Asian Journal of Pharmaceutical and Health Sciences

www.ajphs.com

Quantity of sodium thiosulfate required to neutralize various concentrations of sodium hypochlorite

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ARTICLE HISTORY

Received: 01.05.2012

Accepted: 24.06.2012

Available online: 10.08.2012

Keywords:

Astringent, gingival retraction, gum paint, retraction cord, ayurvedic astringent

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ABSTRACT

The aim of the study was to evaluate the quantity of 5% Sodium thiosulfate required to neutralize 0.5%, 1%, 2%, 3% and 5% Sodium hypochlorite.Different concentrations of the sodium hypochlorite (0.05%, 1%, 2.5%, 3% and 5%) were taken in different test tubes to which 5% of sodium thiosulphate, 0.1ml concentrated hydrochloride were added and 0.5ml crystal violet was added as an indicator. The volume of sodium thiosulphate was noted at which the crystal violet colour persisted. The volume of sodium thiosulphate was increased, if the crystal violet colour disappeared and this was done in fresh test tube repeating the same procedure. Though persistence of the colour itself indicated there was no excess of NaOCl left in the test tubes, all these solutions were decanted into the cuvette and cross checked by the spectrophotometric analysis respectively, by setting distilled water reference.1ml, 1.4ml, 2.4ml, and 3.5ml of 5% sodium thiosulfate when added to 1ml of 0.5%, 1%, 2%, 3% and 5% Sodium Hypochlorite respectively, the colour of the crystal violet persisted indicating there was no excess of hypochlorite left to decolourize it. The quantity of 5% Sodium Thiosulfate required to neutralize Sodium Hypochlorite of 2%, 3% and 5% is 1.4ml, 2.4ml and 3.5ml respectively.

INTRODUCTION

One of the primary goals of endodontic therapy is to eliminate microorganisms from the root canal system. Microorganisms and their end products are considered the major cause of pulpal and periapical pathosis.[1] Hence elimination of microorganisms in infected root canals can directly influence the success of endodontic treatment. Achievement of this objective requires the introduction of an antimicrobial endodontic irrigant during root canal therapy. Several solutions have been suggested as root canal irrigants. Sodium hypochlorite (NaOCl) is one of the most commonly and widely used root canal irrigant in a concentration range from 0.5%-5.25%. It is an irrigant of choice due to its efficacy against pathogenic organisms [2] and pulp digestion.[3]

Complete elimination of microorganisms cannot be achieved consistently with current treatment methods.[4,5] Therefore, an additional goal of treatment is to seal the root canal system from the outside environment with an obturating material and entomb any residual microorganisms. A sealer along with gutta-percha is used to achieve a fluid impervious seal. The sealer serves as a lubricant, as a filling material to fill any voids and gaps between the main root filling material and root dentin. Advances in the adhesive resin technology have shown the utility of resin cements as sealer,[6] intracoronal secondary seals after root canal therapy [7] and for endodontic post cementation.[8] Studies have shown that NaOCl irrigation leads to decrease bond strength between dentin and resin cement and may require a reversal agent.[9] Morris *et. al.* showed that application of 10% ascorbic acid or 10% sodium ascorbate reversed the effect of sodium hypochlorite and restored bond strength to normal levels.[10] Other studies [9, 11] have used sodium thiosulfate and proanthocyanidin agent [12] as neutralizing agent for NaOCl.

As sodium hypochlorite is likely to remain the primary irrigant of choice in endodontics for the near future, and adhesive resin materials are used routinely in endodontics, the interaction between them will have to be addressed.

Various studies have used different quantity of sodium thiosulfate to neutralize NaOCl. None of these studies have clearly mentioned the quantity of sodium thiosulfate required to neutralize different concentration of NaOCl. Hence, the purpose of this study was to evaluate the quantity of 5% sodium thiosulfate required to neutralize 0.5%, 1%, 2%, 3% and 5% sodium hypochlorite.

MATERIALS AND METHOD

Reagents and Solutions

All reagents used were of analytical reagent grade and distilled water was used throughout the study. Sodium thiosulfate crystals, hydrochloric acid (2M) and crystal violet (CV) (0.05% v/v) were also used.

METHODOLOGY

Aliquots of sample solution containing different concentration (0.5%. 1%, 2%, 3%, 5% v/v) of sodium hypochlorite were transferred into a series of test tubes. 1ml of 5% (w/v) sodium thiosulphate, 0.1ml of concentrated hydrochloric acid and 0.5ml (2% v/v) of crystal violet were added to it. The mixture was gently shaken and observed for the persistence and disappearance of the crystal violet color. Persistence of color indicated no excess of NaOCl left in the test tube and disappearance of color indicated excess of NaOCl left in the test tube which is not neutralized.

The sample test tube in which the color of CV disappeared, were tested again with the increased volume of sodium thiosulfate and the value was reported at which the crystal violet color persisted. Though persistence of the color itself indicated there was no excess of NaOCl left in the test tubes, all these solutions were subjected to spectrophotometeric analysis. All solutions were decanted into the cuvette and cross checked by the spectrophotometric analysis (Systronic Spectrophotometer-106, Ahmadabad, India), by setting distilled water as reference.

RESULTS

In test tubes with 0.5% and 1% (v/v) of 1 ml NaOCl, color of the crystal violet persisted indicating complete neutralization of NaOCl, whereas, in test tubes with 2%, 3% and 5% (v/v) of 1 ml NaOCl, color of the crystal violet disappeared, indicating insufficient neutralization of NaOCl. The test was repeated with the increased volume of sodium thiosulfate. At 1.4ml, 2.4 ml and 3.5ml of sodium thiosulfate, the color of crystal violet persisted for 2%, 3% and 5% (v/v) NaOCl respectively. In addition it was observed that some amount of yellow precipitate was formed in all the samples. The formation of precipitate was directly proportional to the concentration of NaOCl.

Table 1 shows the sphectrophotometric readings recorded in % Transmittance *and amount of sodium thiosulfate required to neutralize NaOCl.* The % transmittance of the resulting solution was measured at 590 nm against distilled water. As the sodium hypochlorite concentration increased the % transmittance decreased *because of the presence of precipitates.*

DISCUSSION

It is well established that chemomechanical preparation using files and antibacterial irrigants reduces the bacterial load.[13,14] Irrigants can augment mechanical debridement by flushing out debris, dissolving tissue and disinfecting the root canal system. Sodium hypochlorite solution has been used as an endodontic irrigant for well over 4 decades. It is a potent irrigant with broad-spectrum antimicrobial activity and has potential to dissolve the necrotic pulp tissue and organic debris. It causes alteration in cellular metabolism of microorganisms and causes destruction of phospholipids, degradation of lipids and fatty acids. Its oxidative actions cause deactivation of bacterial enzymes.[15] It is an ideal endodontic irrigant in many ways, but causes problem when used with adhesive resins. Recent studies have shown that residual NaOCl may interfere with polymerization of bonding resin due to oxygen generation. Oxygen is one of the many substances that inhibit the polymerization of resins.[16] Moreover, NaOCl is an efficient organic solvent that causes dentine degeneration because of the dissolution of dentinal collagen by the breakdown of bonds between carbon atoms and disorganization of the proteic primary structure.[17] The reduction in bond strength seen between adhesive systems and dentin walls may be because of the removal of collagen fibrils from the dentin surface, impeding the formation of a consistent hybrid layer.[18]

One possible solution to this problem is the application of a reducing agent to dentin after sodium hypochlorite irrigation. Reducing agents such as ascorbic acid or sodium ascorbate,[10, 19, 20, 21] sodium thiosulfate [22] and proanthocyanidin agent [13] are reported to reverse the negative affects of sodium hypochlorite by oxidation-reduction reaction.[23] The anti-oxidant ability of these agents can help to neutralize and reverse the oxidizing effects of NaOCl.[24] Several studies have used different quantity of sodium thiosulfate to neutralize NaOCl, but none of the studies have reported the quantities of sodium thiosulfate required to neutralize various concentrations of NaOCl. Hence, the purpose of this laboratory study was to evaluate the quantity of sodium thiosulfate required to neutralize different concentration of NaOCl.

Results in this present study showed that 1ml of 5% sodium thiosulfate can neutralize only 0.5% and 1% of NaOCl. The quantity of sodium thiosulfate required to neutralize 2%, 3% and 5% of NaOCl was 1.4ml, 2.4ml and 3.5ml respectively. Following chemical reaction takes place between NaOCl and sodium thiosulfate:

$$NaOCl + Na_2S_2O_3 + HCL \rightarrow Na_2SO_4 + NaCl + SO_{2(g)} + Cl_{2(g)} + H_2O$$

This neutralization reaction resulted in the formation of

Table 1. Spectrophotometric analysis readings and quantity of sodium thiosulfate requirement for NaOCl neutralization.

Concentration of NaOCl	% Transmittance	Sodium Thiosulfate (ml)
0.5%	5.6	1.0
1%	5.4	1.0
2%	5.2	1.4
3%	5.1	2.4
5%	4.8	3.5

soluble yellow precipitates of sodium sulfate and sodium chloride. Precipitates were formed in all the samples but the amount of precipitate increased with increase in concentration of NaOCl.

Several methods have been reported for the determination of hypochlorite. These include colorimetric, chemiluminescent, potentiometric, amperometric, titrimetric, spectrophotometric, Iodometric, polarographic and radiolytically-induced redox methods.[25] In the present study spectrophotometric analysis was done. The method was based on the reaction of hypochlorite with sodium thiosulfate in acidic medium to liberate chlorine. Bleaching of the crystal violet by the liberated chlorine was the basis of the determination and was measured at 590 nm. The % transmittance was observed to be less in 5% NaOCl because of the presence of precipitates. The decrease in % transmittance is inversely proportional to the hypochlorite concentration.

Further studies are required using tooth model to see the effect of dentin on neutralization reaction, minimal time necessary for the sodium thiosulfate treatment of NaOCl treated canal, effect of precipitates on bonding and method of removal of these precipitate from the dentin. The clinical implication of the study is that, with the use of an anti-oxidant such as sodium thiosulfate, clinician can use resin-based sealer after NaOCl treated dentin.

CONCLUSION

Based on the results obtained and considering the limitations of this study, it can be concluded that with the increase in the concentration of NaOCl, the quantity of sodium thiosulfate also has to be increased in order to completely neutralize NaOCl.

ACKNOWLEDGEMENT

We would like to acknowledge Dr. Bhasker, professor and Head, and Dr. Anil Chemistry Department, Amrutha School of Engineering, for their help in this study.

REFERENCES

1. Kakehashi S, Stanley HR, Fitzgerald RJ. The effect of surgical exposures of dental pulps in germ free and conventional laboratory rats. Oral Surg Oral Med Pathol Oral Radiol Endod 1965:20:340-9.
2. Bystrom A, Sundquist G. Bacteriologic evaluation of the effect of 0.5% sodium hypochlorite in endodontic therapy. Oral Surg Oral Pathol Oral Radiol Endod 1983:55(3):307-12.
3. Grossman LI, Meiman BW. Dissolution of pulp tissue by chemical agents. J Am Dent Assoc 1941:28:223 as cited from J Endod 1978:4(2):60-4.
4. Sjogren U, Figdor D, Persson S, Sundquist G. Influence of infection at the time of root filling on the outcome of endodontic treatment of teeth with apical periodontitis. Int Endod J 1997:30:297-306.
5. Nair PN, Henry S, Cano V, Vera J. Microbial status of apical root canal system of human mandibular first molars with primary apical periodontitis after "one-visit" endodontic treatment. Oral Surg Oral Pathol Oral Radiol Endod 2005:99:231-52.
6. Mehdi Rahimi, Angsana Jainaen, Peter Parashos, Harold HM. Bonding of resin based sealer to root dentin. J Endod 2009:35(1):121-4.
7. Costas FL, Wong M. Intracoronal isolation barriers: effect of location on root leakage and effectiveness of bleaching agents on the crowns and roots of discolored teeth. J Endod 1991:17: 365-8.
8. Standlee JP, Caputo AA. Endodontic dowel retention with resinous cements. J Prosthet Dent 1992:68:913-7.
9. Willson VA. Determination of available chlorine in hypochlorite solutions by direct titration with sodium thiosulfate. Industrial and Engineering Chemistry Analytical Edition 1935:7: 44-45.
10. Morris MD, Lee KW, Agee KA, Bouillaguet S, Pashley DH. Effect of sodium hypochlorite and RC Prep on bond strength of resin cement on endodontic surfaces. J Endod. 2001:27:753-7.
11. Jean Camps, Ludovic Pommel, Virginie Aubut, Bernard Verhille, Fukuzaki Satoshi, Bernad Lascola, Imad About. Shelf life, dissolving action and antibacterial activity of a neutralized 2.5% sodium hypochlorite solution. Oral Surg Oral Pathol Oral Radiol Endod 2009:108:e66-e73.
12. V Sujatha Manimaran, Sakhamuri Srinivasulu, AV Rajesh Ebenezar, S Mahalaxmi, N. Srinivasan. Application of a proanthocyanidin agent to improve the bond strength of root dentin treated with sodium hypochlorite. J Conser Dent 2011:14(3):306-8.
13. Bystrom A, Sundquist G. Bacteriologic evaluation of the efficacy of mechanical root canal instrumentation in endodontic therapy. Scand J Dent Res 1981:89:321-8.
14. Peters OA. Current challenges and concepts in the preparation of root canal systems: A review. J Endod 2004:30:559-67.
15. Estrela C, Estrela CRA, Barbin EL et. al. Mechanism of action of sodium hypochlorite. Braz Dent J 2002:13:113-7.
16. Rueggeberg FA, Margeson DH. The effect of oxygen inhibition on an unfilled/filled composite system. J Dent Res 1990:69:1652-8.
17. Ishizuka T, Kataoka H, Yoshioka T et al. Effect of NaOCl treatment on bonding to root canal dentin using a new evaluation method. Dent Mater J 2001:20:24-33.
18. Nikaido T, Takano Y, Sasafuchi Y, Burrow MF, Tagami J. Bond strengths to endodontically treated teeth. Am J Dent. 1999:12:177-80.
19. Ari H, Yaser E, Belli S. Effects of NaOCl on bond strength of resin cements to root canal dentin. J Endod 2003:29:248-51.
20. Lai SC, Mak YF, Cheung GS, Osorio R, Toledano M, Carvalho RM et al. Reversal of compromised bonding to oxidized etched dentin. J Dent Res 2001:80:1919-24.
21. Yiu CK, Garcia-Godoy F, Tay FR, et. al. A nanoleakage perspective on bonding to oxidized dentin. J Dent Res 2002:81:628-32.
22. B. P. F. A. Gomes, C. C. R. Ferraz, M. E. Vianna, V. B. Berber, F. B. Teixeira & F. J. Souza-Filho. In vitro antimicrobial activity of several concentrations of sodium hypochlorite and chlorhexidine gluconate in the elimination of Enterococcus faecalis. Int Endod J 2001:34:4248.
23. Kataoka H, Yoshioka T, Suda H et al. Effect of sodium

hypochlorite on adhesion of 4-META/MMA-TBB resin to dentine. Jpn J Conser Dent 1999:42:241-7.

24. Smit MJ, Anderson R. Biochemical mechanism of hydrogen peroxide and hypochlorus acid mediated inhibition of human mononuclear leukocyte functions in vitro: protection and reversal by anti-oxidants. Agents action 1992:36:58-65.

25. Standard Methods for the Examination of Water and Wastewater, 15th Edn., American Public Health Association, Washington, DC 1980.