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International Journal of Endodontic Rehabilitation

Original Study

Effect of chlorine-based irrigants on push out bond strength of resin sealer to radicular dentin-an in vitro study

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***How to cite**: Mahalakshmi Nandakumar. Effect of chlorine-based irrigants on push out bond strength of resin sealer to radicular dentin – an in vitro study. Int J Endodnd Rehabil Volume 2022, Article ID 22101410, 6 pages.*

Received:05.08.22 *Accepted:29.09.22* *Web Published:14.10.22*

ABSTRACT

Introduction

Sodium hypochlorite (NaOCl) due to its excellent antimicrobial action and tissue dissolving property is the most used irrigant. However, it is toxic if it is extruded beyond apex into the periapical tissues, alters the biomechanical property of dentin of the root canal wall, interferes with the resin sealer polymerization and hence compromises the bond strength. Recently, there has been increased research in search of an alternative irrigant, Calcium hypochlorite.

Aim

To evaluate and compare 3% and 5 %Calcium hypochlorite with 3% sodium hypochlorite root canal irrigants along with sealer to determine push out strength.

Materials and Methods

Thirty teeth having single root were decoronated and randomly allocated into three groups: Group A - 3% NaOCl, Group B - 5% Ca(OCl)2, Group C - 3% Ca(OCl). All the samples were obturated with F3 GP, AH Plus sealer and cut 1mm thick slices and tested in universal testing machine.

Results

Group B>Group C>Group A, with study 5% Ca(OCl)2 has significantly better bond strength compared to 3% Ca(OCl)2 and 3% NaOCl.

Conclusion

Ca(OCl)2 is a promising irrigant with good antimicrobial efficacy against E.Faecalis, acceptable cytocompatibility and does not negatively alter the dentin mechanical properties and also exhibit superior bond strength values as compared to NaOCl.

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***Keywords:** Bond strength, Calcium hypochlorite, Dentin modification, Resin sealer.*

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INTRODUCTION

Success of an endodontic treatment depends mainly upon the ability to eradicate the microorganism from the root canal system. Owing to the different anatomy of the root canals, instrumentation techniques alone are not sufficient to render a bacteria free canal space. Large portion of the root canal system remains untouched by the instruments; therefore, the role of a chemical disinfectant becomes crucial.[1] Various chemical disinfectants in the form of irrigants and intracanal medicaments have been used in endodontics.[2]

Sodium hypochlorite (NaOCl)is the commonly used irrigant because of its excellent antimicrobial activity and tissue dissolving property. NaOCl dissociates into HOCl and OCl ions, HOCl exerts its antimicrobial action by disrupting the oxidative phosphorylation, inhibiting mitochondrial function and DNA synthesis of bacteria.[3] Its tissue dissolving property is due to its non-specific proteolytic action.[4] However, it also has certain demerits; it is toxic if it is extruded beyond apex into the periapical tissues, alters the biomechanical property of dentin of the root canal wall.[5,6,7] There has been a constant quest in search of an alternative irrigant that is able fulfill all the ideal requirements and overcome these drawbacks of the conventional irrigants.

Recently, there has been increased research on other chlorine based irrigants like Calcium hypochlorite and Chlorine dioxide. Calcium hypochlorite ($Ca(OCl)_2$) member of halogen oxyacid salts, is a white powder. This solution is effective against Enterococcus faecalis and tissue dissolving property like that of NaOCl.[8] Therefore, the aim was to compare 3% and 5 % Calcium hypochlorite with 3% sodium hypochlorite irrigants on sealer penetration and adhesion to root canal dentin.

MATERIALS AND METHODS:

Thirty sound human teeth with single root that were removed for periodontal and orthodontic purpose were included in this study. Samples were washed and autoclaved in solution of formalin 10%

Preparation of solution:

3% Calcium hypochlorite was obtained by mixing 3 grams of CaoCl2 powder in 100 ml distilled water.

5% Calcium hypochlorite was obtained by mixing 5 grams of CaoCl2 powder in 100 ml distilled water.

Preparation of the specimen:

Each tooth sample was decoronated to obtain a homogenous length of 13 mm. WL was measured by introducing a 15 size K file till it is seen on the apical end of the tooth and then reducing 1mm from that length.

Cleaning and shaping was done using ProTaper Gold rotary files (Dentsply Maillefer, Ballaigues, Switzerland) until F3 file size. The samples were then randomly divided into three groups for receiving different irrigants during instrumentation:

Group A: 2 ml 3% Sodium Hypochlorite between each consecutive files, followed by final rinse with 1ml of saline.
Group B: 2 ml of 5 % Calcium Hypochlorite between each sequential file, followed by final rinse with 1 ml of saline
Group C: 2 ml 3% Calcium Hypochlorite between each consecutive file, followed by final rinse with 1ml of saline.

Next root canals were dried using paper points, obturated with GP points and filled with Cavit-G(3M ESPE). After which they were sectioned at middle thirds using diamond disk at low speed using constant cooling water, to obtain a uniform section of 1.5± 0.05 mm thickness. The best of these sections were selected and mounted in acrylic resin.

Push-out testing: Each sample was then subjected to bond strength testing using Universal Testing Machine at 1mm/min, a 0.8 mm diameter.

The adhesion (bonding) surface area of each section was calculated as:

A=лL (r1+r2) where, L= (r1-r2)1/2 +h2, л is the constant 3.14, r1 is apical radius, r2 is coronal radius and h is the thickness of sample in millimeters.

RESULTS:

Results done by IBM.SPSS statistic software version 23.0. Table 1 describes the descriptive statistics, mean and Standard deviation used. To find in the multivariate analysis, one way ANOVA and Post-hoc Tukey was used. p value was found to be significant at <0.05.

Table 1: Descriptive Statistics, Mean and Standard Deviation used

Groups	Mean	Std Deviation	p value
Group A	94.3	12.5	0.049
Group B	108.5	16.8	
Group C	102.4	3.0	

Table 2: Post-hoc Tukey test

Groups		Mean Difference	Significance (p value)
Group A	Group B	-14.21500*	.039
	Group C	-8.05100	.322
Group B	Group A	14.21500*	.039
	Group C	6.16400	.508
Group C	Group A	8.05100	.322
	Group B	-6.16400	.508

DISCUSSION

An ideal endodontic irrigant should possess certain characteristics like antimicrobial efficacy, tissue dissolving property, minimal or no cytotoxicity, smear layer removal and minimal or no effect on the microstructure of dentin. Although sodium hypochlorite has been used routinely, it is relatively cytotoxic and on contact with periapical tissues causes severe inflammatory reaction and pain and has proven to adversely affect the dentin bond strength. Several mechanisms are proposed for the adverse consequence of NaOCl on dentin bond strength as the removal of organic matrix could render a less receptive surface for bonding. Another possible cause could be the presence of residual irrigants in the dentinal tubules, that interferes with the diffusion of resin sealer.[9]

Recently, there has been increased research on the potential use of calcium hypochlorite as an endodontic irrigant. Calcium hypochlorite is a halogenated compound and Ca(OCl)2 is a stable compound with relatively higher available chlorine ion percentage than NaOCl.[10] Various studies have been published on properties of Ca(OCl)2 such as antimicrobial efficacy, biocompatibility, effect on dentin hardness. Sedigh- Shams et al, compared the antimicrobial efficacy of calcium hypochlorite and sodium hypochlorite and also evaluated its cytocompatibility, according to him calcium hypochlorite at MIC of 5% was effective in eliminating *E. faecalis* planktonic to that of 0.5% Sodium hypochlorite.[11] Tissue dissolving capacity of 1.36% and 5 % sodium hypochlorite was tested against 5% and 10% Ca(OCl)2, it was concluded that 5% NaOCl showed faster tissue dissolution over the first 35 minutes, but there was no significant difference among the solutions thereafter.[12] However, when the temperature was increased to 45℃, 3% NaOCl and 10% Ca(OCl)2 showed equally effective tissue dissolving property over 20 minutes.[13]

Fracture of endodontically treated teeth is quite common and the resistance of endodontically treated teeth to fracture depends mainly on the RDT in the root canals.[14] NaOCl is a deproteinating agent, that causes morphological modification and structural damage to dentin.[15] Reddy P et al, evaluated sodium hypochlorite and calcium hypochlorite on mechanical properties of root dentin, it was observed that 5% NaOCl more reduction in the flexural strength and MOE of root dentin on comparison to 5% Ca(OCl)2.[16] Also Ca(OCl)2 does not negatively affect the ultimate tensile strength of dentin as NaOCl.[17]

In the current study 5% Ca(OCl)2 has significantly better bond strength compared to 3% Ca(OCl)2 and 3% NaOCl. The outcomes could be attributed to the following possible reason: Firstly, ionization of Ca(OCl)2 , discharging HOCl and calcium hydroxide. The calcium released forming crystals compatible with the dental tissue- stabilizing the dentin microstructure and secondly, lower surface tension than NaOCl.[18] Furthermore, in adhesive surfaces, Ca(OCl)2 no change to alter resin-dentin interface characteristics as observed under scanning electron microscopy.[19]

CONCLUSION

The result of the current study suggests the usage of Calcium hypochlorite as an alternative irrigating solution for root canal treatment, specifically for structurally compromised teeth. Ca(OCl)2 is a promising irrigant with good antimicrobial efficacy against E.Faecalis, acceptable cytocompatibility and does not negatively alter the dentin mechanical properties and also exhibit superior bond strength values as compared to NaOCl. However, further studies on antimicrobial property against other microbial species of root canal flora, flow rate, smear layer removal ability, cytotoxicity are needed to substantiate its use and to bring it into clinical trial.

Financial support and sponsorship – Nil

Conflicts of interest - There are no conflicts of interest.

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