# EFFECT OF DIFFERENT INTRA-ORIFICE BARRIERS IN ENDODONTICALLY TREATED TEETH OBTURATED WITH GUTTA-PERCHA

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Abstract

The purpose of the present study was to compare the ability of three restorative materials (mineral trioxide aggregate (MTA) – composite - glass ionomer cement (GIC)) in coronal sealing of the endodontically treated root canal intra-orifice in extracted teeth.

90 freshly extracted human teeth with single root canal were chosen. X-rays were taken, and the teeth were decoronated using a diamond disc. The canals were prepared and filled with zinc oxide-eugenol sealer and gutta-percha cones using the lateral compaction technique. They were left for 24 hours in order to ensure the quite hardening of the filling material. After that, the filling material was removed vertically using a hot plugger up to a depth of 1 or 2mm inside the root canal, dividing by that the teeth into two main groups of 45 teeth each according to the depth of the intra-orifice. Each group was further divided into three sub-groups of 15 teeth each. The intra-orifice of all the teeth was filled with one of the restorative materials. The teeth were coated with varnish except for 1mm around the root canal intra-orifice. Then, they were immersed in methylene blue dye of 2% for five minutes. After that, the teeth were washed under a stream of copious water and left to dry. Longitudinal sections were made in the bucco-lingual direction. The sections were examined under an optical magnifier to measure the linear dye leakage using a millimeter ruler designed by "Autocad 2013" program.

Statistical analyses were conducted after collecting the data with p-value $<0.05$.

MTA material was significantly the best in coronal sealing. However, there were significant differences between MTA and composite and between GIC and composite at the depth of 1mm, but no such differences were found at 2mm depth.

MTA and GIC offered a higher sealing ability at a depth of 1 and 2 mm, while composite showed the least sealing ability among the materials.

Keywords: Composite - coronal leakage - sealing ability - glass ionomer cement - MTA.

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# EFFET DE DIFFÉRENTES BARRIÈRES INTRA-CANALAIRES EN CAS DE DENTS TRAITÉES ENDODONTIQUEMENT ET OBTURÉS AVEC DE LA GUTTA-PERCHA

*Résumé*

*Le but de la présente étude était de comparer la capacité de trois matériaux de restauration (agrégat minéral de trioxyde - composite - ciment de verres ionomères) à obturer hermetiquement l'orifice intracanalaire des dents extraites et traitées endodontiquement.*

*90 dents humaines monoradiculées fraîchement extraites ont été choisies. Des clichés rétroalvéolaires ont été effectués, les couronnes des dents ont été sectionnées à l'aide d'un disque diamanté. Les canaux ont été préparés et obturés avec du ciment de scellement à base d'oxyde de zinc-eugénol et des cônes de gutta-percha en utilisant la technique de compactage latéral. Après 24 heures, le matériau d'obturation a été retiré verticalement à l'aide d'un obturateur à chaud jusqu'à une profondeur de 1 ou 2 mm à l'intérieur du canal radiculaire, divisant ainsi les dents en deux groupes de 45 dents chacun selon la profondeur de l'orifice intracanalaire. Chaque groupe a été divisé en trois sous-groupes de 15 dents chacun. L'orifice intracanalaire de toutes les dents a été obturé par l'un des trois matériaux de restauration. Ensuite, les dents ont été immergées dans du bleu de méthylène de 2% pendant cinq minutes. Après cela, les dents ont été lavées sous un jet d'eau et laissées pour sécher. Des sections longitudinales ont été realisées dans le sens bucco-lingual. Les coupes ont été examinées à l'aide d'une loupe pour mesurer la microinfiltration linéaire du colorant.*

*Les analyses statistiques ont été effectuées après la collecte des données avec une valeur p $<0,05$.*

*Le MTA était significativement le meilleur en terme d'étanchéité coronaire. Cependant, il y avait des différences significatives entre le MTA et le composite et entre le ciment de verres ionomères et le composite à la profondeur de 1 mm, mais aucune de ces différences n'a été observée à une profondeur de 2 mm.*

*Le MTA et le ciment de verres ionomères ont conféré une étanchéité supérieure à une profondeur de 1 et 2 mm, alors que le composite a montré une moindre d'étanchéité.*

*Mots-clés: composite – infiltration coronaire – ciment aux verres ionomères.*

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## Introduction

Dental sciences have undergone a huge and significant development recently. Amongst these sciences is endodontics [1].

The main purpose of endodontic treatment is to clean the root canal system, disinfect it from bacteria and give the canal the appropriate shape, in addition to the complete seal [2]. This can be achieved by creating a tight and three-dimensional obturation along the root canal from the coronal intra-orifice to the apical constriction [3]. Thus, the importance of coronal seal is equivalent to that of apical seal because saliva is capable of dissolving the root canal filling material, resulting in contamination along the entire root canals and around the apex as well as the development of periapical diseases [4].

Weak coronal sealing may occur in a variety of clinical cases such as a fracture in one of the components of the tooth, loss of restorative material, leakage in the final restoration, occurrence of relapsing caries and hence the occurrence of a subsequent coronal leakage. To avoid the contamination in the endodontically treated root canals in any of the aforementioned clinical cases, root canal intra-orifice must be sealed using various restorative materials before placing the final restoration. This procedure helps to a great extent in protecting the root canals from contamination [5, 6]. It depends on replacing the gutta-percha and filler cement at the root canal entry orifice with various restorative materials to avoid coronal leakage [7, 8].

The aim of the present study was to compare the ability of three restorative materials (MTA – composite - glass ionomer cement (GIC)) to seal the root canal entry of endodontically treated teeth and to prevent leakage from the crown along the canal reaching the apex.

## Materials and methods

### Study sample preparation

The study sample consisted of 90 freshly extracted human teeth, with the following inclusion criteria:

- Permanent teeth (maxillary, mandibular).
- Had a single root and a single, straight or quasi-straight canal.
- Free of caries, cracks and fractures.
- With completely developed apices.
- Intact roots, with no signs of internal or external resorption.
- Chosen without any evidence of prior canal treatment.

X-rays were taken to ensure that the teeth had a single canal and were free from irregularities. The teeth were preserved in a saline solution until their use. Then they were decoronated using a diamond disc under copious water. Access cavities were opened, the pulpal tissue was removed and the working length was determined using a k-file (Mani, Inc., Japan), sizes #10 or #15 to ensure its penetration through the apical constriction. The working length was determined by means of radiographs. After that, the canals were prepared up to size #40 using hand files made of Nickel Titanium (Ni-Ti) type H file (FKG, Dentaire, Suisse).

During the preparation and before moving to the next file, irrigation solutions were used such as sodium hypochlorite 5.25% at a rate of 5ml for every canal and at a rate of 2ml of EDTA at a concentration of 17% (Meta Biomed Co Ltd, Korea). Once the teeth were prepared, the root canals were dried using paper points (Alpha-dent, USA), filled using the lateral condensation technique with standard gutta-percha cones (Alpha-dent, USA), zinc oxide cement and eugenol. Once the filling was completed, the cones were cut and condensed thermally at the root using a hot plugger.

The teeth were left for 24 hours to ensure the complete hardening of the filling material. Later, using a heated plugger, the filling material was removed vertically at two depths of 1 and 2mm within the root canal. Next, the intra-orifice was dilated using gates glidden drills (#2- #6) (Mani, Inc., Japan). This empty space was cleaned from the remnants of the filling material and the gutta-percha cones using paper points and alcohol, then rinsed with saline solution and dried using paper points.

### Coronal seal of the canal orifice

The teeth were randomly divided into two groups depending on the depth of the intra-orifice. Group A (n = 45) was at a depth of 1mm and group B (n = 45) was at a depth of 2mm. Each group was subdivided into three subgroups, each containing 15 teeth.

In subgroups A1 and B1, MTA gray material (Dentsply DeTrey, GmbH, Konstanz, Germany) was used.

The material was mixed according to the directions of the manufacturer. The powder was mixed with distilled water in a ratio 1:3 on a glass board using a metal spatula for 1 minute. Next, the material was transferred to the canal orifice using a special rod so as to completely fill the prepared orifice. Excess material was removed using a moist cotton pellet. Another moist cotton pellet was placed on the canal orifices of the MTA filled teeth and were left for 3 hours to harden completely.

In subgroups A2 and B2, composite material Tetric® N-Ceram (Ivoclar, Vivadent) was used. The entry orifices were dried and etched using phosphoric acid (37%) for 15 seconds. The acid was rinsed with copious water and air dried gently (maintaining the moisture of the dentin). Next, a layer of the bond was applied using a small brush on the entire orifice while stirring it for 20 seconds. It was then cured using a light curing device for 20 seconds. A layer of composite of 2 mm thickness was applied light-cured for 40 seconds, in accordance with the directions of the manufacturer.

In subgroups A3 and B3, glass ionomer cement (Promedica, Neumunster, Germany) was applied. The GIC was

| Score | Observed microleakage |
|---|---|
| 0 | No microleakage |
| 1 | Up to 25% |
| 2 | 25- 50% |
| 3 | 50-75% |
| 4 | 75-100% |

Table 1: Scores of microleakage at the interface tooth material [9].

mixed for 30- 45 seconds on a glass board using a metal spatula at the ratio 1:1 of powder and liquid (at a temperature of 20-25°C). The resultant mixture was transferred into the canal orifice using a special rod until the entire prepared canal orifice was filled. Excess was removed after 4 minutes using a small, vaseline-wetted shovel in accordance with the directions of the manufacturer.

### Study of the dye coronal leakage

Following the complete hardening of the three intra-orifice filling materials, the outer surfaces of the roots of the teeth were coated carefully with two layers of varnish. The teeth were coated completely with the exception of 1mm around the intra-orifice in order to insulate the teeth and prevent the incidence of dye leakage except from the area of the intra-orifice. The teeth were immersed in methylene blue dye at a concentration of 2% for five minutes, to be later rinsed with copious water to remove the dye. The teeth were left for a sufficient time to dry. In order to evaluate the extent of coronal microleakage, longitudinal sections were made in the bucco-lingual direction using a diamond disc and water spray. The cut was made at the level of the restorative material at the intra-orifice and along the root and the filling material (paying careful attention to preserve the root canal filling material, and avoid losing a large amount of it).

To evaluate the linear dye penetration at the inter-surface (filling material-tooth), sections of the teeth in every group were examined under stereomicroscope (magnification x20). The extent of leakage was measured using a milllimetric ruler designed by AutoCAD 2013. The measurements were taken starting from the intra-orifice up to the last area were a dye leakage was noticed in the apical direction. The penetration depth was estimated in millimeters and a score assessment [9] (Table 1) was used to assess the degree of penetration between the restorative material of the intra-orifice and the canal wall.

## Results

The results revealed the occurrence of microleakage at the surface level between the restorative material on one side and the canal walls on another side. This was true for all the examined restorative materials (MTA- composite - GIC).

A comparison among the three restorative materials (MTA – composite - GIC) was conducted to determine the extent of the coronal leakage of the root canal intra-orifice at a depth of (2mm), using the Kruskal-Wallis test.

The results showed that no statistically significant differences existed among the three materials regarding the extent of the coronal leakage ($p>0.05$). It was observed that among the three materials, composite showed the highest percentage of coronal leakage when used to seal the root canal intra-orifices. MTA leaked the least among the studied materials.

To investigate the existence of differences between the individual groups, a subsequent test was carried out as a means of pair-wise comparison (Man-Whitney test).

The results showed that less coronal leakage was observed with MTA compared with composite ($p=0.01$), whereas no statistically significant differences were observed between MTA and GIC.

Also, there was no statistically significant difference in coronal microleakage levels between GIC and composite ($p=0.26$).

A comparison among the three restorative materials (MTA- composite - GIC) was conducted to determine the extent of the coronal leakage of the root canal intra-orifice at a depth of 1mm, using the Kruskal-Wallis test.

The results showed that statistically significant differences existed among the three materials in terms of the extent of the coronal leakage ($p<0.05$). Among the three examined materials, composite resulted in the highest percentage of coronal leakage when used to seal the root canal entry orifices. MTA leaked the least among the studied materials.

To study the effect of the depth (1 and 2mm) of the intra-orifices of the prepared root canals on the quality of the seal of the restorative material, a Man-Whitney test was carried out.

For MTA, there was no statistically significant difference in terms of the extent of coronal leakage occurring at both depths of the intra-orifice ($p=0.123$).

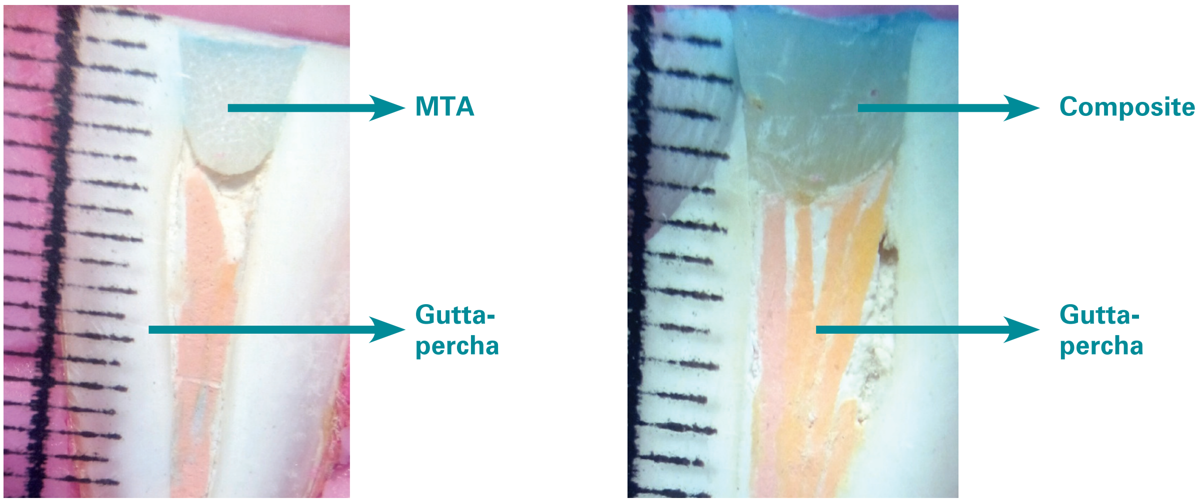


Fig. 1: Longitudinal sections of teeth under optical magnifier at 2mm depth showing dye penetration along the materials. A: MTA; B: Composite.

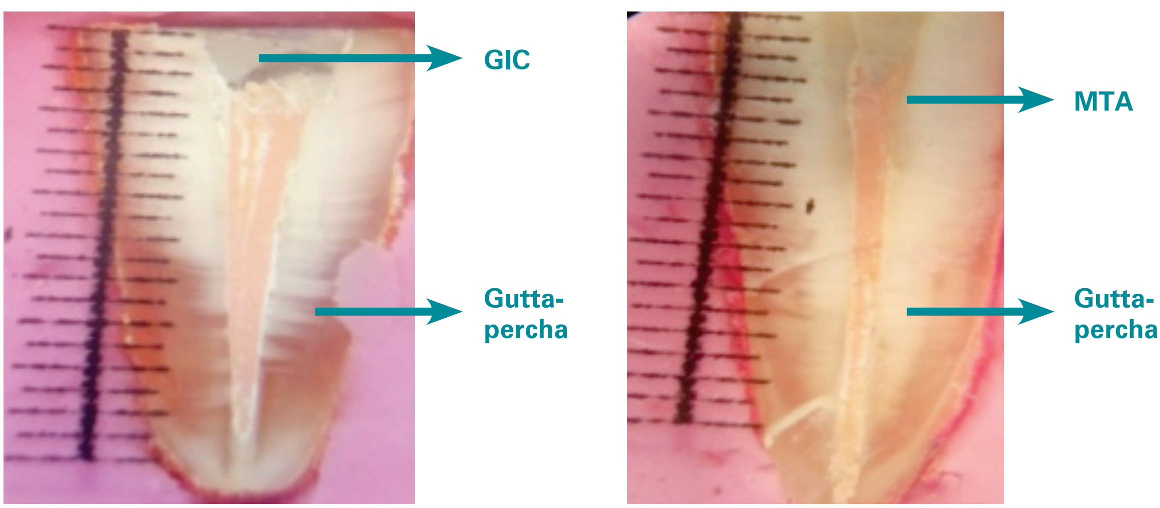


Fig. 3: Longitudinal sections of teeth under optical magnifier at 1mm depth showing dye penetration along the materials. A: MTA; B: GIC.

However, for composite and GIC, statistically significant differences were obtained, related to the extent of coronal leakage at the two depths of the intra-orifice. Both composite and GIC exhibited lesser coronal leakage at 2mm depth of the intra-orifice compared with the depth of 1mm ($p<0.05$).

## Discussion

Coronal sealing is considered one of the most important factors in evaluating the success of endodontical treatment. Weak coronal seal can lead to contamination and entry of saliva, nutrients, germs and their endotoxins into the root canals and hence a failure in the endodontical treatment [4].

Therefore, continuous efforts are made to develop and provide modern filling materials and techniques that achieve an impermeable barrier between the root canal system on one side and the oral environment on the other. Among these modern techniques that limit contamination in endodontically treated root canals, sealing the intra-orifices of root canals with different restorative materials prior to the final restoration have been applied.

This technique depends on removing the gutta-percha cones and the root canal cement filler from the canal intra-orifice at a specific depth and replacing it with a restorative material that prevents coronal leakage in cases of fractures or loss of the final restoration. Thus, several studies have been conducted to evaluate and compare the various restorative materials used to seal the canal intra-orifice [7, 8].

In the current study, three different restorative materials were chosen

(MTA- composite- GIC) to investigate the ability of each bonding agent at providing a coronal seal for the entry orifices of the root canals of single canal, recently extracted, endodontically treated teeth.

Composite was used as one of the materials within the intra-orifice due to its ease of use. It requires etching and a bonding agent before application. Consequently, it depends on adhesion regardless of the depth of the intra-orifice. It can be removed when needed and the gutta-percha is transparent through the composite [10].

As for the second material, the MTA was used because of its high sealing ability as seen by Lee et al. who found that MTA was superior to amalgam and IRM in terms of sealing ability, marginal leakage and stability [11].

Chemical GIC has a chemical bonding ability to the dental structure. This chemical bonding is a result of the reaction between the carboxyl groups in polyacids and calcium in the enamel and dentin [12].

Human teeth with a single canal were prepared in order to expose their intra-orifices. They were chosen in the present study because they can be easily restored [13].

The extent of leakage was assessed using the methylene blue dye [14] due to its availability, to its ease of use and to its proven results [15].

Several studies have been conducted to study the effect of the intra-orifice depth on the ability of the restorative material used to seal the intra-orifice. However, no consensus was reached among the majority of these studies as to the importance of the depth in preventing coronal leakage [16]. These studies utilized varying depth measures, some using a depth of 3mm [6, 7, 17] while some used a depth of 3.5mm [18] and some used a depth of 4 mm [19].

In the current study, depths of 1 and 2mm were used [20, 21]. These two depths were chosen taking into consideration the probable need to remove the intra-orifice barrier if retreatment was required, because placing the restoration in a deeper intra-orifice entails greater difficulty and risk when removing it [19].

At 1mm depth, MTA was better in coronal sealing than composite and likewise, GIC was better than composite. No statistically significant differences were found between MTA and GIC.

The results of this study revealed that there were no differences in coronal leakage between grey MTA material on one hand and GIC on the other hand when they were used as coronal intra-orifice barriers at depths of 1 and 2mm. This corroborates the findings of Tselnik et al. [13], although the later study adopted a depth of 3mm.The lack of differences between GIC and MTA can be attributed to the acidic functional groups in the GIC which react with the dental structure to enhance adhesion and to its GIC water absorption which results in the expansion of the material and better seal.

The superiority of MTA as sealing material may be due to its characteristics particularly its expansion during curing that confers a high sealing ability and an excellent marginal adaptation [22].

Correspondingly, this study found that MTA was better than composite in reducing the coronal leakage at depths 1 and 2mm. This in turn was in agreement with the results obtained by Hamid et al. [23] (depth of 2mm), Jenkins et al. [16] (depth of 4mm) and Gutmann et al. [4] (depths of 2 and 3mm).

The aforementioned studies used different types of composite to seal the canal orifices. In the present study, a conventional hybrid composite was applied. That might explain the discrepancy between the obtained results.

## Conclusions

Within the limitations of the present study, it can be concluded that:

MTA material showed the least microleakage values when applied at depths of 1 and 2mm in the intra-orifice of single root canal teeth. Its use reduces the root canals contamination in cases of fracture or loss of the final coronal restoration.

It advisable not to use conventional hybrid composite in sealing root canal orifices that have been endodontically treated, as it has the lowest coronal sealing ability and caused the most leakage.

## References

1. Hyman JJ, Cohen ME. The predictive value of endodontic diagnostic tests. Oral Surg Oral Med Oral Pathol 1984 Sep;58(3):343-6.
2. Abbott P, Sriwalee L, Sandler B. Apical dye penetration with four root canal sealers and gutta-percha using longitudinal sectioning. J Endod1992;18(11):322-6.
3. Walton RE, Johnson WT. Obturation. In: Walton RE, Torabinejad M, eds. Principles and practice of endodontics. 3rd ed, Philadelphia W.B Saunders, 2002, Ch.14; p:240, 241, 250.
4. Gutmann JL, Witherspoon DE. Obturation of the cleaned and shaped roots canal system. In: Cohen S, Burns RC: Pathways of the pulp, 8th ed. St. Louis: CV Mosby, 2002:pp.313-8.
5. Chailertvanitkul P, Saunders WP, MacKenzie D. Coronal leakage in teeth root-filled with gutta-percha and two different sealers after long-term storage. Endodontics and Dental Traumatology 1997;13(2):82-87.
6. Wolcott JF, Hicks ML, Himel VT. Evaluation of pigmented intraorifice barriers in endodontically treated teeth. J Endod 1999;25(9):589-592.
7. Ziang Q, Zhang He. An evaluation of intra-orifice sealing materials for coronal microleakage in obturated root canals. Quintessence 2009;12:31-36.
8. Maruoka R, Nikaido T, Ikeda M, Foxton R, Tagami J. Effect of resin-coating technique on coronal leakage inhibition in endodontically treated teeth. Int Chin J Dent 2007;7:1-6.
9. Pereira C, Maximiliano SC, Flávio FD. Sealing ability of MTA, Super EBA, Vitremer and amalgam as root-end filling materials. Braz Oral Res 2004;18(4):317-21.
10. Uranga A, Blum JY, Esber S, Parahy E, Pardo C. A comparative study of four coronal obturation materials in endodontic treatment. J Endod 1999;25(3):178-80.
11. Lee SJ, Monef M, Torabinejad M. Sealing ability of mineral trioxide aggregate for repair of lateral root perforations. J Endod 1993;19:541-4.
12. John J, Manappallil . Basic Dental Materials, 3rd ed., Jaypee Brothers Medical Publishers Ltd, 2010, p:49-54.
13. Tselnik M, Baumgartner JC, Marshall JG. Bacterial leakage with minerals trioxide aggregate or a resin modified glass ionomer used as a coronal barrier. J Endod 2004;30:782-4.
14. Hosseinnia A, Keyanpour-Red M, Pazouki M. Photo-catalytic degradation of organic dyes with different chromophores by synthesized nanosize TiO particles. World Applied Sciences Journal 2010;8:1327-1332.
15. Kubo CH, Valera MC, Gomes APM, Mancini MNG, Camargo CHR. The effect of endodontic material on the optical density of dyes used in marginal leakage studies. Braz Oral Res 2008;22(1):25-30.
16. Jenkins ST, Kulild J, Williams K, Lyons W, Lee C. Sealing ability of three materials in the orifice of root canal systems obturated with gutta- percha. J Endod 2006;32(3):225-227.
17. Akbari M, Rouhani A, Samiee S, Jafarzadeh H. Effect of dentin bonding agent on the prevention of tooth discoloration produced by mineral trioxide aggregate. Int J Dent 2012; Article ID 563203, 3 pages.
18. Parolia A, Kundabala M, Acharya S, Sarawathi V, Ballal V, Mohan M. Canal systems obturated with gutta-percha. Endodont J 2008;20:65-70.
19. Bailon- Sanchez MB, Gonzalez-Castillo S, Gonzalez-Rodriguez MP, Poyatos-Martinez R, Ferrer-Luque CM. Intraorifice sealing ability of different materials in endodontically treated teeth. Med Oral, Patol Oral cir Bucal 2011;16(1):e105-e109.
20. Zakizadeh P, Marshall SJ, Hoover CI et al. A novel approach in assessment of coronal leakage of intraorifice barriers: a saliva leakage and micro-computed tomographic evaluation. J Endodont 2008;34(7):871-875.
21. Maloney SM, McClanahan SB, Goodell GG. The effect of thermocycling on a colored glass ionomer intracoronal barrier. J Endod 2005;31(7):526-528.
22. Torabinejad M, Chivian N. Clinical applications of mineral trioxide aggregate. J Endod 1999 Mar;25(3):197-205.
23. Hamid Resa Yavari et al. Microleakage comparison of four dental materials as intra-orifice barriers in endodontically treated teeth. Iranian Endodontic Journal 2012;7(3):156-160.