Original Research

Laboratory Comparison of the Coronal Microleakage of Glass Ionomer, Proroot MTA, and Resilon as Orifice Plug in Root Canal Treated Teeth: an In Vitro Study

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Abstract

Background: One of the most efficient methods for preventing coronal microleakage in root canal treated teeth is an orifice plug. The present study aimed to compare the rate of the coronal microleakage of Glass ionomer, Resilon, and ProRoot MTA as an orifice plug in root canal treated teeth in vitro.

Method: This study evaluated the single-rooted extracted teeth with one canal. A total of 70 single-rooted teeth with single canals were selected. Following the removal of dental crowns, root canals were cleaned and shaped through the step-back technique and were filled with gutta-percha and AH26 sealer by lateral condensation method. Afterwards, 3 mm of the gutta-percha of canal orifice was emptied. The teeth were randomly divided into three test groups (N=20), a positive control group (N=5), and a negative control group (N=5). After filling, the samples were placed in Indian ink for 72 hours and the roots were cut into two pieces. The level of color penetration was evaluated by the ×16 magnification of a stereomicroscope. The data were analyzed by the descriptive statistics and one-way ANOVA test using the SPSS software version 19.

Results: The mean of color penetration in the Glass ionomer, MTA, and Resilon groups was 0.69, 0.73, and 1.1, respectively. The Resilon group had a significant difference with the other two materials ($p<0.5$), while Glass ionomer and MTA were not significantly different. ($p>0.5$).

Conclusion: According to the results of this study, Glass ionomer and MTA as orifice plugs are more favorable than Resilon in preventing coronal microleakage.

Keywords: Glass ionomer, Root Canal Obturation, ProRoot MTA

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Introduction

Most cases of endodontic therapy failure are directly or indirectly related to the presence of bacteria in the root canal. The quality of coronal seal is the most common and the most uncontrollable issue after treatment. Crown restorations protect and seal the teeth as a result control saliva and bacterial dissemination toward the apex to prevent from treatment failure (1, 2).

Microleakage is among the factors that cause endodontic therapy failure. Microleakage might occur from the coronal toward root filling and apical canal, which has been confirmed in various studies (3, 4).Complete sealing of the access cavity and tooth coronal structure is of high importance in root canal therapy for preventing the entrance of saliva and microorganisms to the root structure. Many investigations showed that coronal microleakage also takes place around temporary restoration (5, 6).

Numerous methods have been suggested for reducing microleakage from and around the temporary restoration. Each of these techniques that can delay or prevent saliva and microorganism entrance into the root canal structure is highly beneficial and can elevate the rate of treatment success. Materials used for orifice plug can seal against bacterial penetration, are compatible with the restoration materials for the root and crown, can be placed easily, and can be used again (7-9).

One of the most effective methods with an easy clinical application is the intra-orifice plug, which is placing some material inside the canal orifice after removing few millimeters of canal gutta-percha. Moreover, sealing the base of pulp chamber with restoration materials is another proposed technique. Diverse evaluations have been performed on restoration materials as orifice plug, including Cavit, IRM, super EBA, amalgam, glass ionomer, mineral trioxide aggregate, and dentin bonding. Ideal material for orifice plug can easily be removed by a dentist during treatment, bonds dental structure, effectively prevents coronal microleakage, is easily diagnosed from natural tooth structure, and does not interfere with final restoration (10, 11).

Resilon is a material with a polymer base introduced as a substitute for gutta-percha for filling the root canal. Several studies demonstrated that the canals filled with Resilon have less leakage than the ones filled with gutta-percha (12, 13).Glass ionomer cement has diverse applications due to some properties, such as the ability for binding dentin, proper tissue compatibility, and fluoride releasing. These types of cement are used for sealing orthograde and retrograde root canals, sealing and filling pulp chamber, repairing perforations, and rarely treating vertical tooth fractures (14).

An investigation on Resilon as filling material for root-end concluded that the sealing capacity of Resilon is similar to MTA and clearly better than Super EBA (15). Although Resilon has been utilized as a canal-filling material, considering the high costs of Resilon in Iran, it can be used as a coronal insulator after filling the canal with gutta-percha (12).It seems that Resilon as an orifice plug has all the aforementioned characteristics. No study has used Resilon as a coronal insulator. As a result, the current study aimed to compare coronal microleakage of Resilon, MTA, and Glass ionomer as orifice plugs in canals.

Methods

This was an experimental laboratory study. Sample size was calculated as 18 specimen for each group considering $\alpha = 0.05$, $P = 0.5$, $d = 18\%$, and the power of 80%. Twenty participants were assigned to each group to improve study validity. A total of 70 single-rooted teeth with single canals extracted for periodontal reasons without internal or external resorption, calcification, or fracture in periapical radiograph in two mesiodistal and buccolingual views were selected.

In order to conform the samples, the crowns of the teeth were cut from CEJ by carbon disc. Radiographic and microscopic evaluations were conducted to assess the single canal nature and lack of fracture. Following the crown cut, access cavity was prepared if needed through the

standard method using dental diamond burs (Teeskavan, Iran) with water and air spray.
Pulp tissue removal was followed by determining a working length 1 mm shorter than the anatomic apex by K-file number 15 (Maillefer, Dentsply). The root canal was prepared by the step-back technique as MAF was 40. Afterwards, the coronal part was further flared utilizing Gates-Glidden drills numbers 2, 3, and 4 (Maillefer, Ballagins, Switzerland).
Sodium hypochlorite 2.6% solution was applied for irrigation during preparation and the canals were obturated with gutta-percha (AriaDent, Iran) through the lateral compaction techinique and AH 26 sealer (Dentsply, Germany) after drying by paper point (AriaDent, Iran). Finally, radiographs were taken to evaluate canal filling and then using tapered fissure number 171 bur (Teeskavan, Iran) the gutta-percha of canal orifice was emptied to the depth of 3 mm. Next, the teeth were randomly divided into three test groups of 20 samples, and the two groups of positive and negative controls with 5 samples each.
The teeth were grouped as follow: 1) group one: glass ionomer (Chemfile, Dentsply, Selfcure), 2) group two: ProRoot MTA (Dentsply-Tulsa Dental, ok, USA), 3) group three: Resilon, 4) group four: with five teeth as the positive control, and 5) group five: with five teeth as the negative control.
In the positive control group, only a gutta-percha without sealer was placed in the canal and in the negative control, two layers of nail polish were applied on all tooth surfaces following filling the orifice by wax. Afterwards, all the teeth surfaces in the negative control group and lateral surfaces of the test group were covered by two layers of nail polish as only the canal orifice was uncovered. Furthermore, Indian ink was used as a color.
At the next step, the samples were placed in Indian ink for 72 hours, removed, irrigated by tap water and then two grooves were made on the mesial and distal surfaces (reaching the canal) and finally the roots were divided into two parts . The level of color penetration was measured and recorded by stereomicroscope (Zeiss, Munich, Germany) using magnification ×16 and the accuracy of 0.1 mm.
All the data were analyzed by descriptive statistics (mean±SD) and the one-way ANOVA using the SPSS software. $P < 0.05$ was considered significant.

Results

In the current study, the rate of coronal microleakage was assessed for a glass ionomer, Resilon,and ProRoot MTA as an orifice plug for root canal treated teeth. The results are shown in Table I.
The lowest mean level of color penetration among the studied materials belonged to the glass ionomer group with a mean of 0.69 ranging from 0.15 to 1.17. Moreover, the one-way ANOVA indicated that the three materials were significantly different. The comparison of the means by the Duncan test revealed that Resilon with the highest mean was significantly different from the two other groups, while glass ionomer and MTA were not different.
Comparison of average color penetration in three materials and distribution of the frequencies for MTA, Resilon, and glass ionomer are depicted in figures 1,2,3 and 4, respectively. According to these figures, MTA has a standard frequency distribution.

Discussion

A favorable coronal sealing is one of the most important objectives of endodontic therapy. Diverse materials have different sealing potentials, which have been investigated in distinct studies (16).The findings of studies on leakage after root canal therapy demonstrated that the techniques and materials used for canal filling do not result in hermetic sealing.Temporary restorations prevent root canal contamination with saliva and bacteria from the oral cavity. Moreover, these materials inhibit root canal contamination between the treatment sessions before the completion of endodontic therapy and permanent restoration. An ideal temporary restoration material should have no or minimum leakage in addition to being effective in a humid environment (17, 18). Van der slais et al. (2005) showed that the rate of leakage is different between elliptical and circular canals (19). Therefore, in the present study, we exclusively evaluated the single-rooted teeth with straight roots and circular canals. Intra-orifice plug is one of the approaches for reducing coronal microleakage through filling canal orifice after removing few millimeters of the gutta-percha. Roghanizal and Jones (1996) used amalgam as an orifice plug and concluded that amalgam is more effective than cavit in preventing coronal microleakage (7). Feric Luketic et al. (2008) compared MTA with amalgam and stated that MTA is significantly better than amalgam for preventing coronal microleakage (20). Barrieshi-Nusair and Hammod (2005) applied glass ionomer and MTA as an orifice plug and reported higher microleakage for glass ionomer (21). Although Resilon has been utilized for filling canals, it has not been studied as an orifice plug. Bodrumlu and Tunga (2007) claimed less coronal microleakage for Resilon, compared to gutta-percha (22). In the present study, the rate of coronal microleakage using Glass ionomer, Resilon, and ProRoot MTA as an orifice plug in root canal treated teeth was evaluated. Our results indicated that the lowest color penetration occurred in the glass ionomer group, while the highest rate of penetration was related to the Resilon group and the difference between the two groups was statistically significant but the difference between glass ionomer and MTA was not significant.Wolcot et al. (1999) reported glass ionomer to be successful in preventing coronal microleakage, which is consistent with our findings. On the other hand, glass ionomer in some studies did not reduce microleakage, which is not in line with the current investigation (23, 24). Glass ionomer is a material with unique characteristics being used as a substitute for dentin because of the potency for making chemical bonds with dental structure and generating excellent marginal seal. According to the literature, glass ionomer cement has antibacterial activity due to releasing fluorides. However, the marginal sealing can be different as the result of solubility in tissue fluid and the sensitivity of this technique (25-27).The results of in vitro studies in the field of microleakage are not exactly consistent with clinical results, but are suitable for simple comparison of materials and methods . In vitro studies use color penetration, radioisotope, bacteria, endotoxin, etc. to investigate the amount of microleakage. The method of color penetration was proposed in 1939 and has been the most widely used since then because of its ease, but the microbial microleakage method is very complex.A search of the articles shows that there is no standard method for examining micro-leakage (28),which is limitation of this study so we suggest of other microleakage examination methods can be used to compare resilon with glass ionomer and MTA.

Conclusion

Glass ionomer, Resilon, and MTA prevent coronal microleakage when are utilized as an orifice plug. However, glass ionomer and MTA have been more successful than Resilon.

Conflict of interest

The authors declare that they have no conflict of interest.

Acknowledgment

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Table

Figure 1. Resilon samples prepared for the study of linear color penetration rate

Figure 2. MTA samples prepared to study the extent of linear color penetration rate by a stereomicroscope

Figure 3. Glass ionomer samples prepared to study of linear color penetration rate by a stereomicroscope

Figure 4. All selected teeth

Figure 5. Comparison of average color penetration in three materials

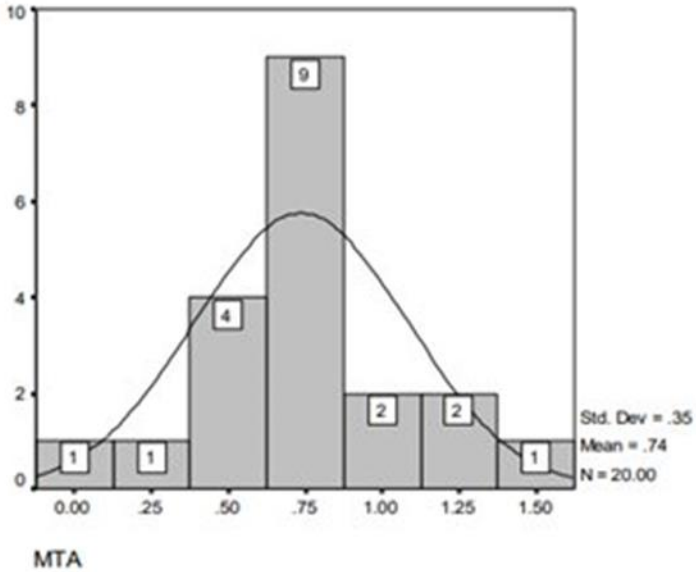

Figure 6. Frequency distribution of MTA

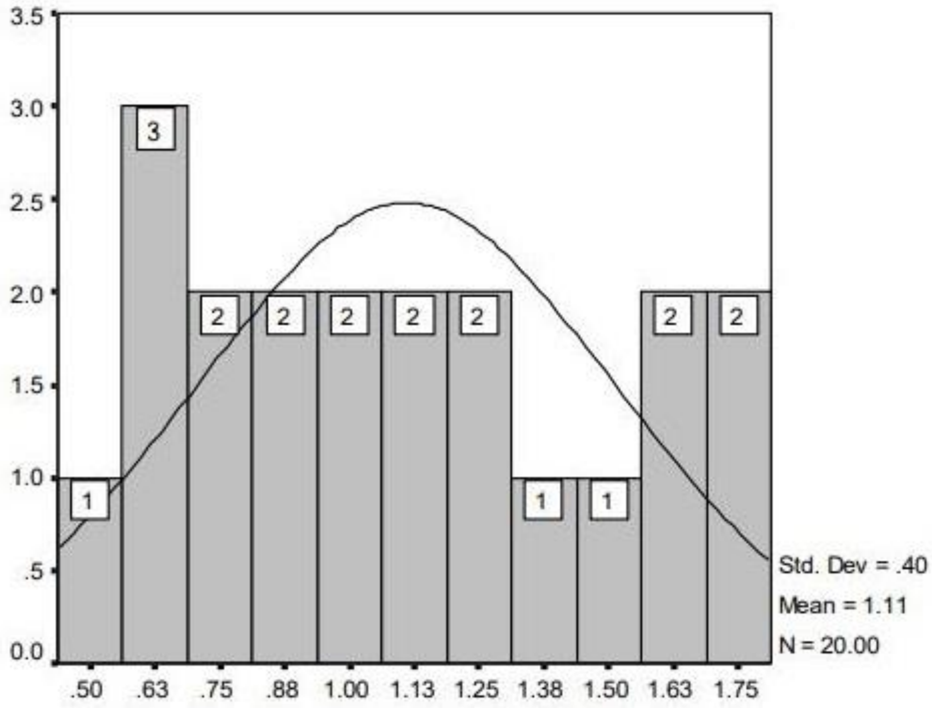

Figure 7. Frequency distribution of Resilon

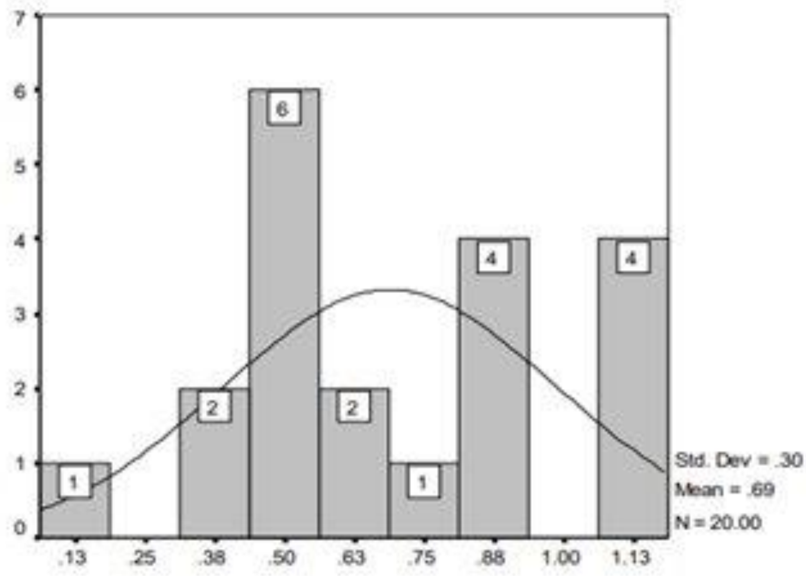

Figure 8. Frequency distribution of glass ionomer

Table I. Mean, minimum and maximum the amount of color penetration between the three materials

	Number	Mean	Standard deviation	Maximum	Minimum
Glass ionomer	20	0.6895	0. 29941	0.15	1.17
MTA	20	0.7370	0.34612	0.0	1.50
Resilon	20	1.1095	0.40099	0.55	1.80
All	60	0.8453	0.39382	0.0	1.80