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Comparative Evaluation of Apical Sealing Ability of MTA based Sealers VS Resin based Sealers using Dye Penetration Technique: An in Vitro Stereomicroscopic Evaluation

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Abstract:- AH Plus is one of the most commonly used epoxy resin-based sealers, due to its favorable properties. Trends in endodontics have shifted towards bio-ceramic materials; newer modification of MTA includes its use as a root canal sealer. The objective of present study comparatively evaluated the apical sealing ability of a new MTA based sealer, MTA Fillapex and a most commonly used resin sealer, AH Plus sealer. Statistical analysis of the results demonstrated significantly less dye leakage for AH Plus compared to MTA Fillapex. Mean value for MTA Fillapex group was 1.375 mm and for AH Plus group was 0.755 mm, which was statistically significant. Apical sealing ability of AH Plus was comparatively better than that of MTA Fillapex.

Keywords:- *AH Plus, MTA Fillapex, MTA Sealer, Resin Sealer.*

I. INTRODUCTION

Endodontic therapy is essentially a debridement procedure, which aims at total removal of all root canal contents followed by complete three-dimensional obliteration of pulp space. Our instruments shape major portions of the root canal wall but a very wide array of micro-anatomical complexities of root canal system remain inaccessible, untouched and un-cleaned.

So, completion of endodontic treatment is accomplished by adequate disinfection of the root canal system followed by best possible three-dimensional obliteration of all the canal spaces called “obturation”, using an inert material along with sealer. This obliteration provides no room for further microbial growth and the obturating materials sandwich the remaining dormant microbes between themselves and the root canal wall by not allowing further nutritional supply or chance of growth. The actual seal in the root canal obturation is provided by an endodontic sealer, which obliterates the micro gaps between the dentin and the root canal obturating material.

Clinicians have used various types of sealers with different chemical compositions such as; zinc oxide eugenol-based sealers, calcium hydroxide-based sealers, glass ionomer-based sealers, silicon-based sealers, methacrylate resin-based sealers, epoxy resin-based sealers, and bio ceramic based sealers over past decades.

AH Plus is one of the most commonly used epoxy resin-based sealers, due to its favorable properties such as low solubility, good sealing ability, better flow rate and low film thickness. In spite of its desirable properties AH Plus being a polymer, it exhibits polymerization shrinkage which can contribute to microbial leakage and subsequent endodontic failure [1], [2].

Recently trends in endodontics have shifted towards the use of bioactive materials. Dr. Torabinejad developed mineral trioxide aggregate in the year 1993. MTA is used primarily to seal perforations, as a root-end filling material, in vital pulp therapy and obturation of apical portion of immature teeth. It is a bioactive material that produces calcium hydroxide, which is released in solution and induces the formation of hydroxyapatite structure, which helps in healing [3].

Newer modification of MTA includes its use as a root canal sealer introduced in the year 2010 as MTA Fillapex.

The most ideal outcome of endodontic treatment is apical hard tissue closure, which permanently separates the root canal content and the root filling from the periapical tissue. Due to its osteoconductive action, filling of the root canal with MTA based sealer promotes the physiological closure of the canal by cementum like hard tissue. MTA based sealers with their features such as osteoconductivity, hydrophilicity and adhesiveness to the root canal dentinal wall appears to an effective approach to eliminate micro space [4].

Though the idea of using MTA based sealer in obturation appears very promising the scientific evidence regarding its sealing ability appears to be insufficient in the literature, on the above background this study was planned to compare.

II. MATERIALS AND METHODS:

A. Preparation of the samples:

Eighty single-rooted teeth were selected and stored in a 5% sodium hypochlorite solution for 20 days. All teeth were radiographed to check for single root and single canal.

Inclusion criteria: Extracted single root teeth with verticci's type I canal anatomy which was evaluated radiographically and tooth with mature apex.

Exclusion criteria: Root fracture, root caries, resorption and extreme root curvature.

Prior to instrumentation, the teeth were marked at 16 mm from the apex with an indelible marker pen to standardize the tooth length. The teeth were sectioned at 16mm margin using a diamond disk (Diamond Technologies Ltd., Israel). Working length was determined by inserting #10 stainless steel K type hand file until it was just visible at the apical foramen, which was then subtracted by 0.5mm. All the samples were cleaned and shaped using the Step Back technique of biomechanical preparation using K- type hand files (Mani Inc., Tochigi, Japan). Apical preparation was done up to 35-K files followed by step back preparation up to 50 K-file (Mani Inc., Tochigi, Japan) [5], [6]. During preparation, each canal was irrigated passively with 2.5% sodium hypochlorite (Dentpro, Amdent, Mohali, India) using a 27-gauge needle (Ramson Tools, Faridabad, India). Activation was carried out with an Endoactivator (Dentsply mallifer, Switzerland). Canal was irrigated with 17% EDTA (AveuPrep, Vasai, India) followed by final irrigation with normal saline (NS, Fresenius Kabi, Germany).

The samples were divided by the lottery method into four test groups (n=20).
- Group I: All samples assigned to group I were obturated using MTA based sealer (Angelus Fillapex) and Gutta-percha.
- Group II: All samples assigned to group II were obturated using Resin- based sealer (AH Plus) and Gutta-percha.
- Group III: All samples assigned to group III were obturated using Gutta- percha without sealer (Positive control group).
- Group IV: All samples assigned to group IV were not obturated and apical patency maintained (Negative control group).

During root canal obturation rotary lentulo spiral (Mani Inc., Tochigi, Japan) was used to apply sealer. Samples were obturated using cold lateral compaction technique. All obturated samples were stored at 37 degrees with 100% humidity for 1 week in an incubator (I-therm AI-7981, Innovative Instrument, Mumbai).

B. Dye leakage experiment:

Samples from the group I and II (test group) were coated with two layers of nail varnish except the apical 2mm. Samples from group III (positive control group) were not covered with nail varnish to test the penetrating ability of methylene blue dye. Samples from group IV (negative control group) were completely covered with two layers of nail varnish to test the impermeability of nail varnish to methylene blue dye. The samples were immersed in 2% methylene blue dye (Merck, Mumbai, India) for 72 hours. Longitudinal guide grooves were then prepared on the buccal and lingual surfaces of each root using a diamond disk at low speed without penetrating the canal. The roots were then split into two halves using a chisel and mallet.

C. Assessment of dye leakage:

Linear apical dye penetration was calculated in millimeters with a stereomicroscope (Magnus, 70T0.867, Olympus Co, Tokyo, Japan) at 10x magnification using Biovis Image Plus software.

D. Statistical analysis:

Inter group comparison (>2 groups) was done using Kruskal Wallis ANOVA followed by pair wise comparison using Mann Whitney U test.

III. RESULTS

Mean value for MTA Fillapex group was 1.375 mm while for AH Plus group was 0.755 mm (Fig. 1 and Fig. 2). Mean value for positive and negative control group was 7.525 mm and 0.02mm respectively (Fig. 1). Out of the two experimental groups, Group I (MTA Fillapex) exhibited a greater amount of dye leakage compared to Group II (AH Plus) (Table 1 and Table 2), which was statistically significant ($p<0.01$). There was a statistically significant difference seen for the values between the groups ($p<0.01$, 0.05) with higher values in positive group and least in negative group (Table 1).

IV. DISCUSSION

The main goal of endodontics is to carry out optimized cleaning and shaping followed by three-dimensional root canal obturation of the pulp space [7]. Even after thorough cleaning and shaping procedure, microorganisms are still present inside the dentinal tubules, thus it is essential to have an apical and coronal seal, which prevents the ingress of fluids and bacteria into the canal system and further reactivation of the dormant microbes [8]. Considering apical leakage to be a common cause of endodontic therapy failure, it is important to have a good apical seal [8]. Sealers are used along with gutta-percha to fill the gaps between the core

filling material and the dentinal walls [9], [10]. AH Plus is one of the most commonly used epoxy resin-based sealer due to its excellent properties like; good sealing ability, low solubility, better flow rate, and low film thickness. Due to these properties, AH Plus has become a benchmark against which all the modern sealers are compared. But being a polymer it exhibits polymerization shrinkage [1], [11].

MTA is primarily used to seal perforations, as a root-end filling material, in vital pulp therapy and obturation of apical portion of immature teeth. MTA consists of fine hydrophilic particles that set-in presence of moisture. Hydration results in the formation of colloidal gel with a relatively high pH that solidifies to a hard structure. It is due to this alkaline pH, it has high antimicrobial properties [12]. MTA has demonstrated excellent biocompatibility and induction of mineralized tissue formation. This has led to the development of an MTA based root canal sealer; MTA Fillapex [13], [14]. MTA Fillapex is supposed to incorporate the advantages of MTA along with good apical seal. However scientific evidence related to the quality of apical seal provided by MTA Fillapex is limited. Hence this study was proposed to determine the apical sealing ability of MTA Fillapex and compare it with AH Plus. Methylene blue dye was used in our study as it has a smaller molecular weight, high degree of staining and high penetrating ability [8], [13], [15]. Longitudinal section were made in this study as this method enables examination of exposed filling material and any dye penetration into the interface on the dentinal walls on one side [8]. To eliminate the inter-operator variability; a single operator completed all the testing procedures.

In this study MTA Fillapex (Group I) exhibited mean apical microleakage of 1.37±0.36 mm, these findings are in the same range as compared to the earlier work done by [16], [17] under similar settings (1.83±0.065 mm and 1.52±0.77 mm). However, [13] reported apical dye leakage of 8.29±2.42 mm with MTA Fillapex in their study, which was also done under similar conditions. There was a vast difference in the values observed in their study. The only observable methodological difference between the study by [13] and the present study was the use of permanent incisors and apical preparation up to #40, whereas in the present study lower premolars were used and apical preparation was up to 35 k file. This deviation may be attributed to relative apical enlargement in both the studies as incisors naturally have a larger apical diameter.

In this study, AH Plus (Group II) exhibited a mean apical microleakage of 0.75±0.18 mm. This was in the same range to the studies conducted by [17]–[19] (1.01 mm, 2.35±1.48 mm and 1.39±0.39 mm) respectively. Out of the two experimental groups, from**,** MTA Fillapex (Group I) exhibited a greater amount of apical dye penetration compared to AH Plus (Group II) which was statistically significant ($p<0.01$). Pairwise comparison using Mann Whitney U test showed that there was statistically significant difference seen for the values between all the pairs of groups.

These findings are in agreement with the studies conducted by [13], [20]–[23] who reported that MTA Fillapex has lower sealing ability than epoxy resin-based sealers. The limitation of the study was that, the study was carried out in extracted teeth thus may not simulate in-vivo conditions. Apical dye leakage was taken as a true indication of the apical seal. Apical leakage was studied using an artificial dye; the dye may not represent the exact ingress of apical fluids in the canal. Linear dye penetration was evaluated in two dimensions, whereas the root canal is a three-dimensional entity.

V. CONCLUSION

The use of MTA has been successfully demonstrated due to its superior properties such as biocompatibility, osteoconductive and hydrophilicity led to the development of MTA based sealer such as MTA Fillapex. MTA Fillapex is a bio ceramic sealer, these materials are known to form colloidal silica after coming in contact with apical fluids, which may eventually improve the seal. Though the observed values in this study were taken after 7 days; further studies can be done to obtain values after a longer period. Nevertheless, these results have been obtained in-vitro. To generate more concrete evidence, in-vivo studies need to be done with these newly developed sealers to check their sealing ability.

VI. FIGURES AND TABLES

Table 1: Inter-group comparation of apical microleakage using Kruskal wallis annova test:

	Mean (mm)	**Standard Deviation**	**Chi square value**	**P-value**
MTA Fillapex	1.375	0.361	73.815	0.000**
AH Plus	0.755	0.184		
Positive control	7.525	0.233		
Negative control	0.02	0.052		
Total	2.418	3.014		

Table 2: Pair-wise comparison of apical microleakage using Mann Whitney U test:

Pairs		**U**	**Z**	**P-value**
MTA Fillapex	AH Plus	15.000	-5.027	0.000**
MTA Fillapex	Positive control	0.000	-5.421	0.000**
MTA Fillapex	Negative control	0.000	-5.635	0.000**
AH Plus	Positive control	0.000	-5.426	0.000**
AH Plus	Negative control	0.000	-5.641	0.000**
Positive control	Negative control	0.000	-5.637	0.004**

Fig. 1. Inter-group comparision of apical microleakage (millimeter):

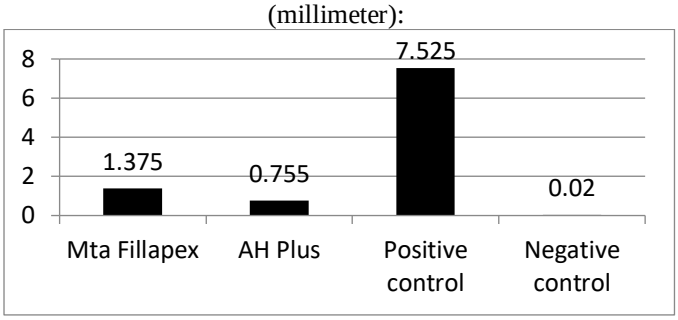
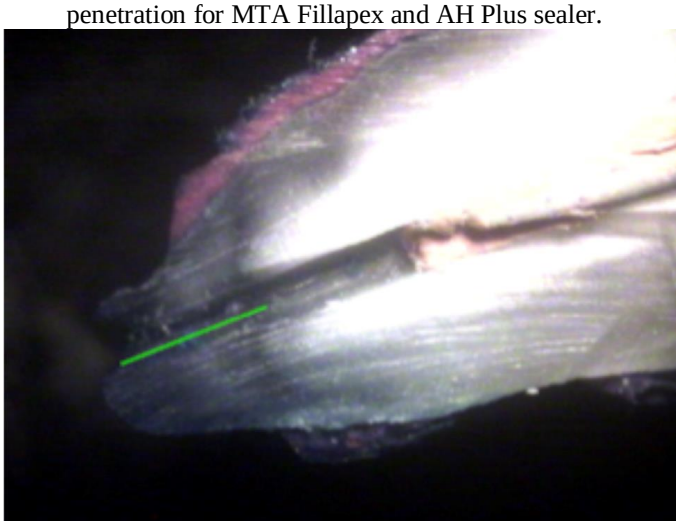
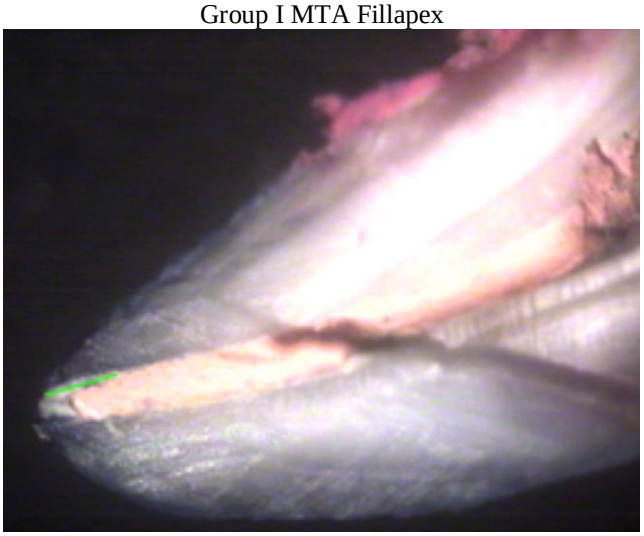


Fig. 2. Stereomicroscopic observation for apical dye penetration for MTA Fillapex and AH Plus sealer.



Group I MTA Fillapex



Group II AH Plus

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