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Effect of Smear Layer on Push Out Bond Strength of Three Resin Based Sealers- An in vitro study.

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Introduction

The purpose driven behind the success of root canal treatment is to obtain a fluid tight seal which will put a stop to bacterial contamination into the root canal space. Bio mechanical preparation of root canal space leads to the formation of surface film of debris formed by the endo dontic files or rotary instruments which retained on the dentin and usually consist of dentin particles, remnant of vital or necrotic pulp tissue, bacterial com ponents and retained irrigant. This is called as the smear layer [1].

It is assumed that this layer impedes with the contact of endodontic sealer to the root dentin as it covers the orifice of the dentinal tubules and prevents the penetration of sealer into the tubules [2]. Study done by Hachem EL et al shows higher penetration depth of sealer into dentin at 1mm and 5mm of section from root apex [3].

So, the removal of smear layer is of utmost importance for better adaptation and penetration of sealer into dentinal tubules.

Various solutions had been developed over past few decades for removal of smear layer which are EDTA (Ethylenediamine Tetra Acetic Acid), citric acid, polyacrylic acid, etc.

Chelating agent such as EDTA have been used during the biomechanical preparation of the root canal which has been suggested to remove smear layer and also demineralizes and softens the dentin [4]. This property of EDTA is responsible for better adaptation of root canal sealer to the root canal wall [4,5].

The use of gutta percha along with a root canal sealer is the most widely accepted root canal filling material [6]. Various types of root canal sealers have been employed clinically for this purpose which includes zinc oxide, epoxy resin, silicate and methacrylate-based sealers. Of the various sealer that are commonly used this day, resin-based sealer are gaining popularity owing to their remarkable properties such as longer setting time, low solubility, high flow rate, low volumetric polymerization shrinkage and interfacial adaptation. Amongst these AH Plus sealer which is an epoxy resin-based sealer is considered as the gold standard in clinical practice and reference material for other types of sealers for clinical research purpose [7].

Thus, AH Plus sealer was used in this study. Resino-Seal (Amrith Chemicals and Mineral Agency, Punjab, India) is a resin-based sealer which is used in this study because it is having high flow rate and longer setting time (9-15 hours) and Epo Seal (PREVEST DENPRO LIMITED, Jammu, India) which is having low solubility and shorter setting time (15-20 minutes) as per the manufacturers. Till date no study have been reported on evaluating the push out bond strength of the Resino-Seal and Epo Seal. Thus, the aim of this study was to evaluate and compare the effect of smear layer on push out bond strength of three different resin-based sealers.

Materials and methods

Sixty single rooted human mandibular premolar teeth extracted for orthodontic or periodontal reasons and the teeth with close apices had been selected for the study. All the samples were decoronated to maintain the standardized length of 16mm. A size #10 stainless steel K file was then inserted into the canal until the file was just visible. The working length was recorded by deducting 1 mm from these lengths. Bio mechanical preparation was done with Pro Taper Universal (Dentsply Sirona, USA) rotary instruments up to size F4. During instrumentation 3ml of 2.5% NaOCl (Prime Dental Products, India) was used with a 30-gauge side vented needle (Neo endo, Orikam Health care, India) inserted to 1 mm short of the working length. The instrumented roots were randomly assigned to two groups (n=30) as follows:

Group 1: the smear layer was preserved and final irrigation was done with 5ml of distilled water and dried using paper points.

Group 2: the smear layer was removed by irrigation with 3 mL of 17% EDTA (Prime Dental Products, India) for 1min using a 30-gauge side vented needle inserted to 1 mm short of the working length. Here the irrigation was first carried out with 3ml of NaOCl to eliminate the action of EDTA and final flush with 5ml of distilled water and dried using paper points. The sealers were mixed as per the instructions provided by manufacturer and applied to the root canal wall with the help of lentil spirals.

Then each group were further assigned to three subgroups (n=10) according to the root canal sealer used.

Group 1: Smear layer preserved.

- Subgroup A: Size F4 gutta percha with Epo Seal sealer

- Subgroup B: Size F4 gutta percha with Resino-Seal sealer
- Subgroup C: Size F4 gutta percha with AH Plus sealer

Group 2: Smear layer removed

- Subgroup A: Size F4 gutta percha with Epo Seal sealer
- Subgroup B: Size F4 gutta percha with Resino-Seal sealer
- Subgroup C: Size F4 gutta percha with AH Plus sealer

The samples were stored in an incubator at 37°C for 7 days to set completely. Following the storage period, each root was sectioned horizontally to obtain three slices 1±0.1 mm in thickness from the coronal, middle and apical thirds.

Push Out Bond Strength Analysis

Each root third were marked and then sectioned into coronal third, middle third and apical third perpendicularly to its long axis into 1±0.1 mm-thick slice using a diamond disc under water stream**.** The samples were subjected to push out bond strength analysis under universal testing machine**.**

The load was applied at a crosshead speed of 0.5 mm/min using three plungers of different sizes (1 mm, 0.8 mm, and 0.5 mm) for the coronal, middle, and apical sections, respectively in an apico-coronal direction. The same procedure was repeated for all samples.

The results were obtained for push out bond strength were statistically analyzed using One-way ANOVA, Post hoc Tukey test and independent t test.

Results

One-way ANOVA test was applied to rule out the difference in intragroup comparison of push-out bond strength.

Table 1: Intragroup comparison of push-out bond strength

Groups	Coronal	Middle	Apical	p value
1A	2.84 ± 0.30	3.78 ± 0.05	6.29 ± 0.05	0.001*
1B	3.42 ± 0.03	7.78 ± 0.06	14.39 ± 0.05	0.001*
1C	3.45 ± 0.05	8.10 ± 0.05	15.08 ± 0.07	0.001*
2A	3.30 ± 0.03	5.10 ± 0.07	8.15 ± 0.04	0.001*
2B	9.38 ± 0.04	11.89 ± 0.06	22.71 ± 0.05	0.001*
2C	10.16 ± 0.05	13.75 ± 0.09	25.17 ± 0.08	0.001*

One-way ANOVA test; * indicates significant difference at $p \leq 0.05$

The above table shows intragroup comparison of push-out bond strength value at coronal, middle and apical third. Apical third shows significantly higher values of push out test as compared to coronal and middle third. Subgroup 2C showed significantly higher values than all other subgroups

Graph 1: Graph on intragroup comparison of push-out bond strength.

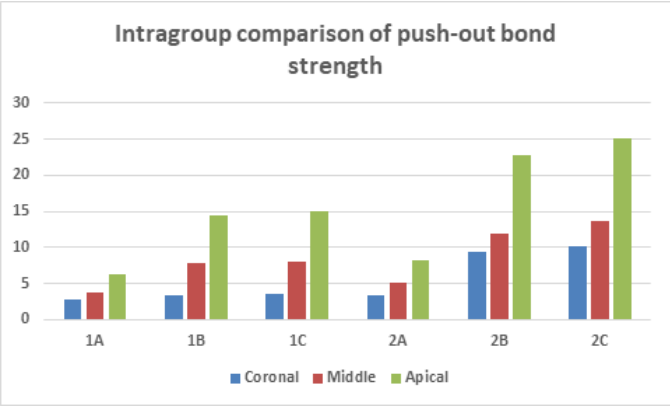


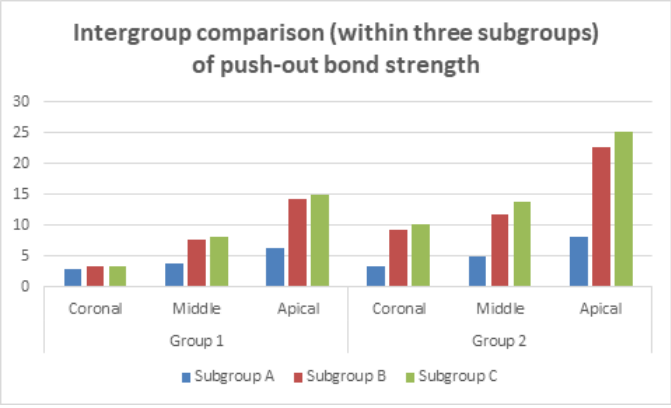
Table 2: Intergroup comparison (within three subgroups) of push-out bond strength

Groups	Region	Subgroup A	Subgroup B	Subgroup C	p value
Group 1	Coronal	2.84 ± 0.30	3.42 ± 0.03	3.45 ± 0.05	0.001*
	Middle	3.78 ± 0.05	7.78 ± 0.06	8.10 ± 0.05	0.001*
	Apical	6.29 ± 0.05	14.39 ± 0.05	15.08 ± 0.07	0.001*
Group 2	Coronal	3.30 ± 0.03	9.38 ± 0.04	10.16 ± 0.05	0.001*
	Middle	5.10 ± 0.07	11.89 ± 0.06	13.75 ± 0.09	0.001*
	Apical	8.15 ± 0.04	22.71 ± 0.05	25.17 ± 0.08	0.001*

One-way ANOVA test; * indicates significant difference at $p \leq 0.05$

The above table shows the intergroup comparison of push out bond strength values. Group 2 shows significantly higher values at coronal, middle and apical third than Group 1. Subgroup 2C showed significantly higher values of push out bond strength at coronal, middle and apical third followed by Subgroup 1C.

Graph 2: Graph on intergroup comparison (within three subgroups) of push-out bond strength



Post hoc Tukey test was applied for pairwise comparison of push-out bond strength values between three subgroups at coronal, middle and apical thirds and showed a significant difference at all the thirds.

While Independent t test was used for intergroup com parison of push-out bond strength among Group 1 and Group 2 at coronal, middle and apical third respectively showed a significant difference among all the subgroups.

Discussion

The success of the root canal treatment lies in complete debridement of the pathogenic bacteria and their by-products thereby filling the root canal space with gutta percha and an endodontic sealer which plays a significant role in achieving the fluid tight seal. Thus proper debridement of the debris and selection of an endodontic sealer are in correspondence with the success and failure of the endodontic therapy.

Whenever the dentin is bio mechanically prepared, either by the use of hand or rotary cutting instruments, the mineralized tissue is shattered and resulted in the formation of certain quantities of debris from the inorganic components of dentin while organic com ponent consist much of the mineralized collagen matrix. This is called as the smear layer [2,8]. In 1970, Eick et al. first reported smear layer under scanning electron microscope. The thickness of smear layer varies from 1-10 µm [9]. Thus, removal of smear layer is essential for better adaptation of resin-based sealer to root canal wall which was in accordance with the study done by Vilanova W V et-al showed that the removal of smear layer had significant effect on bond strength of resin-based sealers. They concluded that the use of 17% EDTA when used as final irrigant reducing the interfibrillar spaces that serve as diffusion channels for infiltration AH Plus sealer thereby increase in its bond strength [10].

An in vitro comparative study done by Singh C V et-al on-penetration depth of AH Plus sealer, Resino-Seal and ZOE sealer using scanning electron microscope found that AH Plus penetrates more in the dentinal tubule

(mean 24 ± 0.15µm) followed by Resino-Seal (mean 20.2 ± 0.17 µm) which has slightly lower values. Thus, Resino-Seal was selected for the study. On the other hand, no studies have been reported with the use of Epo Seal which is resin-based sealer on push out bond strength analysis [11]. Hence, this sealer had been selected for the study.

In the present study, it was observed that Group 2(smear layer was removed) showed higher values of push out bond strength as compared to that of Group 1(smear layer was preserved). Similar results were found in the study done by PEREIRA RD et-al on effect of 17% EDTA on removal of canal wall smear layer from all the parts of the root using scanning electron microscope. They concluded that 17% EDTA is effective in removing smear layer from all the parts of the root canal system [12]. Another study done by Murugesan K et-al on removal of smear layer using different irrigants such as NaOCl, EDTA, Oxum and ozonated water with ultrasonic agitation using Scanning Electron Microscope (SEM) had found that EDTA was superior among all the irrigant used for removal of smear layer from the root canal system, most specifically from the apical third [5].

Three different epoxy resin-based sealers were used in the present study i.e AH Plus, Resino-Seal and Epo Seal in order to evaluate their push bond strength. However, AH Plus sealer showed significantly higher values of push out bond strength followed by Resino-Seal and Epo Seal at coronal, middle and apical third of the root. this is in accordance with Cakici F et-al, where they evaluated the bond strength of three different epoxy resin-based sealers; AH Plus, Acro seal and Ad seal, in the oval shaped canals. They concluded that AH Plus highest values of push out bond strength as it penetrates more in the dentinal tubules and reduces the formation of voids [13]. Another study by Adada Hm et-al evaluated the push out bond strength of four different system; of AH Plus/gutta percha, Gutta Flow, Real Seal and Endo REZ, and concluded that AH Plus/gutta percha had higher values of push out test because of covalent bond formed by epoxide ring in the sealer with amino group of collagens in the root dentin and higher penetration depth of AH Plus into the dentinal tubules [14]. Tyagi Met-al in their study on evolution of root canal sealers stated that AH Plus has better penetration into the micro-irregularities because of its creep capacity and long setting time, which increases the mechanical interlocking between sealer and root dentin [15].

In the present study Subgroup 2C (Size F4 gutta percha + AH Plus sealer; smear layer removed) showed higher values of push at apical third which was in accordance with Mahdi A et-al where they evaluated the push out bond strength of AH Plus/gutta percha, Endo REZ and Real Seal in cervical middle and apical third of the root samples and found that push out bond strength values for AH Plus/gutta percha were highest at the apical third because of limited widening of the canal in the apical portion and having no frictional component with the canal walls[16].

Conclusion

In the present study, removal of smear layer showed improved bonding ability of root canal sealer. The AH Plus sealer showed highest values of push out bond strength followed by Resino-Seal and Epo Seal. The use of 3ml of 17% EDTA for a1 min as final irrigant is associated with the highest bond strength values.

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