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EVALUATION OF SEALING ABILITY OF THREE DIFFERENT ROOT END FILLING MATERIALS USING ULTRASONIC RETROGRADE PREPARATION TECHNIQUE: AN IN-VITRO FLUORESCENCE MICROSCOPIC STUDY

Dentistry

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ABSTRACT

This study was done to comparatively evaluate the sealing ability of three different root end filling materials - MTA Plus, ProRoot MTA and Biodentine, using ultrasonic retrograde preparation technique, by dye penetration method under fluorescence microscope. 65 single rooted human maxillary anterior teeth were obturated and apical root resections were performed. 3mm deep root-end cavities were prepared with an ultrasonic surgical tip. Teeth were assigned into total 4 groups, where 3 groups included 20 teeth each to be filled with 3 respective root end filling materials- MTA Plus, ProRoot MTA and Biodentine and 4th group was a control group- GIC which included 5 teeth. Each specimen was examined as to the adaptation of the root end filling material to the cavity walls using Rhodamine B dye penetration method under fluorescence microscope. Kruskal Wallis test and Mann –Whitney test was used to determine the statistical difference of dye leakage between groups. Out of the three materials evaluated, all the three materials exhibited dye leakage. Of these, MTA Plus exhibited less penetration, thus possessing highest sealing ability when compared to the ProRoot MTA, Biodentine and GIC with highly significant differences between all the groups. MTA Plus is better as a root end filling material to prevent microleakage and thus, can be suggested as a better alternative to other bioactive materials as a root-end filling material.

KEYWORDS

Sealing ability, MTA Plus, ProRoot MTA, Biodentine

INTRODUCTION

Traditionally the 'endodontic triad' concept of cleaning, shaping and filling has been promulgated widely. However, considering that a major goal of root canal treatment is removal of microorganisms from the complex root canal system, it would therefore appear that 'shaping to facilitate cleaning and filling' should be achieved while ensuring conservation of the root structure and maintenance of the canal anatomy.[1]

When conventional root canal treatment is impossible or when failure has occurred after conventional root canal therapy a surgical approach may be necessary to save the tooth. Apicoectomy and retrograde root filling are the common surgical procedures performed in an attempt to seal the root canal system. Adequacy of the apical seal is the single most important factor for the success of an apicoectomy procedure.[2] Several materials have been suggested and clinically tried as root-end filling materials. However, each one of the them have their own limitations.[3]

ProRoot MTA was developed at Loma Linda University as a root-end filling material.[4] MTA has shown promising results due to its good sealing properties, bioactivity, and potential to stimulate cementogenesis. A disadvantage of MTA is its slow setting and less resistance against washing out during placement.[5]

Biodentine is another calcium silicate based material, introduced by Gilus and Oliver in 2010, with good handling property and relatively faster setting time compared to Mineral Trioxide Aggregate (MTA). The sealability and gingival fibroblasts attachment provided by Biodentine is comparable to MTA and other calcium phosphate based cements with less cytotoxic effects as compared to Glass Ionomer Cement (GIC).[6]

Recently, another type of MTA has been introduced in the market called as MTA Plus (Avalon Biomed Inc., Bradenton, FL, USA). According to the manufacturer, MTA Plus is similar in composition to ProRoot MTA and MTA angelus but having finer particle size. It is composed of tricalcium and dicalcium silicate, bismuth oxide, calcium sulfate, and silica with finer particle size than other commercially available MTA versions (50% of the particles finer than 1 μm). MTA Plus particles are smaller in size, and thus have a greater surface area. It also has lower setting time than that of MTA because of the smaller particle size.[7]

Dye penetration studies are the most commonly used technique for the microleakage assessment of root-end filling materials.[8,9] The use of methylene blue in marginal sealing studies have been debated, due to its in-compatibility with alkaline substances, which may induce discoloration of the dye.[10] Rhodamine B is a basic intense organic dye, soluble in water at room temperature and also soluble in alcohols and common organic solvents, in addition to being highly stable.[11] Since color stability of organic dyes is an important factor that must be observed in microleakage studies. Because of the alkaline conditions, in this study Rhodamine B dye was used to evaluate the sealing capacity for the dye penetration test.

The choice of a root-end filling material is one of the many factors relevant to the long term success of endodontic surgery. Hence, the purpose of this present study was to assess effectiveness of three different root end filling materials using ultrasonic retrograde preparation technique.

METHODOLOGY

65 extracted single rooted human maxillary anterior teeth were selected for the study. All of these teeth were sectioned at Cemento-enamel junction using diamond disc mounted on a micromotor straight handpiece. Access cavities were prepared. Canal orifices were located with the help of K-files and canal patency was confirmed. Working length was determined for each tooth by subtracting 0.5 mm from the length at which 15 no. K-file appeared at the apical foramen. Biomechanical preparation was done using hand protapers till F3 (blue 30-9%). Normal saline and Sodium hypochlorite (5.25%) were used as the irrigant alternatively in between instrumentation. Then 5 ml of saline was used as the final irrigant. The cleaned & shaped canals were then dried with absorbable paper points, obturated with laterally condensed gutta-percha & AH Plus sealer (Dentsply Maillefer, Ballaigeus). Radiographs were taken to confirm the quality of obturation. Access opening of each tooth was then sealed with 2-3mm composite resin. The roots were then wrapped in water moist gauze and stored in glass bottles for one week to prevent possible fracture during the cutting procedure.

Root-end Cavity Preparation:

Apical root resections were performed by removing 3mm of each apex at 90 degrees to long axis of teeth with straight fissure bur in a high speed airotor handpiece under constant water cooling. 3mm deep root-end cavities were prepared with an ultrasonic surgical tip (E10D Woodpecker). The root end cavities were then irrigated with saline and depth as well as quality was confirmed using periodontal probe and radiographs.

Two coats of nail polish were then applied to the whole surface of total length of each root except tip of the root where retrograde filling is to be done so as to avoid unwanted dye penetration in other areas of the tooth. All roots were then wrapped in wet gauze and stored in 100% humidity for 24 hours.

The teeth were assigned into total 4 groups, where 3 groups includes 20 teeth each to be filled with 3 respective root end filling material and 4th group was a control group.

Group 1 - MTA Plus (Prevest DenPro Limited, Avalon Biomed Inc, USA)

Group 2 - ProRoot MTA (Densply Tulsa Dental, Tulsa, OK, USA)
Group 3 - Biodentine (Septodont, France)
Group 4 - Glass Ionomer Cement Type-2 (GC Gold Label, Japan) (Control group)

The root end cavities of all the teeth were washed with sterile saline and dried using absorbable paper point. All materials were mixed according to manufacturers direction and retrograde filling were done with each teeth using #2 hand pluggers. The excess material on the root surfaces was cleaned with moist gauze. Radiographs were taken in mesiodistal and buccolingual directions to evaluate the root-end fillings. All roots were then wrapped in wet gauze and stored in 100% humidity for 24 hours.

Apical two-third of all the roots were then immersed in 0.2% Rhodamine B dye solution in a way that coronal portion does not come in contact with the solution and are left at room temperature for 24 hrs. After removal from the dye, teeth were rinsed under tap water. The teeth were sectioned longitudinally into two halves using a diamond disc under continuous irrigation.

Each specimen was examined as to the adaptation of the root end filling material to the cavity walls and the extent of dye penetration along the cavity was measured using fluorescence microscope(Nikon Eclipse Ni, Japan). When the specimens were excited with light, and at 4X magnification, Rhodamine B exerted fluorescence. The extent of dye penetration was then measured quantitatively in micrometers for each tooth using NIS elements imaging software. Each specimen was measured independently by two observers at two different times under similar conditions. The average of the same measurement region from the two observers was then recorded. The collected readings were then subjected to statistical analysis.

FLUORESCENT IMAGES OF THE LONGITUDINAL SECTIONS OF THE RESECTED ROOT-ENDS WITH RETROFILLINGS

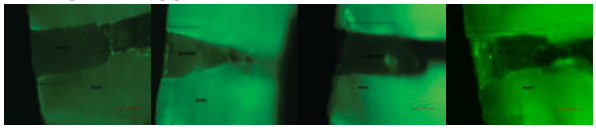


Figure 1: MTA Plus **Figure 2: Biodentine** **Figure 3: Pro-Root MTA** **Figure 4: GIC**

METHOD OF DATA ANALYSIS

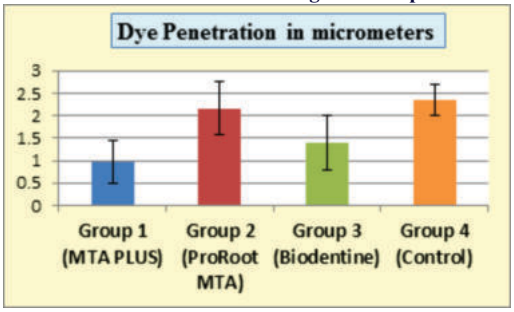
SPSS for Windows, Version 16.0, Chicago, SPSS Inc software was used to analyse the data. Kruskal Wallis test was used to determine the statistical difference of dye leakage between the four groups. Mann –Whitney test was used to determine the statistical difference of dye leakage between multiple individual pair wise group comparisons.

Table 1: Comparison Of Dye Penetration In Micrometers In Group 1 (MTA Plus), Group 2 (ProRoot MTA), Group 3 (Biodentine) and Group 4 (Control) Respectively

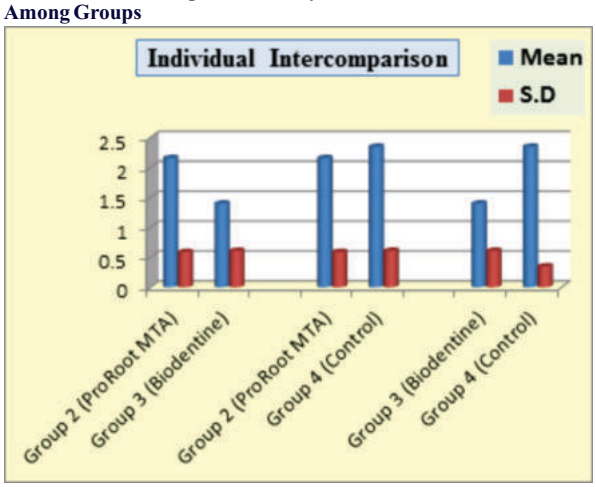
Groups	Mean (S.D)	Kruskal Wallis test	p value, Significance
Group 1 (MTA PLUS)	0.97 (0.47)	29.771	p < 0.001, highly significant difference
Group 2 (ProRoot MTA)	2.16 (0.59)		
Group 3 (Biodentine)	1.40 (0.61)		
Group 4 (Control)	2.35 (0.35)		

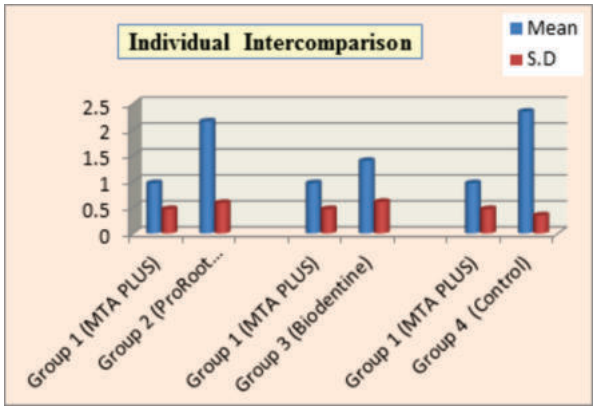
p > 0.05 – not significant p < 0.05 – significant p <0.001 –highly significant

Dye Penetration In Micrometers Among The Groups



Individual Intercomparison Of Dye Penetration In Micrometers Among Groups





The mean dye penetration values, arranged in order, starting from the least to the maximum, are Group 1 MTA Plus (0.97) < Group 3 < Biodentine (1.40) < Group 2 (2.16) < Group 4 (2.35). The obtained results showed that dye leakage was present with all the three materials, with the highest values exhibited by Group 4(control group) followed by Group 2(ProRoot MTA), Group 3(Biodentine) and Group 1(MTA Plus) respectively. Thus, it was found that Group 1(MTA Plus) has least dye penetration and highest sealing ability when compared to Group 2(ProRoot MTA) and Group 3(Biodentine).

DISCUSSION

The prime requisite for a successful endodontic treatment and predictable prognosis is the apical seal which in turn depends on proper instrumentation and cleaning of the root canal system.[12] In some cases, conventional endodontic treatment is not sufficient to solve the problem and surgical endodontic intervention is required. At present, Apicoectomy is performed mainly using a rotary cutting device in clinical settings, but there is concern that the prognosis may be affected by frictional heat, cracks formation and excessive dentin removal causing further damage to the tooth structure. Recently, several reports advocating ultrasonic root-end preparation have been published. They claim that a deeper class I preparation can be made and that the ultrasonic tips follow the root canal space better than conventional techniques. Pannkuk has stated that it is desirable to have the smallest bevel angle necessary to achieve adequate access, thereby minimizing root end filling surface area and maximizing the potential reattachment area.[13] Therefore, in this study, ultrasonic surgical tip E10D Woodpecker was used. E10D ultrasonic surgical tip is a diamond coated tip for endodontic use of root canal retrograde cavity preparation specifically.

Anurag Jain et al compared root end sealing ability of four different retrograde filling materials in teeth with root apices resected at different angles. They found that the root apex sealing ability of Pro-root MTA was superior to Portland cement, Intermediate Restorative Material and light cure GIC.[14]

Prasanti K. P et al evaluated the sealing ability of five different root end filling materials- glass ionomer cement, super-ethoxy benzonic acid,

gray-mineral trioxide aggregate , white-MTA and biodentine. Their overall results showed no statistically significant difference between two types of MTA and Biodentine, but all the three materials are superior to GIC, super-EBA.[15]

Sakshi Malhotra and Mithra N. Hegde evaluated the marginal seal of ProRoot MTA, MTA Angelus, biodentine, and glass ionomer cement as root-end filling materials. They found that least amount of apical dye microleakage was seen in biodentine.[16] Naik MM et al assessed the apical seal obtained after root end cavity irrigation with MTAD and retrograde filling with ProRoot MTA and Biodentine and found that irrigation with MTAD significantly improved the apical seal of Biodentine.[17]

Saraswathi et al in their study evaluated sealing ability of Biodentine, MTA Plus, and MTA under stereomicroscope and found that MTA Plus showed a better seal.[12]

Therefore, from our study, it can be stated that out of the three materials evaluated, all the three materials exhibited dye leakage. Of these, Group 1 (MTA Plus) exhibited less penetration, thus possessing highest sealing ability as when compared to the Group 2 (ProRoot MTA), Group 3 (Biodentine) and Group 4 (GIC-control group) with highly significant difference between all the groups.

CONCLUSION

Thus, within the limitations of this study the following conclusion can be derived:

a. MTA Plus is more efficient in comparison to ProRoot MTA and Biodentine with least leakage and highest sealing ability.

b. MTA Plus is better as a root end filling material to prevent microleakage and thus, can be suggested as a better alternative to other bioactive materials as a root-end filling material.

c. Maximum amount of dye penetration was exhibited by Pro Root MTA root end filling material followed by Biodentine.

Further studies are still needed to correlate with finding of the present study.

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