apical 1/3 of the root canal system. This region is particularly important for clinical trials in terms of determining the quality of the canal filling

material. The prevention of void formation and minimum thickness of the sealing layer are the essentials of long-term success of the root canal treatment. Some researchers take the critical region as 2 and 4 mm from the apex, (6) but in general, apical 1-5 mm of the tooth is known as the critical region for root canal treatment.

It is preferred to remove the smear layer for each canal filling technique in the current study. According to the manufacturer's protocol, resin-based sealers such as Resilon, EndoREZ should be irrigated with EDTA solution at the end of the instrumentation. Removing the smear layer provides a better adhesion of the sealer to the dentinal wall (7).

The dye penetration, the bacterial leakage, radioisotope solutions and electrochemical methods are commonly used for evaluation of leakage of the root canal filling material (8-11). In order to avoid from these weaknesses, the most recent and advanced model "Leica DFC320" stereomicroscope was used in the present study.

The root canal fillings at different horizontal sections were examined immediately after the root canal had filled. Therefore, the study is limited in terms of evaluating the long-term effects and other parameters that might have an effect on the sealing ability of the canal fillings in clinical conditions. Some of these parameters are decomposition of the sealer in tissue fluids over time, dimensional changes due to the volume loss, the bond between core and the sealer, the changes

Table 6. Comparisons of the sealer, debris and voids areas of 1 mm, 3 mm and 5 mm of the same groups to the rates of the total area in themselves

Dunn's Multi Comparison Test ¹	Gutta-percha/AH Plus	EndoREZ	Resilon/Epiphany SE
1 mm / 3 mm	0.409	0.891	0.410
1 mm / 5 mm	0.024	0.999	0.0001
3 mm / 5 mm	0.001	0.900	0.01

¹The difference between two groups are significant ($p<0.05$)

Table 7. Rates of the sealer, debris and voids area of 1 mm, 3 mm and 5 mm of the canal filling substances to the total area in themselves

SDV/Total	1 mm	3 mm	5 mm	KW	p
Gutta-percha/ AH Plus	0.293±0.108	0.34±0.138	0.195±0.094	12.80	0.002
EndoREZ	0.107±0.097	0.119±0.087	0.108±0.051	0.42	0.811
Resilon/Epiphany SE	0.253±0.157	0.206±0.111	0.096±0.052	15.27	0.000
KW	27.94	56.95	37.46		
p	0.0001	0.0001	0.0001		

SDV, Sealer Debris Voids; KW, Kruskal-Wallis Test

in the root canal filling in response to the external forces. Patil et al. (12) found that gutta-percha/AH Plus material has significantly higher bond strength than Resilon Epiphany SE material.

In the current study, gutta-percha had significantly lowest core ratio among all groups at every horizontal section. Jacobson et al. (13) compared lateral condensation gutta-percha technique and the thermoplastic gutta-percha techniques in terms of the amount of leakage. They showed that the lateral condensation technique caused significantly more leakage than the “continuous wave of condensation” and “Obtura II” techniques. Although the lateral condensation technique is the most common technique in clinical practice, the results of the present study supported the view that the sealing ability of this system might be problematic.

According to the Toronto Study, which collects and analyses clinical data for 4-6 years, the thermoplastic gutta-percha technique is reported to have 90% success rate, and the lateral condensation technique is found to have 80% success rate (14).

Biggs et al. (15) filled the teeth either with Resilon/Epiphany SE or gutta-percha/AH Plus and measured the leakage by using the fluid filtration technique after 24 hours, 1 week, 2 weeks, 30 days, and 90 days following the obturation. In their results, there was no significant difference between the sealing ability of Resilon/Epiphany SE and gutta-percha/AH Plus. Also, there was no effect of time on the amount of leakage. However, current study found that Resilon/Epiphany SE has better sealing ability at 3 and 5 mm. There was no difference between these systems in adaptation to dentin at 1 mm. Since the previous study measured the leakage and did not compare the sealing ability of the systems at different cross-sections, they might fail to find an existing difference between Resilon/Epiphany SE and gutta-percha/AH Plus, which is found only at 3 and 5 mm but not at 1 mm. Additionally, in the present study, there was no significant difference between these two groups in terms of void formation.

Shemesh et al. (16) compared the leakages along the coronal region of canal fillings of Resilon/Epiphany, and gutta-percha/AH Plus groups. They found that Resilon/Epiphany leaked significantly less than gutta-percha/AH Plus group. Correspondingly, Resilon/Epiphany SE showed significantly higher adaptation than gutta-percha/AH Plus at 3 and 5 mm under the current

study (no significant difference was found at 1 mm).

Wedding et al. (17) compared microleakage of teeth filled either with gutta-percha and Resilon SE by using a fluid filtration model. They found that Resilon is more resistant to microleakage compared to gutta-percha. In the present study, Resilon/Epiphany SE had the highest core ratio. However, findings are conflicting in terms of void formation.

It was found that, there is no significant difference between AH Plus, EndoREZ and Real Seal groups with respect to leakage. However, all groups allowed the leakage after 20 hours following the obturation (18).

Bodrumlu and Tunga compared the apical leakage of the teeth filled with gutta-percha/AH26, gutta-percha/AH Plus and Resilon/Epiphany by lateral condensation (19). They did not find a significant difference between the groups with respect to the sealing ability. They reported that, root canals filled with gutta-percha/AH26 leaked significantly more than the canals filled with the other sealers. The reason of the leakage might be the voids inside the sealer. In that respect, these findings are supported by the present study finding (the significant difference between Resilon/Epiphany SE and gutta-percha/AH Plus in terms of void formation).

Karapinar-Kazandag et al. (20) compared the microleakage of Resilon/Epiphany, EndoREZ, Activ GP, and gutta-percha/AH Plus technique by using the glucose filtration model. They did not find a significant difference between these root canal filling systems. However, in the present study, Resilon/Epiphany SE showed significantly better sealing ability compared to gutta-percha/AH Plus.

Monticelli et al. (21) compared the sealing efficacy of warm vertical condensation technique with gutta-percha/AH Plus, single-cone technique with Activ GP, and single-cone technique with Gutta-Flow in preventing bacterial leakage. Gutta-percha warm vertical condensation technique showed the highest sealing efficacy in terms of preventing bacterial leakage. However, in the current study, there was no difference between groups in terms of void formation. Differences in methods of measurement may be the reason behind these contradictory findings.

Another study comparing the bond strength and sealing ability of the teeth filled with /gutta-percha/AH Plus, EndoREZ and RealSeal systems with the lateral condensation method found no differences between the leakage amount of

different groups (22). These results show similarity with the present study.

Herbert et al. (23) compared the quality of different sealers (GuttaFlow, Resilon/Epiphany, and EndoREZ) at different horizontal sections, which are at the level of 2 and 4 mm from the apex. They evaluated the adaptation to dentin and the area of voids by using light microscopy. They found that, Resilon showed the highest sealer adaptation to the root canals. However, there was no significant difference between the groups in terms of void formation. The current study also did not found a difference between these groups.

Pereira et al. (24) compared the sealing ability of dog premolars filled with AH Plus, RoekoSeal and EndoREZ. They found that EndoREZ leaked significantly less than RoekoSeal and they found no statistic difference between AH Plus and the other sealers. Although the methods of measurements are quite different, the findings of this study is consistent with the current one since we found a significant difference between the voids area of EndoREZ and gutta-percha/AH Plus groups.

Although gutta-percha is still commonly used in clinical practice, many researchers agree upon the view that it has weaknesses (9). In the evaluation of the sealing ability, fluid filtration tests are the still of choice but these tests usually reveal contradictory results (25,26). Therefore the present study used the histological method for a better measurement of the adaptation and sealing ability of the canal fillings.

The most critical region for the root canal treatment is usually accepted as up to 2 mm from the apex (27). Thus, some researchers prefer to obtain horizontal sections at 2 and 4 mm from the apical foramen (28).

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