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Evaluation of three novel retrograde filling materials (Microleakage study)

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Abstract

The aim of this study was to compare apical microleakage of MTA following reverse retrograde root filling with that following Alumina Cement, Light Cement, Zenium HMP retrofilling. The root canals of 42 extracted teeth were instrumented and obturated with vertically condensed gutta-percha. Each tooth was apically resected and the apex was prepared by fissure bur to 2 mm depth and the root surface isolated with nail varnish. Teeth were divided randomly into four groups of 10 teeth each. First group was retrofilled with MTA, second group with Alumina Cement, third group with Light Cement, and the fourth group with Zenium HMP. Following immersion in 2% Fuchsine dye for 72 hours, the roots were sectioned and the depth of dye penetration was evaluated by a Global stereomicroscope at x70 magnification.The sealing effectiveness of the retrograde filling materials was determined by their ability to inhibit dye penetration. Results showed that the least leakage for zeniuum HMP cement with a mean of 0.6, MTA with a mean of 1.0, light cement with a mean of 1.10, alumina cement with a mean of 1.50 with the most leakage. However, these differences were not seen to be statistically significant using the Kruskal Wallis Test or the Mann Whitney Test. It was concluded that Zenium HMP cement provides a better seal than MTA and Light Cement and Alumina Cement when used as retrograde filling.

Key Words: Retrograde filling, MTA, Apical leakage, endodontic failure.

Introduction

Most endodontic failures occur as a result of leakage of irritants into the periapical tissues.[1,2,3] An ideal orthograde or retrograde filling material should seal the pathways of communication between the root canal system and its surrounding tissues.

It should also be nontoxic, noncarcinogenic, nongenotoxic, biocompatible with the host tissues, insoluble in tissue fluids, and dimensionally stable.[4,5] Furthermore, the presence of moisture should not affect its sealing ability; it should be easy to use and be radiopaque for recognition on radiographs.[4]

Many materials have been suggested as root-end filling materials, including reinforced zinc oxide-eugenol (Cavit), gutta percha, zinc oxide-eugenol, composite resin, gold foil and mineral trioxide aggregate

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(MTA) [4]

Results from most of these investigations indicated that MTA exhibits significantly less dye leakage in comparison with Super EBA, amalgam.[6,7,8] and intermediate restorative material (IRM). [9]

Experimental materials, light cement, Alumina Cement, Zenium HMP, were recently reported to seal off all the pathways of communication between the root canal system and the external surface of the tooth. The principal compounds present in the mineral trioxide material are tricalcium silicate, tricalcium aluminate, tricalcium oxide, and silicate oxide. [10,11]

Alumina Cement a compound with a combination of (Al2O3), (CA2,CA) and partially C12A7 is produced using calcium carbonate and alumina. Zenium HMP A combination of aluminate calcium and a phosphate band-maker (sodium hexa-metaphosphate).

Light Cement a combination of Calcium Aluminate minerals, (AL2O3) and (CA, CA2) and alpha alumina (Al2O3) as main phases and (A7C12) as subsidiary phase (A=Al2O3; C=CaO).

The purpose of this investigation was to assess the effectiveness of Alumina Cement, Light Cement, Zenium HMP in providing an apical seal in comparison with MTA by using a dye penetration method.

Materials and Methods

Seventy-nine freshly extracted, human, single-rooted upper central, lateral and canine teeth were collected and stored in saline. The clinical crowns were removed with a # 557 Carbide bur in a high speed handpiece. The working length was determined by subtracting 0.5 mm from the length at which # 15 K file appeared at the apical foramen. The apical portion of the root canal was prepared to a # 40 K file and the rest of the canal was flared using Gates Gliddden to the full length. NaOCl 5.25% was used as the irrigant. The cleaned and shaped canals were dried with paper points and obturated with vertically condensed ACEONE-ENDO gutta-percha and zinc oxide euginol sealer. The access opening was sealed with the roots were then stored at room temperature and 100% humidity for 1 week. Apical root resections were performed on all roots by removing 2 mm of each apex at 90 degrees to the long axis of the tooth with a # 701 fissure bur with W&H high-speed hand piece with water coolant. A 2 mm deep root-end cavity was prepared with a fissure bur. Two coats of gold star nail polish were then applied to the whole surface of the total length of each root except the tip of the root where the retrograde filling was to be applied. The teeth were assigned randomly into three groups of 10 roots each. Group 1 was retrofilled with MTA (angelous), Group 2 Alumina Cement, Group 3 Zenium HMP, and Group 4 with Light Cement. This was mixed on a glass slap using a powder to water ratio of 3:1. Each of the materials was condensed into the preparation using small pluggers. Two instrumented roots with retro-preparations received no retrograde filling, and these were used as positive controls.

Another two roots were instrumented and obturated with gutta-percha and sealer; their entire root surfaces were covered with two coats of nail polish and were used as negative controls. All roots were stored in 2% solution of fuschine dye for 72 hours, after which the roots were rinsed under tap water, and the nail polish was removed. The teeth were then sectioned mesio-distally using a round disc bur in a high-speed handpiece to nearly the depth of the canal. They were then fractured with the end of a large spoon excavator. The depth of dye penetration was evaluated by a stereomicroscope at a magnification 70x (Global). The roots were evaluated and scored as either (score 0, 1 , 2, 3). Score 0 was given to no leakage ,Score 1 was given to marginal leakage not reaching the retrograde cavity floor, Score 2 was given to leakage all around the retrograde filling ,Score 3 was given to leakage all around the filling, leakage deeper than the retrograde cavity floor.

Statistical analysis of the results was performed using the Kruskal Wallis or the Mann Whitney Test.

Results

The results (Table 1) from Group 1 (Alumina Cement) showed that 3 of 10 samples were scored as 0 and 1 sample with score 1 with 4 samples score 2 and 2 samples score 3.

(Fig. 1)From Group 2 (MTA) 4 specimens were scored as 0 and 4 specimen scored 1 and 2 specimens with score 3. Group 3 Zenium HMP 6 specimens showed score 0 and 3 samples with score of 1 and a single sample with score 3. Group 4 Light Cement showed 3 samples with a score of 0 and 4 samples with score 1 and 2 samples with score of 2 and a single samples with score of 3. The data from all four groups were submitted for statistical analysis. The Kruskal wallis and Mann Whitney tests revealed no significant difference statistically between the Groups. The results showed the least leakage for zeniuum HMP cement with a mean of 0.6, and MTA with a mean of 1.0, light cement with a mean of 1.10, alumina cement with a mean of 1.50 with the most leakage. The positive control samples showed dye leakage throughout the length of the canals, while the negative control samples had no dye penetration.

Discussion

The purpose of placing a root end filling material is to provide an apical seal which inhibits the leakage of irritants from the root canal system into the periradicular tissues. Dye leakage to the full extent of the retrofilling material or beyond was considered as total leakage within the parameters of this study. When dye was prevented from penetrating the full extent of the retrofilling material it was considered that an adequate seal has been provided. Although MTA generally has been the most commonly used root end filling material, it has a number of disadvantages such as discoloration potential, presence of toxic elements in the material composition, difficult handling characteristics, long setting time, high material cost, an absence of a known solvent for this material, and the difficulty of its removal after curing.

A number of reports have complaints regarding the cost of MTA, in a survey in the United Kingdom, 63.6% of consultants in pediatric dentistry were concerned about the cost of MTA and the instruments needed for formation of an apical barrier in teeth with necrotic pulps and immature apexes.

In many of the previous studies authors have used methylene blue 2% to evaluate the leakage but considering the fact that recently has been discussed this dye disappears in alkaline environment which include MTA with a 12 PH level and so in our study we have used fuchsine 2% with small particle size to have sufficient penetration and stability. Fuchsine a synthetic dyestuff, is a mixture of rosaniline and pararosaniline. Its molecular weight is comparable with methylene blue. [12]

Some investigators believe that handling of MTA is not simple for some of its clinical applications and requires practice but the following material were easier to handle in clinical use due to the Sodium phosphate which decreases viscosity of compounds made of aluminate and water. This happens when situation of charges ions in external layer of particles changes by adding an electrolyte. The long setting time of MTA is one of the reasons that MTA should not be applied in 1 visit. This has been cited as one of the shortcomings of this material, the materials mentioned have a faster setting time compared to MTA which is a great advantage to be considered. There is no known solvent for set MTA BioPure MTAD has been reported to partially dissolve WMTA when it remains in contact with the material for 5 minutes. Although the results of this study showed that the novel material have the potential of being used as a root end filling material because it provides an hermetic seal, relevance of dye leakage studies to clinical and practice application are questioned.

Dye studies, however, are the easiest method to screen new restorative filling materials. When a filling material does not allow penetration of small molecules, it has the potential to prevent leakage of larger substances such as bacteria and their byproducts.

Despite its many advantages, MTA has some drawbacks. Efforts have been made to overcome these shortcomings; however, adding or removing various elements to alleviate these shortcomings can affect MTA's ideal characteristics further studies are needed to determine the suitability of these materials for in vivo use.

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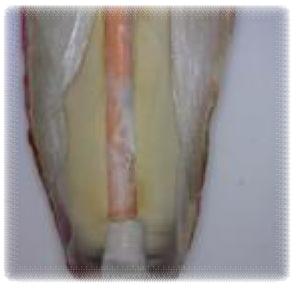
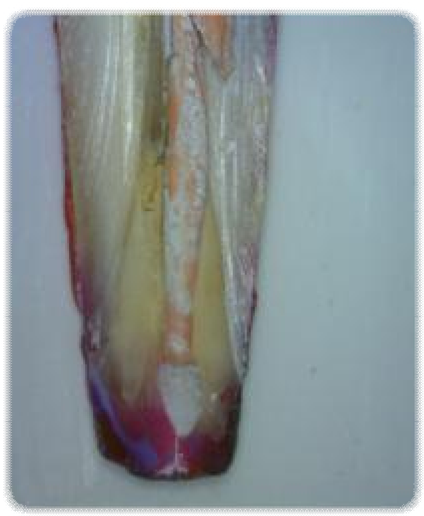
Specialist evaluation	0	1	2	3	Total
alumina cement	3	1	4	2	10
MTA(angelus)	4	4	0	2	10
zenium HMP	6	3	0	1	10
light cement	3	4	2	1	10
Total	16	12	6	6	40



- Score 0
- was given to no leakage

- **Score 1**
- **marginal leakage not reaching the retrograde cavity**



- Score 2
- to leakage all around the retrograde filling

- Score 3
- to leakage all around the filling, leakage deeper than the retrograde cavity floor