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Effect of Calcium Hydroxide, 3-Mixtatin and Silver Diamine Fluoride as Intracanal Medicaments on Push out Bond Strength of AH Plus Sealer: An in-Vitro Study

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Abstract

Purpose: To determine the effect of intracanal medicaments on push out bond strength of AH plus sealer.

Materials: Eighty extracted human permanent single-rooted teeth with fully formed apices were selected, access opening and biomechanical preparation was done, specimens were divided into four groups based on the type of intracanal medicament placed. Group I control with no intracanal medicament, Group II RC cal was placed as intracanal medicament, Group III 3-Mixtatin placed as intracanal medicament, In Group IV Silver diamine fluoride was placed as intracanal medicament, After one week of incubation at 37ºC, the intracanal medicament was removed and obturated with AH plus sealer using single cone obturation technique and the specimens were subjected to universal testing machine.

Results: The highest bond strength was shown by 3-Mixtatin group followed by Silver diamine fluoride, RC Cal and control groups. Among all the groups, the bond strength was higher in apical1/3rd, followed by middle1/3rd and least at coronal1/3rd.

Conclusion: 3-Mixtatin and SDF can be efficiently used as intracanal medicaments as an alternative to conventional medicaments because of improvement in the push out bond strength values of AH plus sealer.

Keywords: Silver diamine fluoride, Bond strength, AH plus sealer, 3- Mixtatin

Introduction

Endodontic treatment is essentially directed towards the prevention and control of pulpal and periradicular infections.[1] Antimicrobial irrigants and medicaments are used during instrumentation in canal which reduce bacterial population effectively, however some bacteria may

survive in lateral canals, accessory canals, isthmi and apical delta. The placement of intracanal medicaments between the appointments helps in eradication of the surviving microorganism and promoting the successful outcome of the treatment.[2]

Calcium hydroxide has been widely used in endodontics because of its antimicrobial activity, organic tissue dissolution capability, anti-inflammatory effects.[3]It was introduced by Hermann in 1920.[1] RC Cal, is a water based radiopaque Calcium hydroxide paste with barium sulfate having high hydroxyl ion release with an high alkaline pH of 11.8 when used as intracanal medicament.[4]

A single antibacterial drug may not be effective though broad spectrum as the bacterial composition of the infected root canals is complex.[5]Acombination of Metronidazole, Ciprofloxacin and Cefixime (3Mix) where, Metronidazole is a nitroimidazole compound that exhibits broad spectrum of antimicrobial activity, Ciprofloxacin a synthetic fluoroquinolone which is effective against Gram-negative bacteria and Cefixime is a third-generation Cephalosporin antibiotic which reduces the stability of bacterial cell walls and promotes bacterial cell lysis.[6,7,8]

To sterilize the deep layers of infected root dentin, the intracanal medicaments should penetrate into the root canal dentin, the insight of these drugs was improved by mixing 3 Mix with Propylene glycol and Macrogol to form an ointment base which further exhibits antimicrobial action. Simvastatin has shown to possess pleiotropic effects such as antimicrobial, anti-inflammatory and bone-forming properties.[9]

In the present study 100 mg Ciprofloxacin, 100 mg Metronidazole and 100 mg Cefixime were mixed in a ratio of 1 : 1 : 1 with Propylene glycol and Macrogal along with two grams of Simavastatin.

Silver diamine fluoride (SDF) has been studied as a potential intracanal irrigant and medicament to disinfect the root canal system.[10] A 3.8 w/v% Silver diamine fluoride solution has been developed as intracanal irrigation which represents a 1:10 dilution of the original 38% $Ag(NH_3)_2F$ solution used for root canal infection.[11]

Complete obturation of the root canal system and stipulation of a proper seal at the root canal walls is one of the important aim of endodontic treatments.[12] The epoxy resin-based sealers, such as AH Plus is used because of its long-term dimensional stability, reduced solubility, better flow characteristics and adequate micro retention to dentin.[13] The bond strength of the sealer to the root canal dentin was assessed by Push out test using Universal Testing Machine (UTM). Aim of the present study is to assess the effect of intracanal medicaments on the push out bond strength of AH plus sealer.

Materials and Methodology

Selection of Teeth

Eighty extracted human permanent single-rooted teeth which were extracted for orthodontic or periodontal reasons with straight or slightly curved, single canaled, fully formed apices which were confirmed radiographically were selected for the study.

Inclusion and exclusion criteria: Teeth with no visible caries, no restorations, no fracture lines or cracks were included in the study. Teeth with presence of caries, restorations, fracture lines, cracks, resorption were excluded from the study.

Specimen Preparation

The external surface of the teeth were cleaned with a hand scaler and were stored in normal saline until use. Access cavities were prepared by using Endo-access bur no.4witha high speed hand piece and the canals were negotiated with #15 K file upto the apex and confirmed radiographically.

Decoronation

Teeth were decoronated at Cemento Enamel Junction (CEJ) with a slow speed hand piece, using a diamond disc to obtain a standardized root length of 14mm. Working length of 13mm was determined with a 15 K file, and was confirmed radiographically. All the teeth were biomechanically prepared by using protaper rotary files up to size F2. Between each instrumentation the root canals were irrigated with 3%Sodium hypochlorite as initial irrigant followed by 17% Ethylenediaminetetraacetic acid (EDTA) each for 60seconds and final rinse was done with 10ml of Normal saline.

Grouping and Placement of Medicament

All the Specimens were divided into four groups (N=20) based on the type of intracanal medicament placed. In Group I no intracanal medicament was placed and considered as control group. In Group II RC Cal a water based radiopaque Calcium hydroxide paste was placed as intracanal medicament for one week .

Preparation of 3-Mixtatin: Antibiotic mixture (3-Mix) was prepared by using 100 milligrams of Metrogyl, Cefixime, Ciprofloxacin and two milligrams of Simavastatin were pre-weighed with micro analytical balance were pulverized by porcelain mortar and pestle to achieve fine powder (3-Mixtatin). One gram of Macrogal weighed with Micro analytical balance mixed with 1ml of Propylene glycol which was measured with micropipette. These were mixed with 3-Mixtatin in a ratio of 1:5 as a vehicle to form a paste on a glass slab with a cement spatula.3-Mixtatin paste was placed as intracanal medicament with 25 size spreader for one week in group III.

3.8% Silver diamine fluoride preparation: 3.8%Silver Diamine Fluoride (SDF)was prepared by diluting1 ml of 38% SDF with 10 ml of Distilled water. 3.8% SDF was placed as intracanal medicament for one week in group IV.

After one week intracanal medicaments were removed by using 10 ml of 3% Sodium hypochlorite and 10 ml of 17% EDTA. All the canals were dried with F2paper points. AH Plus sealer was manipulated according to manufacturers instructions. Obturation was done with Protaper F2 points and AH plus sealer, excess guttapercha was sheared off with GP cutter and were analyzed radiographically.

Prepared teeth specimens were kept in an incubator with relative humidity of 100% at 37ºc for 24 hours. All the specimens were transversally marked and sectioned with a diamond disc into four slices to obtain a thickness of two mm each. The first coronal slice corresponding to cervical was discarded, the remaining slices coronal, middle and apical thirds were subjected to push out bond strength.

Pushout Bond Strength Evaluation

Stainless steel plunger of 1mm diameter for cervical third, 0.8mm diameter for middle third and 0.5mm for apical third were used. The push out bond strength at failure was calculated in Megapascals by dividing the force by surface area of the test material.

The area in each cross section was calculated by

Area = $2\pi rh$

Where π= constant value of 3.14.

r = radius of the intraradicular space (root canal radius).

h = height (thickness of the root dentin slice) in mm.

The obtained readings were subjected to statistical analysis.

Results

Statistical analysis was performed using two way ANOVA analysis for comparison of four groups at coronal, middle and apical third regions with mean push out bond strength at failure. Amongst all the groups, 3-Mix exhibited highest push out bond strength followed by SDF and least push out bond strength was exhibited by CH (graph

1). The mean push out bond strength at coronal, middle and apical thirds, apical third exhibited highest push out bond strength followed by middle and least push out bond strength was exhibited at coronal third (graph 2).

Amongst all the groups, 3-Mix exhibited highest push out bond strength followed by SDF and least push out bond strength was exhibited by CH at coronal third (graph 3).

When all the three regions(coronal, middle and apical) were compared apical third exhibited the highest push out bond strength followed by middle third and least for coronal third (Table 2). Amongst all the groups 3-Mix at apical third exhibited higher push out bond strength and CH at coronal third exhibited least pushout bond strength.

Discussion

Adhesion of root canal filling material to dentinal walls is important in both static and dynamic situations. In a static situation, it should eliminate any space that allows percolation of fluids between the filling and the wall. In a dynamic situation, it is needed to resist dislodgment of the filling during subsequent manipulation.[14]

In the present study RC Cal, 3-Mix, 3.8% SDF were placed as intracanal medicaments in the specimens for one week, it has been reported that a seven-day interappointment dressing with $Ca(OH)_2$ was sufficient to reduce intraradicular bacteria to a level that provided a negative culture. However, the long-term exposure to interappointment medicament has been suggested to affect the mechanical properties of root dentin by either collagen degradation.[15]

V.H. Nunes et al (2008) concluded that AH plus sealer forms covalent bond by an open epoxide ring of the sealer to any exposed amino groups in root dentin collagen. Inan et al (2009) reported that the apical sealing ability of single cone obturation was compatible with that of lateral condensation and thermafil techniques.[16] Therefore, Single cone obturation technique with thin layer of AH plus sealer applied on to the core material was used in the present study. So, as to maintain standardization.

The multiple test panels for measuring bond strength are shear and micro-tensile bond strength tests. The analysis of bond strength is a methodical approach to investigate the dislodgment aversion of the sealer. [17]

In the present study sectioned specimens were subjected to bond strength test using Universal testing machine. As it ensures homogenicity, standardization and convinience.[15] Goracci et al (2004) reported that the bond strength is a very reliable method in determining the binding efficiency of the root canal sealer. [17]

The bond strength of root canal filling materials is affected by different factors, including the anatomy of the root canal, the prior placement of intracanal medicaments, obturation materials and techniques, slice thickness and the final irrigation protocol.[18] The advantages of the push out bond strength method are the possibility of placing the sealer in direct contact with the intracanal dentin walls instead of flat coronal dentin surface, which presents a different tubule arrangement pattern, when the specimen is filled with sealer, the material accomodates the canal shape and penetrates into dentinal tubules, promoting mechanical retention similar to clinical conditions. [19] The high bond strength was shown by 3-Mix followed by SDF, RC Cal and control groups.

Increase in the bond strength of resin-based sealers to dentin after application of Triple antibiotic paste (TAP) could be attributed to the strong demineralizing and erosive effects of the medicament on the radicular dentin due to its low pH value. In addition, a decline in the phosphate/amide I ratio has been reported after treatment of dentin with TAP. This chemical change may also have a promising effect on the bond strength of resin-based sealers to dentin..[20] Merve Akcay et al (2014)reported that the Triple antibiotic paste improved the bond strength in both apical and middle thirds.[21]

The SDF group has shown less bond strength than the 3-Mix group. This might be due the occlusion of precipitated Silver and Fluoride ions in areas of complex root canal system morphology, such as dentinal tubules, thus acting as a barrier to optimum penetration of the root canal filling material and can be considered a potential sealing quality hinderance for the root canal filling sealers to the dentin, thus reducing the bond strength.[22]

RC Cal (Group 2) had shown low bond strength when compared to 3-Mix and SDF groups. The low bond strength was due to the residual $Ca(OH)_2$, which acts as a barrier and prevents the development of the chemical bonds between the sealers and dentin and negatively affects their adaptation with dentinal walls, resulting in decrease in the bond strength.[23] Hosoya et al (2000) reported that the water included in residual CH may affect mechanical properties and apical sealing ability, CH should be removed as much as possible during root canal filling. [24] Findings similar to the present study have been demonstrated by Guiotti FA et al (2014) reported that the Calcium hydroxide residue may have an adverse affect on the bond strength of AH Plus in the cervical and apical thirds by acting as a physical barrier between root dentin and the endodontic sealer.[25]

Among all the groups, the bond strength was higher in apical1/3rd, followed by middle1/3rd and least at coronal1/3rd. Chaubey et al (2022) reported that the apical segment showed higher push-out bond strength to root dentin when compared to the middle and coronal third segments of root dentin.[26] The possible reason might be due to the compaction of the obturating material in the apical 1/3rd region because of down packing, resulting in better penetration of sealer into the dentinal tubules. This leads to less polymerization shrinkage stress in the resin sealer. Thus decreasing voids and achieving homogenous mass at the dentine-sealer and sealer-cone interfaces, which increases bond strength. Findings similar to the present study was reported by Mannocci *et al (2004)* that the higher values of bond strength of dentin are associated with low densities of dentinal tubules and that apical areas of root dentin have higher bond strengths than middle and coronal ones.[27]

Limitations

The following limitations can be drawn from the present study:

1. The effect of intracanal medicaments on push out bond strength of AH plus sealer to root dentin, performed under in-vitro conditions do not stimulate the clinical conditions.
2. The results of push out bond strength performed in single rooted teeth may differ for multirooted teeth because of complex anatomy.
3. The cross head speed of Universal testing machine used i.e., 5 mm/min might not be the same in clinical situations.
4. The use of 3% Sodium hypochlorite and 17% EDTA as irrigants without activation does not adequately remove intracanal medicaments which in turn effects the sealer penetration into dentinal tubules.

Conclusions

Within the limitations of this study it can be concluded that the prior placement of intracanal medicament had effect on adhesion of AH plus sealer to root dentin. Amongst intracanal medicaments used 3-Mix and SDF had showed significantly higher push out bond strength in apical third, followed by middle and coronal thirds when compared to $Ca(OH)_2$ and Control groups. 3-Mix and SDF can be efficiently used as intracanal medicaments as alternative to conventional medicaments because of improvement in the push out bond strength values of AH plus sealer.

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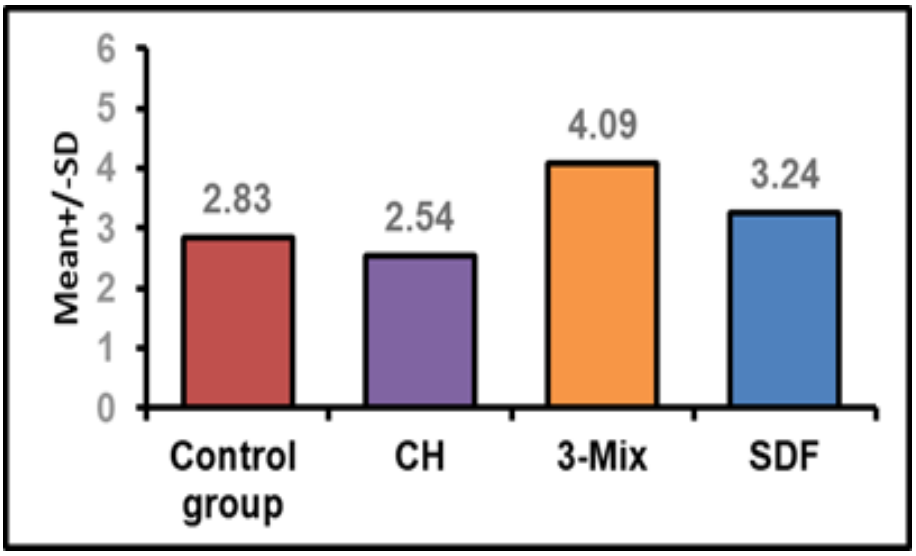
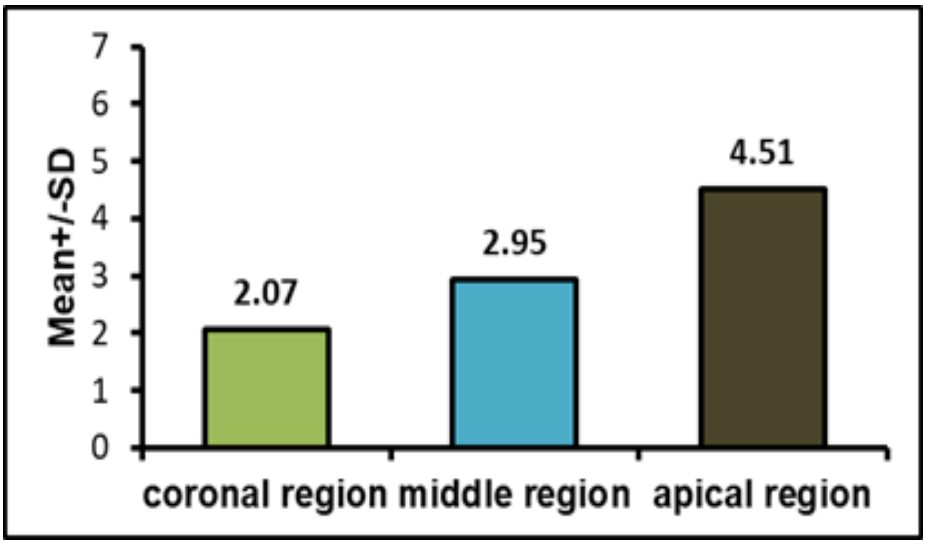
Legend Graphs and Tables



Graph 1: Mean push out bond strength of Control, CH, 3-Mix, SDF at failure



Graph 2: Mean push out bond strength on comparison of coronal, middle and apical third regions at failure.

Table 1: Comparison of Control group, CH, 3-Mix, SDF with mean push out bond strength at failure by Tukey's multiple posthoc procedures.

Groups	Control group	CH	3-Mix	SDF
Mean	2.83	2.54	4.09	3.24
SD	1.37	1.80	1.59	1.75
Control group	-			
CH	P=0.6126	-		
3-Mix	P=0.0001*	P=0.0001*	-	
SDF	P=0.3147	P=0.0173*	P=0.0017*	-

Table 2: Comparison of coronal, middle and apical regions with mean push out bond strength at failure by Tukey's multiple posthoc procedures

Regions	coronal region	middle region	apical region
Mean	2.07	2.95	4.51
SD	1.26	1.33	1.61
coronal region	-		
middle region	P=0.0001*	-	
apical region	P=0.0001*	P=0.0001*	-