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Original Article

Dentistry Section

Effect of Peracetic Acid as A Final Rinse on Push Out Bond Strength of Root Canal Sealers to Root Dentin

NARESH GADDALA[1], CHANDRASEKHAR VEERAMACHINENI[2], MURALIDHAR TUMMALA[3]

ABSTRACT

Background: Smear layer which was formed during the instrumentation of root canals hinders the penetration of root canal sealers to root dentin and affect the bond strength of root canal sealers to root dentin. Final irrigant such as demineralizing agents are used to remove the inorganic portion of the smear layer. In the present study, peracetic acid used as a final rinse, to effect the bond strength of root canal sealers to root dentin.

Aim: The purpose of the present study was to evaluate the efficacy of peracetic acid as a final irrigant on bond strength of root canal sealers to root dentin.

Materials and Methods: Sixty six freshly extracted human single rooted mandibular premolars were used for this study. After decoronation the samples were instrumented with Protaper upto F3 and irrigated with 5.25% NaOcl. The teeth were then divided into three groups based on final irrigant used: Group-1(control group) Canals were irrigated with distilled water. Group-2: Canals were irrigated with peracetic acid. Group-3: Canals were irrigated with smear clear. Each group was further divided into three subgroups (n=30) based on the sealer used to obturate the canals. Subgroup-1: kerr, Subgroup-2: Apexit plus, Subgroup-3: AH PLUS. Each sealer was mixed and coated to master cone and placed in the canal. The bonding between sealer and dentin surface was evaluated using push out bond strength by universal testing machine. The mean bond strength values of each group were statistically evaluated using Two-way ANOVA followed by Tukey post-hoc test.

Results: Significant difference was found among the bond strength of the sealers. But, there is no statistically significant difference between the groups irrigated with peracetic acid and smear clear compared to control group. AH Plus showed highest bond strength irrespective of the final irrigant used.

Conclusion: Peracetic acid when employed as final irrigant improved the bond strength of root canal sealers compared to control group but not statistically significant than smear clear.

Keywords: AH Plus, Apexit plus, Smear clear, Smear layer, Universal testing machine

INTRODUCTION

One of the major goals of root canal treatment is to seal the root canal system three dimensionally. The use of root canal sealers in conjunction with core materials remains the most widely accepted obturation techniques in endodontics. Because of lack of adhesion of gutta-percha, sealer is mainly used to fill any spaces between the canal wall and gutta-percha cone [1].

During root canal preparation, an iatrogenic layer, smear layer which consist of organic and inorganic debris is formed on the root canal walls [2]. The smear layer prevents the penetration of root canal sealers to dentinal tubules, which increases the potential for micro leakage and in turn decreases the dislocation resistance of filling material to root dentine [3].Therefore, its removal is necessary for the successful outcome of root canal treatment [4].

Sodium hypochlorite is most widely used endodontic irrigant because of its strong antibacterial activity and capability to dissolve organic tissue [5]. However, its capacity to remove the smear layer from root dentine is limited. Ethylene Diamine tetra acetic acid has been irrigant of choice to remove the smear layer. It may have antimicrobial activity but relatively limited when compared to NaOCl [6]. Hence, the ideal irrigant should possess the antibacterial properties and should have the ability to dissolve the smear layer. Peracetic acid is strongest disinfect known with antibacterial, sporicidal, antifungal and antiviral. It has been used in the former German democratic republic as single endodontic irrigant [7]. In vitro studies done by Lottanti et al., and De dues et al., proven that peracetic acid is effective in removal of smear layer [8,9]. Therefore, in this study peracetic acid was used to dissolve the smear layer as well as to disinfect the root canal instead of other decalcifying agents [9]. Recently, EDTA based formulations have been used as final rinse solutions, such as Smear clear (Sybron endo, orange, CA) containing EDTA, detergent and cetrimide. This irrigant is specifically designed for the smear layer removal [10].

Some of the studies reported that presence of the smear layer obstructed the penetration of sealers into dentinal tubules and decreased the bond strength of root canal sealers to root dentin. Many studies proposed to use final rinsing to remove the smear layer [11].

Further there have been no studies comparing the effect of peracetic acid with smear clear when employed as a final rinse on push out bond strength of commonly employed root canal sealers of three commonly employed root canal sealers. Hence, the aim of the present study is to compare the effectiveness of peracetic acid and smear clear on the pushout bond strength of three commonly used endodontic sealers kerr, Apexit plus, AH plus to root dentin.

MATERIALS AND METHODS

Experimental short study was conducted in August 2014 for a period of one month at Mamata Dental College. The study protocol was approved by research and ethics committee of Mamata Dental College and Hospital, Khammam, India. Informed consent was taken from patient before extraction.

Sixty six non carious vital mandibular premolars with single roots, extracted for orthodontic reasons, were selected. Teeth with caries, cracks, bifurcated canals, extreme calcification were excluded from the study. Teeth were stored in 0.1% of thymol until further use. Before instrumentation, crowns of each teeth were sectioned at cemento enamel junction using a water cooled diamond disc to obtain a standardized root length of 13mm.Working length was established by inserting k-file No.15(Mani, Tokyo, Japan) short of the apex. The root canals were instrumented and enlarged using Protaper nickel titanium rotary instruments (DENTSPLY, Germany) to size F 3,9% taper, at the working length. Irrigation with 5ml of 2.5% NaOCl was performed between each file size. The samples were then randomly divided into 3 groups (1 control & 2 Experimental groups) according to the final irrigation regimen.

GROUP-1 (n=6):5ml of normal saline (CONTROL) (Nirlife, Gujarat)

GROUP-2 (n=30):5ml of freshly prepared 0.5% of peracetic acid (Prime Laboratories, Hyderabad).

GROUP-3(n=30): 5ml of Smear clear (Sybron Endo, Italy).

Final rinsing was done for one minute in each canal. Canals were rinsed with distilled water to prevent any carry over effect of the final irrigant being tested. Each group was subdivided into three subgroups (n=10) based on the sealer that was used.

Sub group-I: Kerr (Sybron Co, Ltd, Romlus, MI, USA).

Sub group-II: Apexit Plus (Ivoclar Vivadent, Schann, Leichtenstein).

Sub group-III: AH Plus (DENTSPLY, De Trey Gmbh, Konstanz, Germany).

The canals were dried using corresponding Protaper paper points (Dentsply, Malliefer). Sealers were mixed according to the manufacturer instructions. Canals were coated with sealers and obturated using F3 match taper gutta-percha cones. All the specimens were stored at 37°C, 100% humidity for three days to ensure complete setting of the sealers.

Each root specimens were transversely sectioned perpendicular to the long axis of root using diamond disc to obtain a section of 2mm in thickness from middle third as measured using a digital caliper. This methodology is taken from the study done by Amin et al., to evaluate the bond strength of root canal sealers [12]. Middle third section is chosen because the diameter at middle third was standardized for all specimens. However, it was known fact that sealer penetration and bond strength of sealers at apical third was less as shown in previous studies [13]. Each sectioned were coded and photographed from apical and coronal surfaces using a stereomicroscope at a magnification of 120X to measure the diameter of the filling and to calculate the radius.

Push-out testing

The root canal filling in each section was subjected to universal testing machine (MSME testing centre, Hyderabad) at a cross head speed of 1mm/min using a stainless steel plunger of 0.7 mm in diameter as shown in [Table/Fig-1]. Load was applied in apico coronal direction until bond failure occur, which was manifested by extrusion of filling material and sudden drop in load as shown in [Table/Fig-2].The maximum load before failure was recorded in Newton's (N) was to calculate the push out bond strength (Mpa).

Push out bond strength was calculated using a mathematical formula:

$$\text{Push out bond strength (Mpa)} = \frac{\text{Maximum load (N)}}{\text{Adhesion area to dentin (mm}^2\text{)}}$$

$$A = (\pi r_1 + \pi r_2) \times L$$

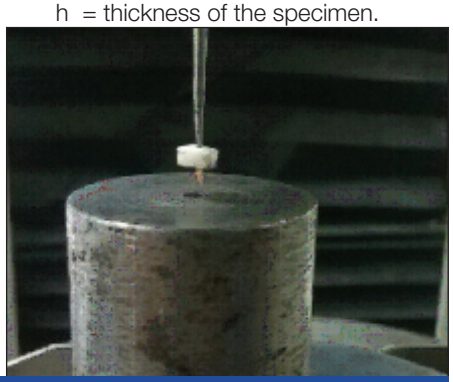
$$L = \sqrt{(r_1 - r_2)^2 + h^2}$$

π = 3.14, constant,

r_1 = smaller radius,

r_2 = larger radius,

h = thickness of the specimen.



[Table/Fig-1]: Specimen mounted on universal testing machine **[Table/Fig-2]:** Extrusion of filling material

STATISTICAL ANALYSIS

The mean push out bond strength values of each group was obtained. The data was analyzed using Two-way ANOVA followed by Tukey Post-hoc test. Significant was established at $p < 0.05$.

RESULTS

Mean push out bond strength values (MPa) of three groups: as shown in [Table/Fig-3].

GROUPS	SUBGROUPS		
	Subgroup-1(Kerr)	Subgroup-2(Apexit plus)	Subgroup-3(AH Plus)
Group-1 (Control Group)	0.587	1.06	1.51
Group-2: (Peracetic acid Group).	0.986	1.743	3.20
Group-3: (Smearclear Group)	0.832	1.656	2.95

[Table/Fig-3]: Shows the comparison of push out bond strength values.

Results showed that Group-1(Control Group) presented lower push out bond strength values than the Experimental Groups (Group-2 & Group-3).

Subgroup-1(Kerr Sealer): Peracetic acid (Group-2) as the final irrigant showed the highest mean bond strength values of 0.986 Mpa followed by smear clear (Group-3), with values of 0.832 ,but no statistically significant difference between the groups were recorded ($p > 0.05$).

Subgroup-2 (Apexit Plus): Peracetic acid (Group-2) as the final irrigant showed the highest mean bond strength values of 1.743 Mpa followed by smear clear (Group-3), with values of 1.656 Mpa, but no statistically significant difference between the groups were recorded ($p > 0.05$).

Subgroup-3 (AH Plus): Peracetic acid (Group-2) as the final irrigant showed the highest mean bond strength values of 3.20 Mpa followed by smear clear (Group-3), with values of 2.95 Mpa, but no statistically significant difference between the groups were recorded ($p > 0.05$).

DISCUSSION

The root canal instrumentation produces the smear layer that may also contain bacteria and their by products, obliterating the dentinal tubules, preventing penetration of sealers and endodontic materials into dentinal tubules there by affecting the adhesion of filling materials to the dentin [4, 14]. The removal of smear layer facilitates the diffusion of irrigants, intracanal medicaments, and sealers and increases the apical sealing of root canal filling [4,15].

According to the study done by Mc Donnel and Russel peracetic acid is proven to be strongest disinfectant known with antibacterial, sporicidal, antifungal and antiviral [5] and it has been used as single endodontic irrigant to disinfect the root canals [7]. In aqueous solution, peracetic acid (PAA) is in equilibrium with hydrogen peroxide, acetic acid and acetyl hydroperoxide. Peracetic acid (Prime laboratories, Hyderabad, India) is not inactivated in the presence of organic material [16] does not leave residues, and does not produce byproducts harmful to the environment [9,16]. The mechanism action of peracetic acid is mainly because of its ability to release free oxygen and hydroxyl radicals when it decomposes into oxygen, and acetic acid [9,16]. Acetic acid liberated or present in peracetic acid possess the ability to dissolve smear layer and provide thorough disinfection of the root canal pretreated with NaOCl [8]. Investigations about its use in endodontics revealed its ability to remove the smear layer [9,17]. Because of these properties, it may be evaluated as an endodontic irrigation solution. Lottanti et al., [8] investigated the effects of 2.25% PAA and EDTA on the smear layer in their study and found comparable results between the irrigants. They also found dentin erosion after the use of 2.25% PAA solutions in the root canals. De-Deus et al., [9] indicated that PAA solutions in various

concentrations could dissolve the smear layer quickly as 17% EDTA solutions. They found that PAA in low concentration (0.5%) did not irritate the oral mucosa and was able to remove the smear layer that's why in the present study we preferred to use 0.5% PAA.

In the present study, Smear clear removed the smear layer as effective as peracetic acid. Smear clear has been introduced in order to increase the efficiency of EDTA based agents to remove the smear layer through the addition of cetrimide and other surfactants. It was believed that addition of surfactant in an irrigating solution would increase the efficiency of irrigation in removal of smear layer and penetration of sealers into dentinal tubules thereby enhancing their bonding ability [17]. It was also seen to be as effective as EDTA for residual removal of smear layer from the root canal wall [18,19].

AH Plus (DENTSPLY, Germany) sealer was used for the current study because it has been shown to have the highest bond strength to root dentin [20] because of its ability to form covalent bond by an open epoxide ring to any exposed amino group in collagen, long term dimensional stability and low polymerization stresses. In the present study, AH Plus showed highest bond strength, irrespective of the final irrigant used ,as compared to other sealers because of these favourable factors.

Final rinse in the present study was done for one minute for both the irrigation groups and doesn't have any undesirable effect [21]. As it has been seen that longer than one minute causes inadvertent erosion of root canal wall and decrease the fracture resistance of the root [21,22].

Bond strength testing was used for determining the effectiveness of adhesion between endodontic materials and tooth structure. Pushout bond strength testing was most popular method among other tests and chosen for this sudy. Probable reasons are that with this design, it is easy to align samples for testing. It is less sensitive to small variations among specimens and to the various of stress distribution in load application [20].

Results of present study showed that Group-1 (control group) presented lower push out bond strength, in which specimens were not irrigated with final irrigant, as compared to experimental groups, indicating that the smear layer removal with final irrigating solutions is essential to facilitate the sealers to penetrate the dentinal tubules and to enhance their bond strength to root dentin [4].

Peracetic acid (0.5%) used in the present study as final irrigating solution effective in removal of smear layer similar to the results shown in the study done by De Deus et al., and Lottanti et al., [8,9]. Results of the present study showed that peracetic acid was also increased the bond strength of root canal sealers tested in the study but not statistically significant than smear clear.

LIMITATIONS OF THE STUDY

Limitations of the present study was we took only middle third sections of root as specimens and further studies should be done evaluating the bond strength as taking into consideration of apical third sections.

CONCLUSION

Within the limitations of present in vitro study, peracetic acid when employed as final irrigant improved the bond strength of root canal sealers compared to control group but not statistically significant than smear clear.

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PARTICULARS OF CONTRIBUTORS:
1. PG Student, Department of Conservative Dentistry and Endodontics, Mamata Dental College, Andhra Pradesh, India.
2. Professor and HOD, Department of Conservative Dentistry and Endodontics, Mamata Dental College, Andhra Pradesh, India.
3. Reader, Department of Conservative Dentistry and Endodontics, Mamata Dental College, Andhra Pradesh, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Muralidhar Tummala,
Reader, Department of Conservative Dentistry and Endodontics, Mamata Dental College, Andhra Pradesh, India.
Email: naresh5may@gmail.com

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