Effects of an Intracanal Glass Ionomer Barrier on Coronal Microleakage in Teeth with Post Space

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Abstract

Bacterial microleakage of the remaining gutta-percha in teeth prepared for post space with and without the use of an intracanal glass ionomer barrier was evaluated. Forty distal roots of mandibular molars were instrumented, obturated with gutta-percha and AH Plus sealer, and post spaces created. Teeth were divided as follows: Group I, 3 mm of gutta-percha; group II, 4 mm of gutta-percha; group III, 2 mm of gutta-percha plus 1 mm of Vitrebond; and group IV, 3 mm gutta-percha plus 1 mm Vitrebond. The roots were suspended in Rogosa SL broth and *Lactobacilli casei* was used as a microbial marker. At the end of 92 days, the mean number of days for the broth to turn turbid was group I, 23.8; group II, 43.0; group III, 57.4, and group IV, 70.5. A two-way ANOVA showed differences between the groups and a post hoc Tukey HSD analysis revealed the following significant differences ($p < 0.05$): Group I leaked faster than groups III and IV and group II leaked faster than group IV. In clinical situations of teeth with compromised crown-root ratio that require a post and core, 1 mm of Vitrebond over 2 or 3 mm remaining gutta-percha could reduce the risk of recontamination of the apical gutta-percha. *(J Endod 2006; 32:120–122)*

Key Words

Coronal microleakage, glass ionomer, intraorifice barrier, intracanal barrier, post and core, post space

Microleakage because of missing or compromised coronal seal is often implicated in the failure of root canal therapy. In teeth that require a post to retain a core, the period after obturation before the post is permanently cemented allows numerous opportunities for the root canal to become recontaminated. Torabinejad et al. stated that sealed root canals can be recontaminated under several circumstances: (a) if the endodontic therapy was completed but the placement of permanent restoration was delayed; (b) if the seal of the temporary filling material has broken down; or (c) if the restoration and/or tooth structure has fractured or is missing (1).

Restorative treatment plans for the endodontically treated tooth often call for the placement of a post and core and a crown. The removal of gutta-percha for post space is dictated by biomechanical considerations for the length of the post and dimension of the remaining gutta-percha (2, 3). The strict aseptic conditions practiced in endodontics are frequently neglected during the post space preparation. Removal of the gutta-percha without proper rubber dam isolation can potentially allow ingress of oral fluids and microorganisms into the canal and potentially result in failure of the endodontic treatment. Additionally, contamination of the root canal system may occur with inadequate temporary restorations.

Contamination of the root canal system with saliva has been identified as a potential cause of endodontic failure (4). Swanson and Madison reported that exposure of the coronal segments of obturated root canals to artificial saliva resulted in recontamination of 79 to 85% of the root canal system in as little as 3 days (5). Torabinejad et al. demonstrated that over 50% of obturated root canals were contaminated after 19 days of exposure to *Staphylococcus epidermidis* (1).

Investigators began to look at barriers to help prevent coronal microleakage. Pisano et al. showed that an intraorifice barrier provided a secondary seal for obturated teeth without a restoration (6). Chailertvanitkul et al. demonstrated that a glass ionomer cement (Vitrebond) intraorifice barrier also provided an adequate barrier for endodontically treated teeth (7).

Gutta-percha remaining after post space preparation does not provide a seal equivalent to the intact root canal filling. Abramovitz et al. demonstrated that 5 mm of gutta-percha after post space preparation seal was inferior to the intact filling within a few days (8). Metzger et al. compared remaining gutta-percha after post space preparation of 3, 5, 7, or 9 mm and found that the seal of 3, 5, and 7 mm remaining gutta-percha was inferior to an intact filling of 14 mm (9).

Several methods have been used to demonstrate the sealing ability of materials, but because of the limitations of dye, radioisotope, and pressure driven fluid transport methods (10), a bacterial challenge may provide a more accurate indicator of clinical applications. The literature supports the use of an intraorifice glass ionomer barrier to protect the root canal filling as a second line of defense for the temporary coronal seal (7, 11–13). However, there are no reports documenting the use of an intracanal glass ionomer barrier in endodontically treated teeth with post space created. The purpose of this study was to evaluate the bacterial microleakage of the remaining gutta-percha in teeth prepared for post space with and without the use of an intracanal glass ionomer cement barrier.

Methods and Materials

Forty, freshly extracted, intact, mandibular first and second molars with one canal in the distal root were stored for 4 weeks in 0.2% sodium azide. Teeth were examined

for fractures or defects by transillumination at ×3.5 magnification. Specimens were decoronated 1 mm coronal to the cementoenamel junction and the roots were separated.

The apical terminus of each tooth was determined by passing a #15 file through the apical foramen until visible and the working length was set at 1 mm short of that point. Canals were prepared using a crown down/step-back technique. The apical seat was prepared to a #60 file and 5.25% sodium hypochlorite (NaOCl) irrigation was used throughout instrumentation with patency maintained. The smear layer was removed with 17% EDTA and 5.25% NaOCl. Canals were dried and obturated with gutta-percha and AH Plus sealer (Dentsply, Tulsa, OK) using cold lateral compaction. Post space was created with warm pluggers and excess root canal sealer was removed.

Specimens were randomly divided into four experimental groups of eight teeth as follows: group I (3 mm gutta-percha), group II (4 mm gutta-percha), group III [2 mm gutta-percha plus 1 mm Vitrebond (3M, St. Paul, MN)], and group IV (3 mm gutta-percha plus 1 mm Vitrebond). Two positive controls were nonobturated canals. Two negative controls were obturated, post prepared with 4 mm of remaining gutta-percha and the root completely sealed with cyanoacrylate and nail polish.

Vitrebond was mixed according to the manufactures recommendations and placed directly over the remaining gutta-percha with a Centrix syringe and AccuDose needle tube (Centrix Inc., Shelton, PA). Using the dental operating microscope, glass ionomer cement was injected until the gutta-percha was no longer visible, which produced 1 mm of Vitrebond. Each specimen was radiographed to verify the thickness of the gutta-percha and the glass ionomer barrier. The Vitrebond was light cured for 60 seconds. The specimens were placed in 100% humidity for 48 hours to allow the sealer to set.

The experimental model was based on Pisano et al. (6). A hole was made in the center of the plastic top of each scintillation vial so that a one-quarter inch vinyl tubing would fit snugly through the hole and the junction was sealed with cyanoacrylate. Each root was reduced coronally to produce convergent axial walls, which provided better adaptation to the vinyl tubing as well as increased surface area for bonding and sealing the tooth/tubing interface. Two inch sections of the vinyl tubing were bonded over the coronal aspect of the root with cyanoacrylate. Except for the apical 2 to 3 mm, experimental teeth and positive control teeth were coated with cyanoacrylate and then two coats of nail polish, which controlled for any lateral or accessory canals.

Each scintillation vial, top, and root assembly was individually wrapped and sterilized with a low temperature hydrogen peroxide gas sterilizer (Sterrad, Johnson & Johnson, Arlington, TX). After sterilization, the scintillation vials were assembled under a biological hood. The specimens were suspended in the vials with sterile Rogosa SL broth (Difco, Detroit, MI) that covered the root ends. An inoculum containing *Lactobacilli casei* (ATCC # 11578, Rockville, MD) was introduced into the vinyl tubing that led into the root canal and was changed every 5 days. Samples were incubated at 37°C. If the broth turned turbid, the microorganism had penetrated the entire length of the root canal. The day number that samples turned turbid was recorded and the experiment was terminated on day 92 when the broth of the last experimental tooth turned turbid. Each sample that produced turbidity was then tested with methylene blue dye to determine any false positives. Presence of Lactobacilli in the turbid samples was verified by Gram stain. The mean days to turn turbid data for each experimental group were analyzed using SPSS software version 9 (SPSS Inc., Chicago, IL). A two-way ANOVA was run to determine differences between groups and Tukey HSD post hoc analysis was run with the level of significance set at $p < 0.05$.
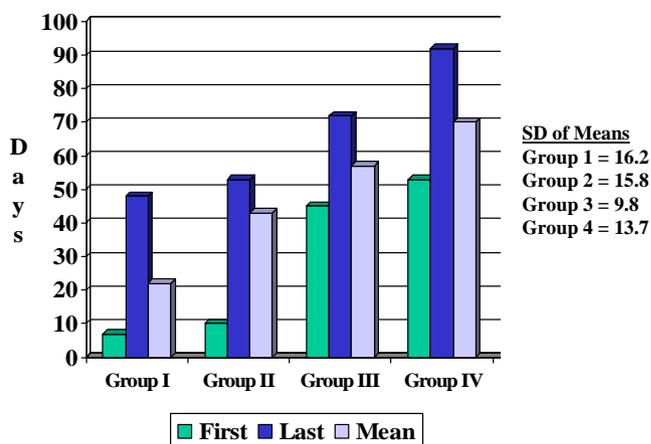
Figure 1. First day, last day and mean days to turn turbid for teeth in the experimental groups. Standard deviations (SD) for the means of the groups are listed on the right.

Results

All positive controls were turbid in 12 hours and negative controls remained nonturbid for the entire 92 day experimental period. Group II produced the only false positive, which was because of a vertical root fracture. At the end of 92 days, the mean number of days to turn turbid (with standard deviations) by group was group I, 23.8 (SD 16.2); group II, 43.0 (SD 15.8); group III, 57.4 (SD 9.8); and group IV, 70.5 (SD 13.7) (Fig. 1). A two-way ANOVA showed a difference between groups and the post hoc Tukey HSD analysis revealed significant differences (p < 0.05) comparing groups as follows: group I leaked faster than groups III and IV and group II leaked faster than group IV.

Discussion

Microleakage dye penetration study designs face challenges related to the nature of the penetrating material (radioisotopes, liquid dyes, fluid filtration, and electro-chemical), which because of differences in molecular size, viscosity, surface tension, or decoloration could influence the penetration capability and detection (1, 5, 6, 10, 14, 15). In this study, *Lactobacilli casei* was specifically chosen because it is a facultative anaerobe that is easily cultured and identified under a microscope, and is commonly found in contaminated root canals. Since it can be selectively cultured on agar plates and in Rogosa SL broth, it eliminated the risk of cross contamination from other microbes because of its low pH. Therefore, when broth turbidity occurred, it was because of lactobacilli penetration of the root canal system and not from other sources.

Teeth requiring a post space generally lack coronal tooth structure. Placement of an additional intracanal barrier inside the root canal over the remaining gutta-percha is a logical adjunct to prevent contamination of the vulnerable remaining gutta-percha (Fig. 2). However, the placement of a glass ionomer barrier should not replace or preclude the placement of an interim temporary restoration in the coronal third of the tooth.

There was no statistical difference in comparing the mean turbidity time periods of groups I and II. However, group I, 3 mm of gutta-percha, was highly unpredictable (Fig. 1). Portel et al. found a significant increase in the amount of apical leakage when only 3 mm of filling material remained after preparation (16). In a pilot study, groups of 1 and 2 mm of remaining gutta-percha all turned turbid within 5 days. Therefore, no material thickness of gutta-percha or combination with glass ionomer less than 3 mm was used in this study. The technical challenges

Figure 2. Intracanal glass ionomer barrier illustrated under post in the second premolar. Introrifice glass ionomer barriers over the canals and over the pulpal floor demonstrated in the first molar.

of leaving 3 mm or less of remaining gutta-percha could account for the unpredictability of group I.

The results of this study are in agreement with other studies that reported root canal filling materials do not prevent bacterial microleakage and penetration for an indefinite period of time (1, 5, 17, 18). Therefore, it is imperative that a permanent restoration is placed as soon as possible for the overall success of the treatment (3, 19). Wu et al. found in a fluid transport model that 4 mm of remaining gutta-percha leaked significantly more than the original full-length root canal filling, but a cemented post was able to compensate (20). In a recent study, Moshonov et al. concluded that the remaining gutta-percha should be in contact with the post (21).

The time between obturation and placement of the permanent restoration is critical to prevent recontamination of the remaining apical gutta-percha (3). In this study, Vitrebond proved an acceptable intracanal barrier material and should provide a superior secondary seal for the temporary coronal restoration.

Retreatment and ease of removal of the intracanal barrier was considered during the selection of the material. An ultrasonic tip can be used to easily remove the Vitrebond barrier from the canal.

In this study, teeth with 2 mm of gutta-percha plus 1 mm of Vitrebond were nonturbid for a mean of 57.4 days, while teeth with 3 mm of gutta-percha turned turbid at 23.8 days and the difference was statistically significant (p < 0.05). In the compromised clinical situation of a short tooth needing a post and core, which only allowed 3 mm of remaining gutta-percha, a glass ionomer barrier over the gutta-percha could reduce the risk of recontamination of the apical gutta-percha.

Acknowledgments

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