Journal of Oral Science, Vol. 52, No. 1, 83-87, 2010

Original

Effect of chlorhexidine on coronal microleakage from root canals obturated with Resilon/Epiphany self-etch

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(Received 7 September and accepted 22 December 2009)

Abstract: This *ex vivo* study compared saliva coronal microleakage in root canals filled with Resilon/Epiphany Self-Etch (SE) system after final irrigation with different solutions. A total of 60 extracted single-rooted human teeth were instrumented using Mtwo Ni-Ti rotary instruments and divided into two experimental groups (n = 20 each) and positive and negative control groups (n = 10 each). The canals were irrigated with 1.3% NaOCl during instrumentation. After removing the smear layer with 17% EDTA, the root canals in groups A and B were flushed with distilled water and 2% chlorhexidine (CHX), respectively, after which they were obturated with Resilon/Epiphany SE using lateral compaction technique. After sterilizing the whole system with gamma-rays, saliva leakage was tested using a split-chamber model. Specimens were monitored every 24 h for 60 days. The data collected were then analyzed using the chi-square test and Kaplan-Meier survival analysis. As compared with group A, the specimens in group B tended to be more resistant to saliva leakage; however, the difference was not significant (P > 0.05). In conclusion, our findings suggest that 2% CHX is a good conditioner for root canal dentin before use of Resilon/Epiphany SE. (J Oral Sci 52, 83-87, 2010)

Keywords: chlorhexidine; Epiphany self-etch (SE), microleakage; Resilon; saliva.

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Introduction

The aim of endodontic treatment is to eliminate microorganisms and their byproducts from the root canal system and to create a tight seal that prevents re-infection (1).

Resilon is a synthetic polymer-based root canal filling material developed recently to replace gutta-percha and traditional sealers. The Epiphany obturation system consists of three elements: Resilon, Epiphany, and self-etching primer (2,3). More recently, a new Epiphany Self-Etch (SE) soft resin endodontic obturation system has been marketed; it consists of two components: Epiphany SE sealer and Resilon. The third generation of methacrylate resin-based sealers has eliminated the use of self-etching primers by incorporating acidic resin monomers in the sealers (4).

Alternating use of EDTA and NaOCl has been recommended for removal of the smear layer (5). Because NaOCl is a strong oxidizing agent and adversely affects the bond strengths of resins (6), the manufacturer recommends that sterile water or 2% chlorhexidine (CHX) be used as the final irrigant before root canal obturation with Resilon/Epiphany.

Different irrigation regimens may cause chemical and structural changes in dentin (7); these changes then affect

the adhesion of bonded materials to dentin surfaces (8). For bonded materials, the loss of bond strength has been attributed mainly to degradation of the hybrid layer at the dentin-adhesive interface (9). It has been shown that the application of a synthetic protease inhibitor, such as CHX, improves the integrity of the hybrid layer and resin-dentin bond stability (10,11). Furthermore, several studies have shown that CHX, when used as an intracanal medicament/irrigant, increased the time required for recontamination of a root filled with gutta-percha (12,13).

This study compared saliva penetration of root canals filled with Resilon/Epiphany SE system after using distilled water or 2% CHX as the final irrigant. To our knowledge, this is the first report on the effect of CHX on the resistance to microbial leakage of roots filled with Resilon/new Epiphany SE system.

Materials and Methods

A total of 60 extracted single-rooted human teeth, stored in 0.5% chloramine-T at 4°C, were used in this study. The teeth were decoronated to produce 13-mm-long root samples. The working length was established visually by subtracting 1 mm from the length of a size #10 K-file (Dentsply Maillefer, Ballaigues, Switzerland) at the apical foramen. The root canals were prepared using Mtwo Ni-Ti rotary files (VDW, Munich, Germany). Six instruments were used at the working length in the following sequence: 10/.04, 15/.05, 20/.06, 25/.06, 30/.05, and 35/.05. All canals were irrigated between each file with 3 ml of 1.3% NaOCl. After canal preparation, the canals were irrigated with 3 ml of 17% EDTA for 1 minute to remove the smear layer. The specimens were then randomly divided into two experimental groups (A and B) of 20 each and two control groups of 10 each.

In groups A and B, the root canals were flushed with 3 ml of either distilled water or 2% CHX (Consepsis, Ultradent, South Jordan, UT) for 10 min, respectively. Then, the root canals were dried with paper points and obturated with Resilon/Epiphany SE sealer (Pentron Clinical Technologies, LLC, Wallingford, CT, USA) according to the manufacturer's instructions. Epiphany SE sealer was mixed, and a Resilon master cone (size 35/.02) was coated with Epiphany SE and placed into the canal to a working length. The root canals were filled using lateral compaction technique. After removing excess Resilon with a heated instrument, the coronal surface of the obturation was light-cured for 40 s according to the manufacturer's instructions.

In the positive and negative control groups, which contained 10 teeth each, 5 root canals were irrigated with distilled water in the same manner as group A, and 5 in the same manner as group B. In the positive control group, the roots were filled only with a single Resilon cone (size 35), without Epiphany sealer. In the negative control group, the root canals were obturated using laterally compacted Resilon/Epiphany SE. The roots were then radiographed to confirm the quality of obturation. All teeth were kept at 37°C and 100% humidity for 7 days. All but the apical 3 mm of teeth in the experimental groups and positive control group were coated with two layers of nail varnish (Arcancil, Paris, France). The roots in the negative control group were coated completely with two layers of nail varnish.

A modification of the microbial leakage model consisting of an upper chamber and a lower chamber, as described by Torabinejad et al. (14), was used. The tapered ends of 2-ml Eppendorf plastic tubes (Eppendorf-Elkay, Shrewsbury, MA, USA) were cut and the roots were inserted individually into the tubes until the roots protruded through the end. The junction between the plastic tube and the extruded root was then sealed with sticky wax. The Eppendorf tubes were placed in glass tubes containing 10 ml sterile brain-heart infusion (BHI) broth (Merck, Darmstadt, Germany), so that at least 3 mm of each root apex was immersed in the broth. The junction between the Eppendorf tube and glass tube was sealed with sticky wax. The whole apparatus was sterilized by exposure to 25-kGy gamma irradiation. The specimens were then incubated at 37°C for 3 days to confirm the sterility of the system. Samples that showed any sign of turbidity were discarded. Human whole saliva (45 ml) was collected from one individual between 8:00 A.M. and 11:00 A.M. on each day of solution change. The volunteer did not brush for at least 12 h before collection, and chewed a piece of Parafilm (American National Can, Neenah, WI, USA) to stimulate salivary flow. The saliva was stored in a brown, glass, 70-ml screw-cap container and then mixed with BHI broth in a 3:1 (v/v) ratio. Then, the upper segment of each split chamber was filled with 1 ml of the mixture of saliva and BHI broth. The mixture was replenished every 3 days. The whole system was incubated at 37°C and checked daily for 60 days for the appearance of turbidity in the lower segment of the chamber, which was filled with BHI. To confirm identical bacterial contamination in both the upper and lower chambers, cultures from the lower segment were streaked onto blood agar culture plates and incubated under aerobic and anaerobic conditions at 37°C.

The data were analyzed using the chi-square test and Kaplan-Meier survival analysis. The significance level was set at 0.05. Statistical analysis was performed with SPSS 11.5 software for Windows (SPSS Inc, Chicago, IL).

Results

The microorganisms obtained from turbid BHI broths in the lower chambers were normal salivary flora. Thus, we ruled out the possibility of BHI turbidity due to contamination during the experiment. All specimens in the positive control group leaked within 4 days of incubation; there was no leakage in the negative controls. The number of days (mean ± standard deviation) before leakage occurred in groups A and B was 31.55 ± 5.42 and 40.90 ± 4.87, respectively; the difference was not significant ($P > 0.05$). The Kaplan-Meier curves are shown in Fig. 1.

Discussion

It has been reported that penetration by bacteria and their by-products along root fillings exposed to the oral environment compromises endodontic treatment outcomes (15). Therefore, bacterial leakage tests are frequently used to evaluate the sealing ability of root filling materials (16). However, the antibacterial and cytotoxic effects of root canal sealers and root-filling materials may limit the ingress of bacteria, thereby resulting in conflicting data from different leakage models that use divergent bacterial leakage strategies (17). The method for saliva leakage evaluation used in this study was similar to one reported previously (13).

Although there was no statistical difference between final irrigants in the present study, there was a trend toward less saliva leakage with the Resilon/Epiphany SE when the final irrigant was 2% CHX. After final irrigation with 2% CHX, the mean number of days before leakage occurred was higher than for specimens flushed with distilled water.

Chlorhexidine is a cationic bisbiguanide (18). It adsorbs onto dentin and prevents microbial colonization for 48 to 72 h (19,20). However, Rosenthal et al. (21) demonstrated that the antimicrobial activity of 2% CHX was maintained for up to 12 weeks after a 10-min application, which suggests that CHX delays recontamination of the root canal system (9,12,13).

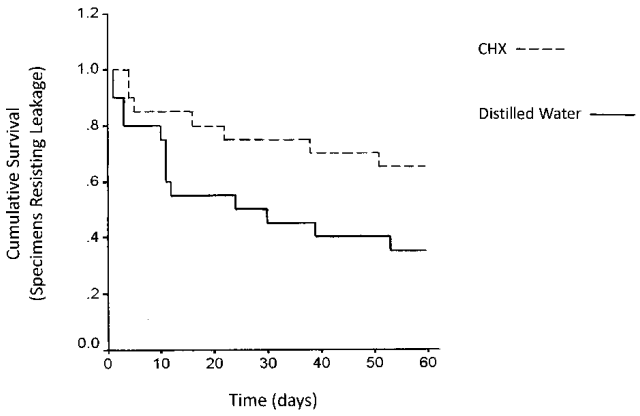

Fig. 1 Kaplan-Meier survival curve for the experimental groups.

The characteristics of CHX-treated dentin might also explain the greater resistance to microbial leakage. Different irrigation regimens may alter the chemical and structural composition of dentin (7), thereby affecting the adhesion of bonded materials to the dentin surface (8). The presence of surface surfactant in CHX increases the surface energy and wetting ability of dentin. This may positively affect the adhesion of hydrophilic bonded materials like ActiV GP (22) and Epiphany. Hashem et al. (22) showed that flushing root canals with 2% CHX after 17% EDTA doubled the bond strength of ActiV GP.

It has been shown that deterioration of dentin collagen fibrils causes hybrid layer disintegration, resulting in bond failure (23,24). Matrix metalloproteinases (MMPs) present in dentin can degrade unprotected collagen fibrils (9). CHX has been shown to have a broad-spectrum MMP-inhibitory effect (25). Several *ex vivo* and *in vivo* studies demonstrated that the application of CHX, a synthetic protease inhibitor, improved both the integrity of the hybrid layer and resin-dentin bond stability (10,11,26).

Resilon/Epiphany SE resisted microbial penetration. It is not possible to achieve a gap-free monoblock, with adhesion of Epiphany sealer both to the Resilon and dentin walls (27). This is due to the unfavorable configuration factor (C-factor) within the root canal system – which results in maximizing the polymerization shrinkage stress of adhesive systems and rendering the obturation mass vulnerable to debonding (28) – to incomplete smear layer removal (17), and to the incomplete infiltration of resin into the demineralized dentin (29).

Biodegradation of Resilon may result in bacterial leakage at the sealer – Resilon interface. It has been shown that polycaprolactone, the primary component of Resilon, is biodegradable under microbial attack (30) and susceptible to alkaline and enzymatic hydrolysis (31,32). Therefore, when evaluating the sealing ability of root filling materials, it is essential to use leakage models that simulate clinical situations.

Under the conditions of this *ex vivo* study, we conclude that the Resilon/Epiphany SE soft resin obturation system did not completely resist saliva leakage during a contact period of 60 days. In addition, our results show that CHX may be a good conditioner for root canal dentin before the use of Resilon/Epiphany SE. Further investigations should be conducted to evaluate the effects on treatment outcome of the different irrigants used in root canal therapy.

Acknowledgments

This study was supported by a grant from Tehran University of Medical Sciences and Health Services (grant number: 5803). The authors wish to thank Dr. Mohammad J. Kharrazifard for his assistance in statistical analysis.

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