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CLINICAL INVESTIGATION

A Comparative Microleakage Study of Retrograd Filling Materials

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Abstract: The aim of the retrograde filling in apical resection operation is to obtain an effective and hermetic apical sealing. According to the development of technology many materials are now used in apical resection operations for retrograde fillings. An in vitro dye leakage study was performed to test the sealing ability of IRM, MTA, amalgam and zinc-phospate cement materials. Forty single rooted extracted human teeth were used in this study. After cleaning and shaping, all the roots were obturated with zinc-phospate cement and gutta-percha. Teeth were randomly divided into four groups. After root-end resections of the teeth in all groups, 3 mm depth of retrorgade class I cavities were performed in 3 groups with micro-handpiece preperations. Retrofillings of each group were performed with IRM, MTA and silver amalgam. Methylene blue was used to determine the apical leakage. After sectioning the roots longitudinally linear dye penetration in denting and cement was measured with a caliper under stereomicroscope and the results were statistically analyzed.

Key Words: Retrograde filling, IRM, MTA, amalgam, zinc-phospate cement

Introduction

The preferred treatment of failing endodontic cases is non-surgical retreatment and these retreatments usually have succesful outcomes. However, because of the complexity of root canal systems, inadequate instrumentation and presence of physical barriers, sometimes achievement is impossible. In these cases surgical endodontic therapy becomes the first alternative (1,2).

Among the possible causes of failure in endodontic surgery, the most frequent is the incomplete cleaning of the root canal and sealing of all communications between the root canal and periradicular tissues (3,4,5). It was pointed out that possible bacterial infiltration through the tubules can take place more frequently in the presence of coronal leakage into the root canal system, (6,7) and leakage tests performed on patients of different ages showed greater leakage in young subjects (8).

The primary goal in apical resection is to perform a hermetic sealing between the apical portion of the root canal and periapical tissues by retrograde root end filling. By hermetic sealing with a root end filling, prevention of the passage of microorganisms and their products into the periapical tissues can be achieved. (9,10,11) Root end filling materials can be used into a class I cavity after the resection of the root. It should'not be forgotten that as the angle of the bevel increases, the apical leakage also increases due to the permeability of the dentinal tubules (12). So the root should be resected as perpendicular to the long axis of the root as possible (13,12). Although at least 2-3 mm of root end removed is recomended in apical resection (14) Philip et al showed in their studies that 2 mm or 4 mm of the apex resection did not show a significant difference in apical dye penetration (15). Root end cavity can be prepared by a bur or an ultrasonic instrument. The researches have demonstrated that ultrasonic instruments create more micro fractures than burs during root end cavity preperations (12). Also the depth of the root end cavity is a significant factor achieving hermetic apical seal. Frank et al demonstrated that 3 mm depth class I cavity for an amalgam root end filling reduced apical leakage (16,17,18,19).

With an ideal material, the apical portion of the canal can be sealed from the surrounding tissues to prevent bacterial migration (20,11). The improvements of technology provide the opportunity of testing many materials and selecting the best retrograde filling material. It has been suggested that the ideal retrograde filling material should be non-toxic, non-carcinogenic, biocompatible and should prevent leakage of microorganisms to thae apical tissues. Sealing ability of materials should not change due to the tissue fluids or the moisture in the environment. Also materials should be easy to manipulate and be radioopaque in order to be recognized (13).

Numerous materials have been suggested as root end filling materials: gutta-percha, amalgam, polycarboxylate cement, zinc phospate cement, zinc oxide eugenol paste, IRM cement, Eba cement, Cavit, Glass ionomers, composite resins and other materials such as gold foil and leaf, silver points, cyonoacrylates, polyhema and hydron, diaket root canal sealer , titanium rews and teflons (11,13,15,16,21-23).

The aim of this study was to compare the sealing ability of zinc-phospate cement and gutta-percha, amalgam, IRM (intermediate restorative material) cement and MTA (mineral trioxide aggregate) with each other.

Materials and Methods

Forty extracted single rooted human upper incisors and canines were used in this study. Root lengths were at least 11-12 mm and these with no evidence of previous root canal therapy of teeth were selected. Teeth were collected and stored in 10% formalin. X-rays were taken to assess the absence of anatomical anomalies in the canal system. After an ultrasonic cleaning for the remnants and calculus remaining, endodontic treatment beginning from 15 K-type file up to 45 K-type file was performed at a working length of 1mm shorter from the apical foramen. 5.5% solution of NaOCl was used as an irrigant. All roots were sectioned 3 mm from the apex at an angle of 90^0 with a micro reciprocating saw (Ref:5100-37 TPS) under water irrigation (15). All canals were dryed with paper points and filled with zinc-phospate cement (Adhesor, Spofa Dental) and gutta-percha points. Teeth were randomly divided into four groups, with ten teeth in each group. Retrograde preparation of 3mm length cavities drilled with a reverse-conic bur (no: 6, acurata) were mounted on a contra-angle high speed hand piece in first three group. Retrograde cavities of the first group were filled with IRM. IRM was prepared by a microspatula and was treated to teeth with a micropacker. Amalgam was used as a retrograd filling material in the second group. Amalgam was treated to cavities with a microspatula and brinsuar. Third group's retrograde cavities were filled with MTA. The filling materials were prepared according to manufacturers recommendations. The fourth group was left untreated with zinc-phospate cement and gutta-percha filled root canals.

After retrograde root filling procedures were completed, teeth were coated with three layers of nail varnish except for the apical portion. Then teeth were allowed to dry for 30 minutes. After the drying period, teeth were placed into four tubes containing 1% methylene blue solution for 48 hours.

After 48 hours, teeth were rinsed under running water for 5 minutes and allowed to dry. The roots were divided into two equal halves along the long axis with a micro reciprocating saw (Ref: 5100-37 TPS). The sections were observed under a stereomicroscope at 1,6 X 10 magnification (Leica MS5 Switzerland) and the linear depth of dye penetration was measured on both sides of the retrograde filling metarial in all sectioned roots of all groups with caliper (Vernier Caliper 200xmm) One Way ANOVA analysis of variance followed by the Dunnett T_3 test for individual contrasts was used to compare the dye penetration.

Results

Dentinal and apical dye penetration was observed by the stereomicroscope. Dentinal and apical dye penetration in the four groups are seen in Figure (1-4). Figure 1 demonstrates dye penetration of amalgam, Figure 2 MTA, Figure 3 IRM, Figure 4 zinc-phospate cement fillings. The mean linear measurement values for apical dye penetration of the specimens in each group are shown in Table 1. The mean differences and the significance of values between groups are shown in Table 2. The test specimens which received reverse MTA fillings showed the least leakage but showed no significant difference between reverse amalgam fillings (p = 0,221). The specimens which received reverse IRM fillings showed significantly more dye penetration than the reverse amalgam (p = 0,022) and MTA fillings (p = 0,0005) There was no significant difference between the specimens received reverse IRM fillings and zinc-phospate cement fillings (p = 0,123).

Figure 1. Dye penetration of amalgam filling.

Figure 2. Dye penetration of MTA filling.

Discussion

The primary aim of root canel treatment is the elimination and future exclusion of all microorganisms from the root canal system. Conventional root canal treatment is the preferred treatment to achieve this aim. However, if conventional root canal treatment is impossible or has failed, an alternative approach will be necessary. Periapical surgery which entails apicotomy and retrograde root filling may be performed. A retrograde root filling is placed to establish an "apical seal" to prevent the passage of microorganisms or their products into periapical tissues. 'Apical seal' is the single and most

Figure 3. Dye penetration of IRM filling.

Figure 4. Dye penetration of zinc-phospate cement filling.

important factor in achieving success in surgical endodontics (18,24-28).

The most commonly used retrograd root filling material is amalgam but it does not provide a satisfactory seal and there are numerous disadvantages with this material (29-33). In the quest for an effective apical barrier various techniques and materials have been investigated (21,29-33). There is a long history of using leakage studies to asses the suitibility of potential root-end filling materials. There is no standardized leakage test to evaluate the sealing ability of endodontic materials (21). Despite criticism, dye leakage tests still remain the

Table 1. Showing the mean linear measurement values for apical dye penetration of the specimens in each group.

Group	Mean Std.	Deviation	N
1	2.4150	1.2579	20
2	1.3125	0.9716	20
3	0.7650	0.6341	20
4	1.6550	0.6316	20
Total	1.5369	1.0782	20

F = 11.47; P = 0.0005
One way ANOVA

Table 2. Showing the mean differences and the significance of values between groups.

Multiple comparisons					
GROUP	(I)	GROUP (J)	Mean Difference (I-J)	Std. Error	Sig.
Dunnett T3	1	2	1.1025	0.2884	022
		3	1.6500	0.2884	0.0005
		4	0.7600	0.2884	0.123
	2	1	-1.1025*	0.2884	0.022
		3	0.5475	0.2884	0.221
		4	-0.3425	0.2884	0.710
	3	1	-1.6500*	0.2884	0.0005
		2	-0.5475	0.2884	0.221
		4	-0.8900*	0.2884	0.0005
	4	1	-0.7600	0.2884	0.123
		2	0.3425	0.2884	0.710
		3	0.8900*	0.2884	0.0005

best test for screening adaptation and sealing ability and it is stated that dyes are simpler, cheaper, safer and easier to handle than radioisotopes (13,21,34). The use of dyes is one of the oldest and commonest methods of studying microleakage. (21,35-48) A variety of dyes have been used; these include indian ink, erythrosine B solution, aqueous solution of fuchsin, fluorescent solution, methylene blue solutions and others (37-43).

Kersten and Moorer (49), found that leakage of the commonly used dye methylene blue was comparable with that of a small bacterial metabolic product of similar molecular size.

Higa et al (50), evaluated the influence of storage time (0 versus 24 hours) on the amount of dye leakage of amalgam, super EBA, or IRM and their results showed that storage time had no significant influence on the amount of dye leakage . It was concluded that 3 mm deep retrograde cavities or cavities extended coronally into the root canal at least to the height of the bevel significantly reduced the apical leakage (15,16,18,25). So we prepared 3 mm depth of apical cavities in our study. Methylene blue dye was chosen for this study not just because it is the most commonly used but because it exhibits a sensitivity surpassing even that of radioactive isotopes.

It has been demonstrated that as the angle of the bevel increases the apical leakage also increases due to the greater apical surface and greater number of dental tubues and its permeability (3,13,52). So we resected all root ends as perpendicular to the long axis of the root as possible.

Higa et al (50), Abdal and Retief (43), Smee et al (27) and Bondra et al (28), showed that IRM provided a better seal than amalgam or super EBA. In a similar study Stabholtz et al (53), found that Restodent sealed significantly better than zinc phospate cement , cavit.w, durclon and amalgam. According to their investigation amalgam was significantly inferior to the four other materials and in addition they showed that zinc phospate did not differ significantly from cavit or durclon.

In a clinical retrospective study, Dorn and Gartner (31), examined the success rate of EBA, IRM, zinc free high copper amalgam and found super EBA and IRM had significantly higher success rate than amalgam.

Sealing ability of MTA was superior to that of amalgam or Super EBA in different dye and bacterial leakage methods (40,54). Setting time of MTA was much longer than amalgam or IRM and marginal adaptation was better than amalgam and IRM (55).

In our study, reverse MTA filling showed the least leakage but the difference between amalgam and MTA was not significant. Dye penetration was significantly more in IRM fillings and zinc phospate cement than MTA and amalgam. There was no significant difference between the specimens that received reverse IRM fillings and zinc phospate cement fillings. These results corrabarate with previous findings that show MTA seals significantly better than amalgam and IRM. Dye penetrations in MTA placed cavities were less than that of others. This is probably due to its superior marginal sealing ability.

Comparison of the data obtained from various leakage studies shows considerable variation in the results of these investigations, and examination of clinical studies shows that there are many variables in these investigations. The main variables include: the number of cases, materials tested, different procedures, techniques and different kind of dyes, lack of standardization or evaluation criteria for quantitative results obtained in these studies. Because of these variables it is difficult to compare the results with one another.

The majority of leakage studies have been performed in vitro with little or no similarities to in vivo conditions. One of their major limitations is the amount of fluid exchange between the apical root canal walls and the root end filling material. On the other hand the purpose of placing a root end filling material is to prevent penetration of irritants from the root canal system into periradicular tissues. Thus coronal seal of root end filling material is probably more important than that of the apical seal.

As a result despite their popularity and ease of use the results and clinical significance of leakage studies have been questioned.

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