Original Article

In-vitro Sealing Ability of Calcium Enriched Mixture Cement Versus Amalgam as Retrograde Filling Materials

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Abstract

Introduction: Sealing ability of a retrograde filling material is an important factor for a successful endodontic apicoectomy. The purpose of this in-vitro study was to compare the sealing ability of calcium enriched mixture (CEM) cement versus amalgam as root-end filling materials. **Methods:** A total of 36 canals of extracted maxillary central incisors were instrumented and obturated using lateral compaction technique. The apical 3 mm of each root was resected and root-end prepared to a depth of 3mm.The teeth were randomly divided into two experimental groups of 15 teeth according to tested materials (Amalgam, CEM cement) and two negative and positive control groups of 3 teeth. Root- end cavities were restored with amalgam (group 1) or CEM (group 2). Sealing ability was evaluated by dye penetration method using Pelikan ink, and a stereomicroscope at x10 magnifications and 0.01 mm accuracy. Data were analyzed by T-test and $P<0.05$. **Results:** The mean linear dye microleakage for CEM cement and amalgam retrofilled groups were 2.08 and 3.77 mm, respectively. There was a statistically significant difference between the two groups ($p<0.0001$). **Conclusion:** under the condition of this in vitro study, CEM cement provides a better seal than amalgam when used as a retrograde filling material.

Key words: Sealing ability, Amalgam, CEM, Retrofilled.

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Introduction

Endodontic surgery is an alternative to avoid tooth extractions when endodontic therapy or root canal retreatment fails or is not feasible (1-3). Apicoectomy followed by retrograde filling is a well-established procedure to treat teeth with persistent periapical infections and teeth in which conventional root canal therapy has failed (4). Sealing ability of a retrograde filling material is an important factor for a successful endodontic surgery. Among a variety of materials which have been used as retrograde filling materials, amalgam was the common material in the past decade. A review of literatures on dental materials used as retrograde fillings showed that amalgam was the most frequently material used in control groups. Advantages associated with amalgam are its low cost, easier handling and condensation and clinical success (3, 5, 6). However, it has a number of disadvantages such as scattering of amalgam particles into the surrounding tissues, corrosion, and setting properties which allow dimensional changes (4). Calcium enriched mixture (CEM) cement contains mainly CaO, SO3, P2O5 and SiO2 was introduced recently (7). CEM is an alkaline cement that exhibits several advantages including tissue biocompatibility, hard tissue induction, and effective sealing ability, ability to set in an aqueous environment, antibacterial effects, and resistance to washing out (8-10).

A literature search showed that most of the previous published investigations compared sealing ability of CEM versus MTA as a root - end filling material (11-13). A limited number of studies compared the sealing ability of CEM cement versus amalgam, the most common root end filling material used in the past decade. Kazem et al.

(14) compared bacterial and dye microleakage of amalgam, CEM, Root Mineral Trioxide Aggregate (Root MTA) and White ProRoot MTA (WMTA). They reported that after 70 days, there was 100% bacterial leakage in amalgam, and CEM cement, 91.7% in WMTA, and 75% in Root MTA. This difference was not significantly different. The difference in complete dye leakage was also not significant. The purpose of this in-vitro study was to compare the sealing ability of CEM cement versus amalgam as root-end filling materials.

Materials and Methods

Thirty-six recently extracted maxillary human single root teeth without cracks, caries, restoration and resorption were disinfected using 5.25% hypochlorite sodium for thirty minutes. All teeth were decoronated at the cementoenamel junction, so that the remaining roots were about 15 ± 1 mm. A #10 K-file (Mani, INC, Japan) was inserted and advanced into the canal until it was just seen penetrating the foramen. Working length was calculated by subtracting 1mm from this level. All root canals were cleaned and shaped with K-files using Step-back technique up to #35 file. Flaring was performed by Gates Glidden #1 through #3 (Mani, Beijing, Japan), followed by hand files #40-60. Irrigation with 2 ml of 2.5% Sodium hypochlorite solution was performed using a 22-gauge needle between each file.

Positive control teeth were filled with gutta-percha (Gapadent Co., Germany) alone and negative controls were sealed entirely with sticky wax. All experimental canals were obturated with laterally condensed gutta-percha and AH26 (Dentsply Detrey, Konstanz, Switzerland). Access cavities were filled with Coltosol (Colten, Altstatten, Switzerland) and the quality of obturation was checked radiographically.

The apical 3 mm of root-ends were resected perpendicular to tooth long axis using a high-speed handpiece with a diamond fissure bur (Tizkavan, Tehran, Iran) under continuous water spray. The root –end cavities were prepared with a #2 inverted bur at low speed. The depths of root-end cavities were standardized at 3 mm. The teeth were then coated with two layers of nail polish except for the resected root-end surface.

The prepared roots were randomly divided into two experimental groups of 15 teeth according to tested materials (Amalgam and CEM cement). In group 1 root-end cavities were filled with CEM cement (BioniqueDent, Tehran, Iran). CEM cement was mixed according to the manufacturer's instructions on a sterile glass slab and filled into the cavities with the aid of a small condenser (Kerr Hawe, Orange, CA, USA). Any excess material was removed with a wet sterile cotton swab. In group 2, root–end cavities were filled by condensing amalgam (Cinalux, Tehran, Iran).

All teeth were kept at 37°C and 100% humidity for 48 hours, and then immersed into the Pelikan ink (Pelikan, Hanover, Germany) for 7 days, the roots were then washed with water and were left to dry for 24 h. Nail polish was then removed by Acetone. The roots were then sectioned buccolingually. The greatest penetration of dye was measured blindly by two examiners using a stereomicroscope at x10 magnifications (Olympus, Tokyo, Japan) and a digital caliper to accurate 0.01mm. The mean scores of data were calculated and was analyzed using SPSS version 10. Finally, collected data were compared using independent T-test at a significant level of $P<0.05$.

Results

The negative leakage control demonstrated no dye penetration while the positive leakage control showed dye penetration along the entire root canal.

The mean linear dye leakage for all groups is shown in Table-1. The results of the Shapiro-wilk test evaluating normality of data showed that the data had a normal distribution. T-test analysis showed that there was a significant difference between the microleakage of CEM cement and amalgam as a retrofilling material ($P<0.0001$).

Table 1. Mean dye leakage (mm) in experimental groups

Groups	Mean(SD)	t	P-value
amalgam	3.77(1.22)	4.093	<0.0001
CEM	2.08(1.02)		

Discussion

Several methods have been employed to evaluate microleakage of dental materials. In the present study, we used linear dye penetration method because it is convenient, sensitive, easy to accomplish and does not required sophisticated materials or equipment (15). As CEM cement consists of different calcium compounds which releases calcium hydroxide during and after setting (14), Pelikan ink was used for dye penetration because previous published studies showed that this dye is not discolored by calcium hydroxide (16, 17). Under the condition of this in vitro study, all of the positive controls showed microleakage throughout the cavities, confirming that retrograde material was necessary to prevent leakage. In contrast, all negative controls showed no microleakage, showing that nail polish prevented microleakage, with dye only penetrating the apical portion of the roots.

In this study, extracted central teeth with large and straight canals were selected and were instrumented to #

35 master apical file. The diameter of the orifices and root canal flaring was also checked to be equal. In this way, variables such as anatomical variation, the canal size and diameter which can affect the dye leakage were minimized. As it has been reported that longer roots have a potential for greater leakage (18), roots with 15 ± 1 mm long were used.

In order to eliminate the operator variable, all preparations were completed by a single operator. Two examiners measured dye leakage levels in order to eliminate or reduce possible bias and evaluator error.

The apical 3 mm of each root was resected perpendicular to the long axis of the roots. This method exposes a lower number of dentinal tubules and provides a more effective removal of root ramifications (19), which decreases the apical leakage.

Furthermore, 3 mm depth conventional class I cavities were prepared after root resection, based on less leakage reported in these cavities (20-22). Although the use of ultrasonic retrotips is recommended for better access and maintenance of tooth structure, the results reported by O·conner et al. (23) showed no significant difference between the preparation with ultrasonic tips or handpieces in the sealing of retrofillings. We prepared cavities using a low speed handpiece due to lack of access to ultrasonic tips.

According to the results of the present study, CEM as a retrofill material provided significantly a better seal than amalgam. This finding was different from the result reported by Kazem et al. (14). They showed that after 72 hours, microleakage of methylene blue 1% demonstrated 16.7% complete dye penetration in CEM cement and WMTA, and 33.3% in amalgam and Root MTA which was not statistically significant. Furthermore, the results of dye leakage studies which compared the sealing ability of CEM cement versus MTA as retrograde filling materials were also different. Using India ink dye, Milani et al. (11) reported that if limited access prohibits retrofill placement, MTA or CEM cement can be used to fill the canal prior to root-end resection, as they have similar sealing ability. Using methylene blue dye, Hasheminia et al. (12) concluded that sealing ability of CEM cement was superior to MTA as root- end fillings in saliva contamination.

These differences in results may be attributed to study design and variables such as the method of dye usage, the operators, cavity preparations, type of used materials (dye, sealer, amalgam and CEM cement) and the limitations of used techniques for evaluating microleakage. Most dye leakage studies have measured the degree of leakage in one plane, making it impossible to evaluate the total leakage (24). PH and chemical reactivity may also influence the degree of dye penetration (24). Thus, the result of this in-vitro study needs to be verified by further laboratory and clinical studies.

Conclusion

Under the condition of this in vitro study, CEM cement provides a better seal than amalgam when used as a retrograde filling material.

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