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Original Article

Dentistry Section

Coronal Microleakage of the Resilon and Gutta-Percha Obturation Materials with Epiphany SE Sealer: An in-vitro Study

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ABSTRACT

Introduction: The coronal leakage of bacteria and other irritants to the root canal system is one of the main factors that may result in clinical failure and affect the long term success of endodontic treatment. The Resilon/Epiphany obturation system has been developed as an alternative to gutta-percha and traditional sealers.

Aim: This study aimed to evaluate and compare the coronal leakage between Resilon obturation material and gutta-percha using the same sealer.

Materials and Methods: In this invitro study, 72 freshly extracted single-rooted human teeth were used, and were sectioned at CEJ with 13mm length. The roots were randomly divided into four groups. In Group I, 30 roots were obturated using Resilon and Epiphany SE sealer, Group II, 30 roots were obturated using gutta-percha and Epiphany SE. Group III and Group IV, 12 roots were used as control groups (positive and negative). The coronal leakage was measured using the dye penetration technique. Data were statistically analysed by a One-Way ANOVA test.

Results: There was a significant difference between the two experimental groups where Resilon revealed less microleakage than gutta-percha group ($p < 0.05$).

Conclusion: Resilon is a suitable replacement for gutta-percha on the basis of its increased resistance to microleakage, but it failed to provide complete hermetic coronal sealing.

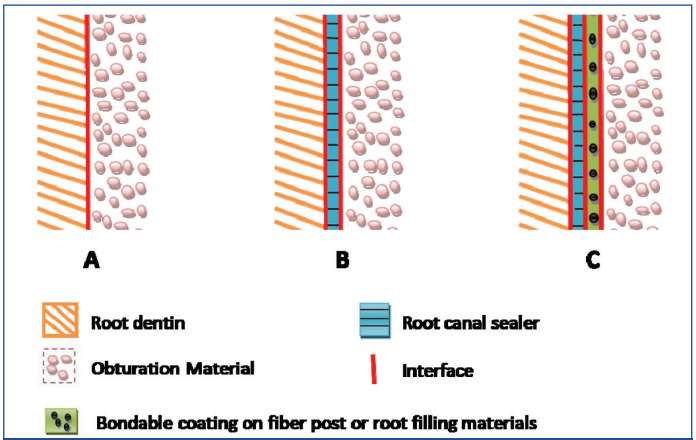
Keywords: Coronal sealing ability, Longitudinal sectioning, Methylene blue, Protaper rotary system, Stereomicroscope

INTRODUCTION

Microleakage, whether coronal or apical, adversely affects the success of root canal therapy. Many parameters influence microleakage during the course of root canal treatment like: isolation, patient co-operation, canal anatomy, root morphology, operator skill, root canal sealing and the choice of filling material [1,2]. Cleaning and shaping, and three-dimensional obturation of the root canal system are essential for promoting periapical healing [3,4]. The material chosen for root canal filling is also a critical determinant for success or failure of endodontic treatment [5].

A traditional obturation material used in Endodontics is gutta-percha. Since the introduction of gutta-percha, it has been the standard obturation material [4]. Shortages of gutta-percha including lack of dentinal adhesion, insufficient rigidity, and shrinkage during cooling or solvent evaporation [6] have produced a call for new and improved products, one of which is Resilon/Epiphany system (Pentron Clinical Technologies, Wallingford, CT, USA) [7]. The Resilon/Epiphany endodontic obturation system has been developed as an alternative for gutta-percha and traditional sealers [4]. Resilon is a thermoplastic synthetic polymer-based on polymers of polyester [4,5]. The corresponding sealer, Epiphany is a self-etch and dual-cure dental resin composite sealer [4,8]. It adheres to the resilon resulting in what is termed as 'monoblock bond' of filling material which penetrates and adheres chemically to the dentin walls of the root-canal system [Table/Fig-1] [4,5,7]. It is believed to overcome the limitations and problems with gutta-percha [7].

Microleakage continues to constitute a main reason for failure of root canal therapy [1,2,4], and achieving an adequate seal is one of the most important goals in endodontics [8]. Despite the fact that Resilon has been developed as an alternative to gutta-percha, its advantages over gutta-percha remain controversial [9]. Oddoni et al., and Shashidhar et al., recommended further studies to be done regarding microleakage and other properties of Resilon/Epiphany sealer [10,11]. Since limited data is available about the coronal sealing properties of Resilon/Epiphany, this study, therefore was planned to compare the coronal microleakage of Resilon and gutta-percha using the same sealer (Epiphany SE sealer) for both groups.



[Table/Fig-1]: Classification of endodontic monoblocks. A. Primary monoblock B. Secondary monoblock C. Tertiary monoblock.

MATERIALS AND METHODS

This invitro study, conducted between March and August 2010, was carried out in the Department of Conservative Dentistry, University of Science and Technology, Yemen. The study was approved by the Research and Ethics Committee, Faculty of Medicine and Health Sciences, University of Science and Technology (UST).

Teeth Collection and Selection

Freshly extracted lower first premolars were collected from orthodontic dental clinics. Teeth were placed in a 5.25% sodium hypochlorite (NaOCl) (Quneex, Saudi Industrial Detergents Company, K.S.A) for five minutes. Teeth were then carefully cleaned with curette (Brite Sources, USA) to remove the soft tissue and calculus remnants. Teeth were stored in saline solution until further instrumentation.

Collected teeth were examined by naked eye and digital radiographs (Genoray Portable Dental X-ray, Genoray Co. Ltd, Korea). Roots were also examined for cracks by trans-illumination using standard light curing unit (Coltene/Whaledent Inc., USA). Seventy-two teeth were selected with intact, relatively straight, and completely formed roots. Any root with cracks, fracture, curvature, caries, open apices, more than one canal, wide canal, resorption, calcifications, or root canal filling was excluded. Additionally, short and long teeth were excluded. The sample size was decided based on feasibility rather than formal calculations.

Preparation of Root Canals

The crowns were removed at the cemento-enamel junction at 13 mm from the apex using diamond disc (HP, EDENTA, Switzerland) under water cooling [4]. The root surface was cut parallel to the horizontal plane. In order to minimize experimental variables, all procedures were performed by the same operator. Canal lengths were established by placing a size 10 or 15 K-type file (Innovative Material and Devices, Inc., (IMD), China) into each root canal using reciprocating back and forth motion until the tip of the file was visible at the apical foramen. The working length was established 1mm short of the apical foramen.

All procedures were conducted with the teeth held in saline-moistened gauze to avoid drying, and to facilitate handling. Throughout the experiment, the teeth were stored at 100% humidity in normal saline to avoid dehydration. The root canals were prepared with PROTAPER (Dentsply-Maillefer, Switzerland) in sequence till Finishing file number 2 (F2). Every PROTAPER files Kit was replaced by a new one after preparation of six canals. Six roots were prepared daily to avoid unstandardization due to fatigue. NaOCl irrigant, and Glyde lubricant (Dentsply-Maillefer, Ballaigues, Switzerland) were used throughout instrumentation. After completing the instrumentation, 10 ml of 17% EDTA (ethylenediamine tetra-acetic acid) (Produits Dentaires SA, Switzerland) was placed in the canal to be used for two minutes (under a constant speed of 5ml/per minute). This was followed by 10 ml of 5.25% NaOCl irrigation. Finally, the root canals were flushed with 3 ml distilled water. Then canals were dried with paper points.

Seventy-two specimens were randomly divided into four groups, two experimental (I, and II), and two control group (III and IV):

Group I: 30 roots were obturated with Epiphany SE sealer and Resilon cones.

Group II: 30 roots were obturated with Epiphany SE sealer and gutta-percha cones.

Group III: Six roots were used as Positive control group. Three roots were filled with gutta-percha and the other three roots were filled with Resilon without Epiphany SE sealer.

Group IV: Six roots were used as Negative control. Three roots were filled with gutta-percha/Epiphany SE where other three were filled with Resilon/Epiphany SE.

Obturation

A size 25 taper 0.02 standardized Resilon or gutta-percha cone was used as master cone that matched the last used rotary file F2. It was fitted to the working length with tug-back sensation. A lentulo spiral filler no. 25 (Thomas Endo, Bourges Cedex, France) was used to introduce the sealer into the canal. For Groups I and II, Resilon or gutta-percha master cone was coated with Epiphany sealer. Master cone was inserted and condensed using the lateral cold condensation technique with finger spreader size 25 (Innovative Material and Devices, Inc., (IMD), China). Accessory points were placed in the canal in sequence (Medium-fine, fine, and Medium). Inability of the spreader size 15 to be inserted into the canal indicated complete obturation. A heated spoon excavator (Brite Sources, USA) was used to sear off the excess obturation material either gutta-percha or Resilon. Light curing was carried out for 40 seconds on the coronal surface with a standard light curing unit (Coltene/Whaledent Inc., USA). Ten roots were obturated daily.

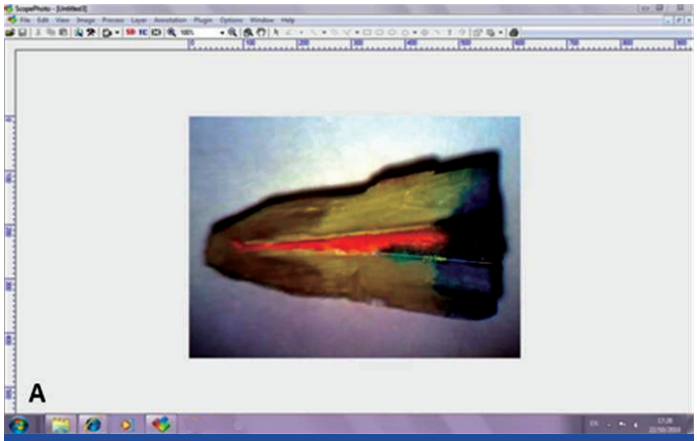
Radiographs were taken to evaluate the quality of the root canal filling with regard to homogeneity and apical extension. The filling was considered adequate when it was fitting to the canal and no gaps could be observed [12]. All specimens were then stored in normal saline solution at 37°C in incubator for 72 hours to ensure complete setting of the sealer [3,7].

Microleakage and Evaluation

The experimental roots were coated with two layers of cyanoacrylate superglue (ABR super glue, USA) except 1mm to the coronal access. The negative control group roots were completely covered with two layers of cyanoacrylate including their apical foramen and coronal access, while the positive control group roots were covered with two coats leaving 1mm to their apices and coronal access.

All roots were then placed into 2% methylene blue (Scharlau Chemie S.A, European Union) for seven days at 37ºC in incubator. After being removed from the dye solution, specimens were rinsed under running water for one minute and then dried with a napkin. Then each root was centralized to be sectioned longitudinally in buccolingual direction by measuring the mesiodistal width with a calibrator, and dividing it into two halves. Root was longitudinally grooved on both sides (buccal and lingual side), using a long thin fissure diamond bur (Horico, Diamant, Germany) under constant cooling. Root was split with a chisel (Brite Sources, USA) into two equal halves by levering action [4].

The two halves of each root were digitally photographed with stereomicrscope (Trinocular Zoom Stereo Microscope, Proway Optics and Electronics Co., Ltd., China) and Digital Camera (3M pixels CMOS chip, Yee Mau Industrial Co, China) under magnification of 1.3. Next, the photographs were transferred to a personal computer. Coronal leakage was measured from the coronal end of dentin-obtutration material interface, to the most apical extent of the dye using measurement tool of Scopephoto 3.0 image analysis software (ScopeTek Scopephoto 3.0, Hangzhou scopetek opto-Electric Co., Ltd, China) [Table/Fig-2]. The most linear dye penetrated interface measurements were collected. Data were tabulated and statistically analysed using a One-way A NOVA test analysis in Spss, version 17 (Spss inc., USA).



[Table/Fig-2]: Coronal leakage measurement.

RESULTS

All positive controls showed complete dye penetration throughout the length of the root canals. The negative controls showed no dye penetration in any of the samples. All specimens in the experimental

groups demonstrated different degrees of coronal leakage. The gutta-percha group exhibited more coronal dye penetration than Resilon group. All mentioned descriptive statistics data of linear dye penetration measurements for both groups were illustrated in [Table/Fig-3,4].

Variable	N	Mean	Median	TrMean	StDev	SE
Gutta-percha	30	279.2	245.1	277.2	105.4	19.3
Resilon	30	197.4	181.1	189.5	109.2	19.9

[Table/Fig-3]: Descriptive data of both groups.

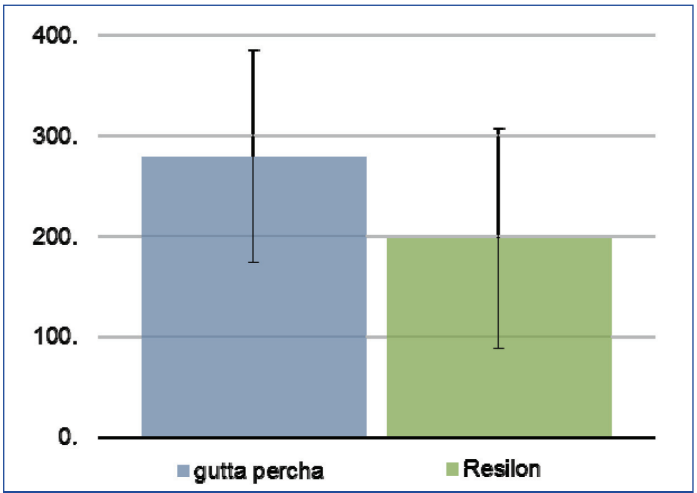
Variable	Minimum	Maximum	Q1	Q3
Gutta-percha	115.5	488.5	210.6	384.4
Resilon	50.1	436.1	116.9	226.5

[Table/Fig-4]: The minimum, maximum, Q1 (first quartile), and Q3 (third quartile) for gutta-percha and Resilon groups.

Source	(DF)	(SS)	(MS)	F ratio	p-value
Material	1	100262	100262	8.70	0.005
Error	58	668194	11521		
Total	59	768456			

[Table/Fig-5]: One-way ANOVA: Analysis of Variance for leakage) leakage versus material).
DF: Degree of freedom SS: Sum of square MS: Mean square.

One-way ANOVA test revealed that there was a high significant difference of the leakage versus material) F= 8.70, p=0.005 (as displayed in [Table/Fig-5]. Resilon/Epiphany combination revealed superiority to gutta-percha/Epiphany combination [Table/Fig-6].



[Table/Fig-6]: Coronal leakage values for both groups.

DISCUSSION

Contamination or recontamination of the root canal system is a challenge to avoid after completion of root canal treatment [13]. Additionally, Britto et al., reported cases presenting inadequate obturation with clinically suitable coronal restoration that showed clinical and radiographic manifestations of failure [14]. Thus, it indicates the importance of good root canal obturation to resist leakage besides an adequate coronal restoration. The majority of previous leakage studies investigated apical dye penetration. Nonetheless, the ingress of dye into apical foramen is minimal, compared to the possible penetration through a larger coronal opening [15]. Coronal leakage is far more likely to be the major determinant of clinical success or failure [16].

The dye penetration method was used because of its simplicity, pervasive usage all over the world [17]. Pitout et al., reported that the dye penetration method brings about similar results to the bacterial leakage method [18], which is considered to be the most clinically relevant [19]. Methylene blue dye was used in this study owing to its molecular size that is similar to bacterial byproducts such which can leak out of infected root canals to irritate periapical tissues [20]. It also easily allows quantitative measurement of dye penetration extension by linear measurement techniques [1,3]. The results of this study indicated that a total seal was not obtained with any specimen. This might be in general due to the unfavorable geometry of root canal system for resin bonding [21]. The cavity configuration factors (C-factor) and polymerization shrinkage stress (S-factor) in root canals are obstacles to a gap-free filling with adhesive systems. The force of polymerization shrinkage may exceed the bond strength to dentin, allowing disunion of one side of the filling to relieve stress, thus increasing leakage [22]. The incomplete infiltration of resin into the demineralized dentin is another limitation, as a result of the difficulty in achieving the ideal ratio between the degree of the dentin demineralization and the ability of resin infiltration [23].

The better sealing ability of Resilon may be due to the chemical bonding of the Resilon cone to the Epiphany sealer. In addition, Epiphany adheres and penetrates into the dentinal walls tubules of the root canal system [3,8], while there is a general agreement that gutta-percha does not bond to dentin and there is no chemical adhesion between gutta-percha and resin-based sealer. Its slight elasticity causes a rebound action and recession from the canal walls. This might explain the increase of the sealing ability of Resilon/Epiphany combination over gutta-percha/Epiphany combination.

When comparing the findings of the current study with that of previous studies that used the same combination (Resilon/Epiphany and gutta-percha/Epiphany), it can be said that the results of the present study confirm the finding of Shipper et al., and Kocak et al., [8,24]. Moreover, comparing the results of the present study with other coronal studies used other material groups, the studies of Bodrumlu and Tunga, Shipper et al., and Eldeniz and Ørstavik, Hegde and Arora, Bhandi and Subhash revealed similar findings to the current study [4,25-28]. However, the present study disagrees with some coronal studies; Oddoni et al., Pitout et al., Kececi et al., de Almeida-Gomes et al., and de Fátima et al., regarding the superiority of Resilon over guttta percha [10,18,29-31]. Although, the other studies did not indicate the superiority of Resilon over gutta-percha, no published study was found that reported a superiority of gutta-percha over Resilon. Conflicts in results can be explained by methods of evaluation or leakage methods [29]. Furthermore, the study design may well affect the results. For instance, the using of hand or rotary preparation of the root canal, lateral condensation, thermoplactisized or other obturation technique, and irrigation with sodium hypochlorite or other irrigants could be other contributors in difference of results.

LIMITATION

The present study has some limitations that should be considered. This invitro study was carried out on extracted teeth. However, laboratory conditions are not exactly similar to that of clinical conditions, and results obtained by invivo studies may differ. Therefore, it is recommended to carry out invivo studies (animal studies) on Resilon/Epiphany sealer to show its coronal sealing ability under clinical conditions i.e., natural saliva and oral circumstances, and to study its effect on the periapical healing process. In addition, dye leakage test is a commonly used method, and it was applied in the present study. Additional leakage studies using different leakage methods are recommended, since this may give additional information about the sealing ability, especially when there is no standardized method for testing leakage invitro.

CONCLUSION

Within the parameters of the study, it was concluded that Resilon/Epiphany can be a good alternative for gutta-percha/sealer as a

root canal filling material on the basis of its increased resistance to coronal microleakage. However, the Resilon/Epiphany system failed to provide complete hermetic coronal sealing which means that complete sealing is still a challenge with this system.

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