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"Comparison of Sealing Ability of Non - Resin And Resin Based Endodontic Sealers by Determining Dye Infiltration Degree Using Stereomicroscope: An In Vitro Study"

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ABSTRACT: Aim: To compare the sealing ability of non-resin-based sealers with resin-based sealer.
Methodology: Study was done on 40 extracted permanent teeth. The samples were prepared and then randomly divided into two groups (n = 10) and obturated by cold lateral condensation technique. **Group 1:** using non-resin-based sealer (Apexit Plus, Endomethasone, MTA Fillapex) **Group 2:** using Resin based sealer (AH Plus). Micro leakage was evaluated using dye penetration method. Indian ink was used followed by the clearing technique. Dye penetration evaluation was done under stereomicroscope (2.5x magnification).
Result: Sealing ability of resin-based sealers is better than that of non-resin-based sealers.
Conclusion: AH Plus (RESIN BASED SEALER) showed the best sealing ability among all the root canal sealers.
Keywords: Apical micro leakage, clearing technique, root canal sealers, stereomicroscope

I. INTRODUCTION

The internal architecture of the root canal system (RCS) is intricate and frequently causes complications. [(1)] The purpose of a root canal procedure is to get rid of bacteria and stop reinfection. [(2)] Appropriate access, root canal cleaning and shape, disinfection, and sealing are essential for the clinical outcome of endodontic therapy.[(3)]

With an incidence rate ranging from 22% to 77%, Enterococcus faecalis is known to be resistant to treatment and is the most frequent reason why root canal therapy fails. [(2)] Because E. faecalis can withstand hunger, high pH, and penetration of the dentinal tubules, secondary infection might result. [(4)] Also, incomplete and incorrect root canal system obturation accounts for over 60% of endodontic therapy failures. [(3)]

Therefore, the three- dimensional filling of the RCS is considered one of the most important requirements of a satisfactory endodontic treatment. In order to stop additional bacterial contamination and diffusion into the deepest regions of dentinal tubules and accessory canals, it is recommended that sealing materials that can fill these canals be used. [(1)] In order to prevent leakage, the root canal sealer should ideally be able to form a strong link between the dentine and the core material. Additionally, it must to be non-toxic and, ideally, promote the healing of periapical lesions. [(5)]

Antibacterial sealers may have a stronger antibacterial impact if they penetrate deeper into the dentin. Endodontic sealers' chemical and physical properties have an impact on the penetration depth. In order to improve sealer adaption, the smear layer should be eliminated since it may impede sealers' and disinfectants' ability to enter dentinal tubules. [(6)]

There are numerous brands and types of root-canal sealers used in current endodonticpractices.Theygenerallycanbeclassifiedbasedontheirmainingredientsas Zincoxidebased, Calcium hydroxide based, Resin based and Glass ionomer based. Zinc oxideeugenol sealers have been a standard in endodontics formany years.[7]

Endomethasone is a sealer with significant antibacterial activity that is based on zinc oxide and ethylene glycol (par formaldehyde). Endomethasone N, composition does not include par formaldehyde. Endomethasone N exhibits cytotoxicity that is about thirty times less than that

of a sealer that contains formaldehyde. Comparing this sealer to AH26, Tubli-Seal, and CRCS, it is also less cytotoxic. [8] In the orthograde obturation of root canals, endomethasone is still a good choice. [9]

Calcium hydroxide-based sealers called Apexit and Apexit Plus (Ivoclar Vivadent Inc., NY, USA) were just released. At 100% relative humidity, Apexit was said to set in less than two hours. Calcium hydroxide-based sealers are not better than other sealer groups in terms of leakage. Additionally, apexit shows significant water sorption, which results in a little change in overall dimensions. [10,11] A research evaluating the sealing abilities of three sealers—Topseal, Roth 811, and Apexit—was carried out by Christo Dandakis et al. They came to the conclusion that, in comparison to Roth 811, Apexit had reduced leakage levels. [12] Schroeder brought epoxy resin-based sealers to the field of endodontics, and modern iterations of his initial formulation are now often utilized. Because of its improved apical seal, decreased solubility, and micro-retention to root canal dentin, epoxy resin sealers have been employed. The two paste systems that make up AH Plus are supplied in two tubes and a brand-new double barrel syringe. Aerosol iron oxide, zirconium oxide, calcium tungstate, and epoxy resin are all present in the resin paste.

Based on the current state of knowledge, AH Plus underwent a number of tests to rule out any potential interactions with live tissue. The results showed that AH Plus was safe and harmless. AH Plus is considered the "Gold Standard" sealer because of its exceptional qualities, which include low solubility, modest expansion, adherence to dentin, and extremely good sealing ability. [11] The novel endodontic materials known as MTA-based sealers are predicated on the physiochemical characteristics of MTA. Along the apical and middle third of the enamel wall, these sealers promote mineralization, show low solubility, low expansion during setting, and increase apatite-like crystalline deposits. [11, 13]

In 2010, a new endodontic sealer based on MTA, MTA Fillapex ® was developed by Angelus (Londrina/Parana/ Brazil) and was launched commercially. MTA Fillapex is a sealer that comes in a paste/paste form and is made up of pigment, bismuth trioxide, resins, and nanoparticulated silica. Its maker states that it has a good operating time, great radiopacity, and simple handling.[14,15]. MTA obturation demonstrated a better rate of healing in cases when there was bacterial contamination and long-term micro leakage. [16]
The purpose of this in vitro study was to compare the sealing ability of resin and non- resin based endodontic sealers by determining dyeinfiltration degree using stereomicroscope.

II. MATERIAL AND METHOD

40 extracted maxillary and mandibular freshly extracted mono and biradicular teeth with absence of pulpal calcifications were selected. The samples were kept in a 0.9% sodium hypochlorite (NaOCl) solution for three days to remove organic material from the root surfaces. Diamond and fissure burs were used to prepare the access cavity. Working length of all root canals was determined using a n° 10-k type file and radiographs were taken for confirmation. The working length was set to be 0.5 mm less than the radiographic apex.

All of the teeth's root canals were prepared with stainless steel hand files (#15-#30) (K-files, Mani) and nickel titanium rotary files connected to an Endomotor.

Each instrument's tip was coated with ethylene diaminetetraacetic acid during root canal shaping (EDTA). Before and after each instrumental penetration, 2.5% sodium hypochlorite was used. The canals were irrigated with EDTA at 17% for 2 minutes, then rinsed with distilled water, irrigated with sodium hypochlorite, rinsed with distilled water again, and finally dried.

Gutta percha cones (NeoEndo,Orikam) were chosen as master points after drying the canals using absorbent paper points and Radiographs were taken. Samples were randomly selected and divided into four groups of 10 teeth each. The sealers used were as follows:

Group 1 - Non-resin- based sealer (Apexit plus, Endomethasone, MTA Fillapex) and gutta percha
Group 2 - Resin based sealer and gutta percha (AH Plus)

All the teeth were filled with a root canal sealer and gutta percha points using the cold lateral condensation technique followed by coronal restoration.

The roots were covered with coats of nail varnish after the coronal repair with composite resin, except the apical 2 to 3 mm. Each sample was put in a Pyrex test tube filled with Indian ink and centrifuged for 10 minutes in a Vortex shaker.

The dye deposited on the root surface of each tooth was removed. Each set of samples was immersed in 5% nitric acid for 5 days for demineralisation. The teeth were thoroughly rinsed with running water for 2 h. Dehydration of the roots was carried out using ethanol solutions in an increasing way (75%, 85%, 95%, and pure ethanol)

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for 24 hours each.

Each group of teeth was placed in a Petri dish containing a methyl salicylate solution for 24 hours to make the tooth root transparent.

The samples were then examined and evaluated under the stereomicroscope for dye infiltration. The stereomicroscope was used to photograph the several teeth in each group. The dye rise measurements were performed at a magnification of 2.5x. ImageJ software was used to estimate the distance from the apex to the end point of dye penetration in micrometres.

Fig 1. 2a-Study samples, **2b-**Working length radiograph of one of the samples, **2c-**Working length with placement of rubber stopper on reference point, **2d-**Length measured on Endobloc, **2e-**Tooth preparation using K-files, **2f-**Obturation radiograph of one of the samples, **2g-**Samples coated with nail varnish, **2h-**Indian ink, **2i-**Samples placed in test tubes and immersed in Indian ink, **2j-**Centrifugation by placing test tube in Vortex shaker, **2k-**Nitric acid for decalcification, **2l-**Ethanol for dehydration, **2m-**Methyl Salicylate to make root transparent, **2n-**Sample after clearing technique, **2o-**Samples of four groups after clearing technique **and 2p-**Stereomicroscope

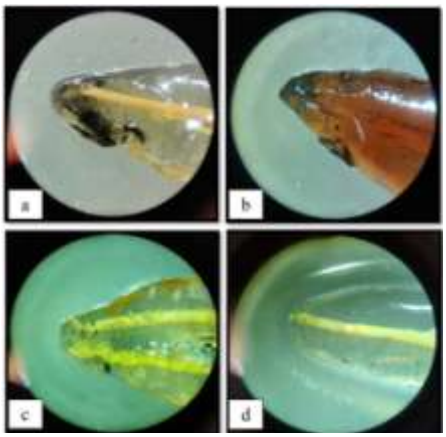

Fig 2.Examples of stereomicroscopic observation of teeth.

2a. Group 1: Apexit Plus: Complete and homogeneous obturation, insufficient external cleaning and slight dye penetration at the apical level.

2b. Group 2: Endomethasone N: Complete and homogeneous obturation and dye penetration at the apical level does not exceed 1 mm and insufficient external cleaning.

2c. Group 3: AH Plus: Complete and inhomogeneous obturation and the cement covers

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all the Intra-radicular walls as well as the gutta percha cone. No dye infiltration.

2d. Group 4:MTA Fillapex: Complete and homogeneous obturation and the cement covers all the Intra-radicular walls as well as the gutta percha cone. No dye infiltration.

III. STATISTICS AND RESULTS

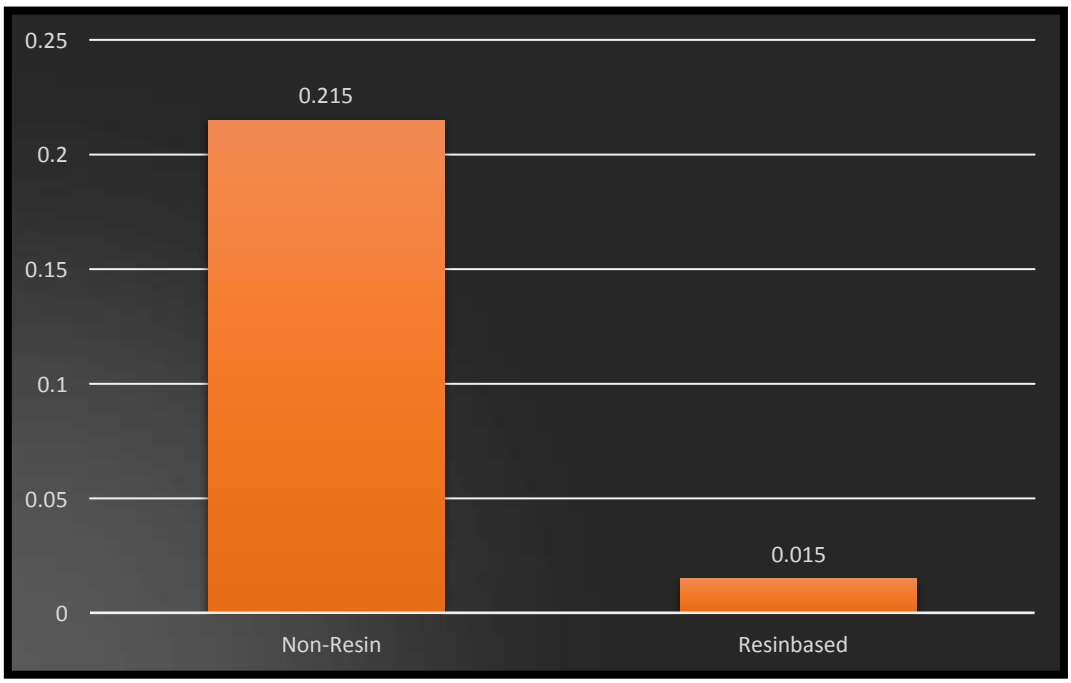
The data for the present study was entered in the Microsoft Excel 2007 and analysed using the SPSS statistical software 23.0 Version. The descriptive statistics included mean, standard deviation. The level of the significance for the present study was fixed at 5%.

Dye penetration was measured in terms of millimetre and was recorded for all samples using Image J software.

Non-resin-based sealers include Apexit Plus, Endomethasone-N and MTA-Fillapexand resin-based sealer is AH Plus. While comparing them, it was found that the meandyepenetrationscoreinthenon-resin-basedcementswas0.215withstandarddeviationof 0.291. In the resin-based cements the mean dye penetration score was 0.015 with standard deviation of 0.021. The intergroup comparison between the two groups was done using the independent t test with p value of 0.001.

Table1–Comparison between Non-resin and resin-based sealers

	Mean	StdDev	StdError	P value	Inference
Non-Resin	0.215	0.291	0.056	0.001	Significant
Resinbased	0.015	0.021	0.006		



Graph1-Comparison between Non-resin and resin-based sealers

Hence, sealing ability of resin-based sealers is better than that of non-resin-based sealers.

IV. DISCUSSION

A number of elements, including appropriate equipment, biomechanical preparation,

obturation, and post-endodontic restoration, are necessary for the best root canal therapy. Therefore, the primary goals of RCT are to eradicate microbes and stop root canal reinfection. It has been demonstrated that 13 coronal and apical leaks are significant causes of root canal treatment failures. (19)

The introduction of microorganisms or the seepage of tissue fluids into the canal space is referred to as apical leakage. However, leakage will happen between the dentin and sealer, as well as between the obturating substance and sealer.(20)

A root canal sealer will not only assist in filling irregular spaces but also in enhancing the seal during compaction and penetration into small, normally inaccessible areas, i.e., the dentinal tubules.21 As per Cohen S et al., treatment failures can be attributed to insufficient apical seal in as many as 60% of cases. (16)

In addition to sealing off voids, patent auxiliary canals, and numerous foramina, endodontic sealer cement should also form a hermetic seal with the dentin in the root canal. When the sealer sets, it shouldn't shrink or discolor the tooth's structure. They should also be radiopaque and insoluble in tissue fluids. (21)

In the present study, Apexit Plus (Non resin based), Endomethasone N (Non resin based), and MTA Fillapex (Non resin based, AH Plus (resin based))wereused.

Dye penetration technique (Moradi S, Lomee M, Gharechahi M (2015)) is a very common in vitro method for evaluation of microleakage that is relatively easy and fast to gauge by allowing the tracer agent to penetrate the filled canal. This technique is not complicated and doesn't call for a lot of equipment. Indian ink, methylene blue, crystal violet, eosin, basic fuschin, erythrosine, fluorescein, Rhodamine B, radioisotopes, microbes, and their byproducts, such as endotoxins, are among the frequently used colors. (16, 20)

One of the most common dyes used in dye penetration tests is Indian ink. The reason for this is because its tiny size (≤3 μm) allows for excellent penetration. Therefore, it is doubtful that sites with periapical bacterial invasion will be immune to ink penetration. (21, 24)

In the present study, dye penetration test was done using Indian ink and clearingtechnique

The clearing process is more widely recognized, requires less area and equipment, and can be finished in five days. A three-dimensional assessment of the teeth and an illustration of the internal structure of the root canal, including the lateral and auxiliary canals, are made possible by clarification. Lussi et al. state that cross sectioning makes it possible to see dye penetration into the root canal and the obturation material itself, whereas cleaning simply finds dye between the sealing material and the root canal walls. (21, 24, 25)

The centrifuging dye penetration technique is still a widely used instrument for evaluating root canal filling quality. Dyes have the potential to chemically react with dentin or sealing materials, affecting their diffusion and preventing a reliable assessment of marginal leakage. The filling's trapped air might change the level of dye penetration. It has been recommended that vacuum or centrifugation be used to overcome this. (19)

In the present study, resin-based sealer (AH Plus) showed lowest dye penetration (0.0157 mm) than non-resin-based sealer. {MTA Fillapex (0.0341 mm) and Apexit Plus (0.236 mm); while Endomethasone-Nshowedthe highest penetration (.3759)}.

Previous research has shown that a material's physicochemical behavior is directly influenced by its makeup. They have clarified that the covalent attachment of an opened epoxy ring to any exposed amine group in collagen accounts for the maximum bond strength values attained by epoxy resin-based cements, providing minimal polymerization tension and long-term dimensional stability. Thus, using a scanning electron microscope, AH plus demonstrated longer, more uniform tags as well as a higher bonding capability. (3) Its creep capability and extended setting time, which improve the mechanical coupling between the sealer and root dentin, are responsible for the greater penetration into the micro-irregularities. This property, together with the cohesiveness of sealer molecules, results in increased resistance to dentin displacement and removal, or increased adhesion.30, 31

Within the limitations of this in-vitro study, AH Plus showed highest sealing ability ascompared to other groups. However, further studies are needed to establish the sealingability of these sealers and their physical properties using more precise and advanced methods of evaluation.

V. CONCLUSION

With the results obtained after evaluation, and comparison of the sealing ability of the four endodontic sealers, it could be concluded that;

- All sealers showed some amount of dye penetration.
- Sealing ability of resin-based sealers is better than that of non-resin-based sealers.S
- AHPl us seems to be a promising filling material because of its reduced solubility,

better apical seal, micro-retention to root can aldentin, low shrink age, and high dimensional stability.

- The results of the scanning electron microscopic study corroborated the findings of the dye penetration study.

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