SciForschen
Open HUB for Scientific Research

ISSN 2378-7090

International Journal of Dentistry and Oral Health

Review Article | Volume: 1.4 | Open Access

Sodium Hypochlorite Dental Emergency-A Review

Shibu Thomas Mathew*

Department of Endodontics, Riyadh Colleges of Dentistry and Pharmacy, Riyadh, Kingdom of Saudi Arabia

***Corresponding author:** Shibu Thomas Mathew, Asst. Professor. Department of Endodontics, Riyadh Colleges of Dentistry and Pharmacy, Riyadh, Kingdom of Saudi Arabia, Tel: 00966 509136903; **E-mail:** shibust_mathew@rediffmail.com

Received date: 2 May 2015; **Accepted date:** 8 June 2015; **Published date:** 12 June 2015.

Citation: Mathew ST (2015) Sodium Hypochlorite Dental Emergency-A Review. Int J Dent Oral Health 1(4): doi http://dx.doi.org/10.16966/2378-7090.114

Abstract

Root canal irrigants play an important role in the success of root canal treatment. As the major objective in root canal treatment is to disinfect the entire root canal system, it requires that the pulpal contents be eliminated as sources of infection. This goal may be accomplished using mechanical instrumentation and chemical irrigation, in conjunction with medication of the root canal between treatment sessions. However there remains a risk of extrusion of these irrigants beyond or into the surrounding tissues and cause severe complications. Sodium hypochlorite is widely used in dental practice during root canal treatment. Although generally regarded as being highly effective as an irrigant, potentially severe complications occur when it comes in contact with soft tissues. This article discusses the use, inadvertent effects of sodium hypochlorite and considers the appropriate management for a practitioner when faced with potential adverse incident with this agent.

Keywords: Sodium hypochlorite; Root canal treatment; Irrigation; Antifungal; Toxicity; Extrusion; Dissolution

Introduction

Endodontic emergency is a condition associated with pain, swelling which require immediate diagnosis and treatment. The main causative factors responsible for the occurrence of endodontic emergencies are mainly pulp and periradicularpathosis, traumatic injuries, procedural complications etc, among which sodium hypochlorite accidents can occur.

Success of root canal treatment relies on thorough debridement and shaping of canals. It is well documented that the impetus behind root canal cleaning and shaping is the elimination of tissue remnants, bacteria and toxins from root canal system. Mechanical preparations alone are insufficient for total canal cleaning [1]. If instrumentation were 100% effective in removing all bacteria and debris from canal, irrigation would be an insignificant factor to mechanical debridement. Unfortunately this is not the case. There are many studies that show the limited ability of instrumentation alone to debride and clean the canal [2-6]. Wu and Wesselink reported uninstrumented areas in 65% of instrumented oval canals [7]. The complete shaping and debridement of root canals is often difficult because of the morphology of the canals. Therefore, irrigating solutions should support and compliment endodontic preparation. The irrigants used should flush out dentin debris, dissolve organic tissue, disinfect the canal, and provide lubrication effect during instrumentation without irritating the surrounding tissues. Some of the irrigants used include hydrogen peroxide,chlorhexidine, saline, among which sodium hypochlorite more commonly used. Sodium hypochlorite is used as an irrigant because of its effective antimicrobial and tissue dissolving capabilities. A variety of sodium hypochlorite concentrations ranging from 0.5%-5.2% have been advocated. Generally the solution is applied to the canals during and after mechanical preparation. The effective concentration range of sodium hypochlorite is from 2.6 to 5.25% [8,9].

Advantages

- Due to the high pH ,the hydroxyl ions alters the integrity of cytoplasmic membrane of microorganisms, causes irreversible enzymatic inhibition, biosynthetic alterations in cellular metabolism and phospholipid degradation by liquid peroxidation.
- Antifungal activity (Table 1)
- It disrupts or removes biofilms (Table 2).
- Strong dissolving action in the presence of organic tissue and microorganisms, by breaking down of proteins into aminoacids (Table 3)
- Haemostaticproperty (Table 4).

Disadvantages

The negative property or drawback of sodium hypochlorite is, it can cause soft tissue inflammation if expressed outside the confines of root canals [27]. Acute inflammation followed by necrosis results when sodium hypochlorite comes into contact with vital tissue. It causes

Author	Year	Findings
Sen et al. [10]	1999	Evaluated antifungal properties of 1% NaOCl, and 5% NaOCl and 0.12 % CHx against candida albicans using cylindrical dentin tubes, and found that in absence of smear layer, candida albicans display antifungal activity after 30 minutes.
Ferguson et al. [11]	2002	Determined in-vitro susceptibility of candida albicans to various irrigants and medicaments, and found out that NaOCl , hydrogen peroxide were effective against candida albicans even when diluted.
Marcia et al.	2009	Evaluated the action of NaOCl associated with an intracanal medicament against candida albicans and E.faecalis and found that 1% NaOCl irrigation were effective in eliminating E.faecalis and candida albicans.
Ruff et al. [12]	2006	Found that 6 % NaOCl was equally effective and statistically superior to Biopure MTAD and 17 % EDTA in antifungal activity

Table 1: Antifungal activity

Author	Year	Findings
Spratt et al. [14]	2001	Evaluated the effectiveness of NaOCl 2.25 %, 0.2% CHx, 10% povidine iodide agent. Monoculture biofilm of 5 rootcanal isolates including P.intermedia, peptostreptococusmiro, streptococcus intermedius and found that NaOCl was more effective.
Clegg et al. [15]	2006	Evaluated effectiveness of three concentrations of NaOCl (6,3,1.5%),2% CHX and biopure MTAD on apical denti film in vitro and found out 6% NaOCl was only capable of both rendering bacteria nonviable and physically remove the biofilm
Ozok et al. [16]	2007	Compared growth and susceptibility of different concentrationsofNaOCl of mono and dual species biofilms of fusobacteriumnucleatum in-vitro at 24 hrs and found out at 243hrs they were more resistant to NaOCl.
Giardino et al. [17]	2007	Evaluated efficiency of 5.25% NaOCl and MTAD against E.Faecalis biofilm and found that only 5.25% NaOCl can disgregate and biofilm every time.

Table 2: Biofilm

Author	Year	Findings
Grossman et al. [18]	1941	5% NaOCl dissolves tissue in 20 minutes to 2 hrs.
Moorer et al. [19]	2003	Tissue dissolution was dependent on 3 factors-frequency of agitation, amount of organic matter in relation to amount of irrigant in system and surface area of tissue.
Okino et al. [20]	2004	Evaluate tissue dissolving ability of 0.5,1,2.5% NaOCl, 25 aqueous solution of CHX, 2% CHX gel and found that 0.5.1,2.5% NaOCl had dissolution speeds at the highest
Naenni et al. [21]	2004	Assessed necrotic tissue dissolution capability of 1% NaOCl, 10% CHX,30%H_2O_2,10% peracetic acid and found out that only NaOCl had the dissolution property.
Clarkson et al. [22]	2006	Evaluated tissue dissolution ability of two concentrations of NaOCl on porcine incisor pulp and found greater concentrations provide more dissolution of tissue.
Marcus et al.	2011	Evaluated the tissue dissolving capacity of various concentrations of NaOCl either alone or in combination of 17%EDTA and found that dissolution property was more with NaOCl alone.

Table 3: Tissue dissolving effect

Author	Year	Findings
Hafez et al. [24]	2002	Showed that 3% NaOCl was biocompatible as a haemostatic control agent
Murina et al. [25]	1986	Showed that concentrations higher than 1mm, suppresses ADP dependent aggregations of blood platelets.
Murina et al. [26]	2006	Showed that anti-aggregant effects of NaOCl are probably due to the oxidation modification of sulphur containing groups in platelet plasmatic membrane.

Table 4: Haemostatic activity

severe inflammation and cellular destruction in all tissues except heavily keratinized epithelium [28]. The severity of the complication depends on the concentration of solution, its pH and its duration of exposure. Sodium hypochlorite has a pH of 11-12.5 which causes injury by oxidation of proteins. Higher concentrations have some irritating effects on the periodontal ligament [29].

This article reviews the potential complications that can occur with sodium hypochlorite in clinical practice, discusses the measures that can be taken to minimize the risk and provides details to appropriate management in rare cases of suspected tissue damage.

Toxicity of Sodium Hypochlorite

Sodium hypochlorite when comes in contact with tissue proteins, forms nitrogen, formaldehyde and acetaldehyde in short time and peptide links are broken resulting in dissolution of proteins. During the process, hydrogen in the amino groups is replaced by chlorine thereby forming chloramines which plays an important role in antimicrobial effectiveness. Necrotic tissues are thus dissolved and microbial agent can reach and clean the infected areas better. Pashley et al. [27] demonstrated the cytotoxicity of Sodium hypochlorite using three independent biological models. They found that a concentration as low as 1:1000 (v/v) Sodium hypochlorite in saline caused complete haemolysis of red blood cells *in vitro*. As the solution used in this study was isotonic and thus excluded an osmotic pressure gradient, the observed haemolysis and loss of cellular protein was due to the oxidizing effects of Sodium hypochlorite on the cell membrane. Undiluted and 1:10 (v/v) dilutions produced moderate to severe irritation of rabbit eyes whilst intradermal injections of undiluted, 1:2, 1:4 and 1:10 (v/v) dilutions of Sodium hypochlorite caused skin ulcers. Kozol et al. [30] proved Dakin's solution to be detrimental to neutrophil chemotaxis and toxic to fibroblasts and endothelial cells.

Heggers et al. [31] examined wound healing relative to irrigation and bactericidal properties of Sodium hypochlorite *in vitro* and *In vivo* models. They concluded that 0.025%Sodium hypochlorite was the safest concentration to use because it was bactericidal but not tissue-toxic. Zhang et al. [32] evaluated the cytotoxicity of four concentrations of Sodium hypochlorite (5.25%, 2.63%, 1.31%, and 0.66%), eugenol, 3% H_2O_2, $Ca(OH)_2$ paste and MTAD results showed that toxicity of Sodium hypochlorite was dose-dependent. Barnhart et al. [33] measured the cytotoxicity of several endodontic agents on cultured gingival fibroblast using the CyQuant assay. The results showed that IKI and $Ca(OH)_2$ were significantly less cytotoxic than Sodium hypochlorite. Most complications of the use of sodium hypochlorite appear to be the result of its accidental injection beyond the root apex which can cause violent tissue reactions characterized by pain, swelling, haemorrhage, and in some cases the development of secondary infection and paresthesia [34]. A great deal of care should therefore be exercised when using sodium hypochlorite during endodontic irrigation. Ehrich et al. [35] suggested that a clinician should check, both clinically and radiographically for immature apices, root resorption, apical perforations or any other conditions that may result in larger than normal volumes of irrigant being extruded from the root-canal system into the surrounding tissue. Irrigation should be performed slowly with gentle movement of the needle to ensure that it is not binding in the canal. In an *in vitro* study by Brown et al. [36], the use of a reservoir of irrigation fluid in the coronal access cavity and carried into the root canal during filing resulted in significantly less apical extrusion of irrigation solution than with deep delivery with an irrigation needle.

Complication during Irrigation

During root canal irrigation, accidental extrusions can occur. Even minute quantities if extruded cause vascular probabilities in blood vessels due to the damage to the vessels as well as release of chemical mediators

such as histamine for the involved tissue. This causes immediate swelling and often profuse bleeding through the root canal.

In a case report, after wedging the irrigating needle into the root canal, 2.5% sodium hypochlorite was extruded beyond the apex of maxillary left central incisor. The patient experienced severe pain during irrigation of root canal system so the root canal preparation was discontinued immediately and temporary dressing given. 3 hrs later, the patient came back to clinic with an extended odema and ecchymosis over the left side of face, infraorbital region and upper lip mucosa. After removing the temporary filling, heavy bleeding from the canal was observed. The canal was biomechanically prepared by hand files with sterile saline solution irrigation. Antibiotics were prescribed against secondary infection and analgesics were also administered for pain control. Cold compress, warm mouth rinses was also advised on the first day. On the third day, pain and ecchymosis was reduced. By the 10th day, no bleeding, pain, or ecchymosis was observed. By the 20th day root canal obturation was performed.

Reeh and Messer reported on a case of injection of sodium hypochlorite (1%) through a mid root perforation of a maxillary central incisor. The patient experienced the typical symptoms of immediate severe pain and swelling, followed by fistulation and erythema extending to the infraorbital area. Paraesthesia of the floor and ala of the patient's nose persisted for more than 15 months. In a case report presented by Sabala and Powell 5.25% sodium hypochlorite was injected into the Periapical tissues of a left maxillary second premolar. The patient experienced symptoms of sudden, severe pain and a swelling rapidly developed, followed by ecchymosis of the skin. Root canal treatment was completed at the same appointment. To prevent secondary infection, antibiotics were prescribed and a surgical drainage performed. Nine days later the symptoms had resolved.

Signs and symptoms

- Immediate severe pain (for 2-6 minutes)
- Immediate oedema or ballooning of adjacent soft tissues
- Spread of oedema to cheeks, periorbital region or lips.
- Ecchymosis on skin
- Profuse inrtraoral bleeding from canal
- Smell and taste of chlorine
- Severe initial pain with numbness related to tissue destruction and distension.
- Reversible or persistent anesthesia
- Possibility of secondary infection or spreading of infection

Prevention of sodium hypochlorite extrusion

- A good proper straight line access cavity design with adequate coronal preparation.
- Preoperative Periapical radiographs to access the root and canal anatomy.
- Use of specialized needles like LeurLok needles.
- Determine proper working length and carefully adjust the rubber stopper.
- Do not wedge the needle tip in the canal, has to be placed loose inside.
- Avoid using excessive digital pressure especially with the thumb.
- Constant in and out movements of the irrigating needle into the canal.
- Flow back of the solution as it is expressed into the canal, should be observed.

Management (Table 5)

- Immediate irrigation of canal with normal saline to dilute the sodium hypochlorite.
- Let the bleeding response continue to flush the irritant out.
- Advice ice pack compression for 24 hours (15 minutes interval) to minimize the swelling.

Author	Year	Findings
Veeresh et al.	2011	A patient with continuous , severe pain, oedema on left side of face, managed by antibiotics, analgesics, cold compress and 10th day all symptoms suppressed.
Dominic et al.	2014	Patient with NaOCl extrusion followed endodontic treatment in maxillary first molar with excruciating pain, with blood stained fluid from left nostril; all managed by first ENT consultant for nasoscopy and then later root canal treatment completed.
Jonathan et al.	2015	A patient with NaOCl extrusion followed perforation during rootcanal treatment in maxillary first premolar with swelling, bruising; pain was managed by i.v antibiotics, analgesics, steroids and then surgical intervention and finally full recovery was observed.
Bernardo et al.	2014	A patient with NaOCl apical extrusion followed rootcanal returned in 24 hours with extreme pain, burning sensation in maxillary region with oedema and was managed by amoxicillin 500 mg orally for 7 days then dexamethasone 4 mg I.M. for 3days. Symptoms subsided after 8 months.

Table 5: Management of NaOCl

- Recommend warm, moist compress after 24 hours (15 minutes interval).
- Prescribe Acetaminophine based narcotic analgesics for 7 days.
- Prophylactic antibiotic coverage for 10 days to prevent secondary infection. Amoxcycillin 250 mg TDS or Metronidazole 200 mg TDS in penicillin allergic patients.
- Steroid therapy for 2-3 days to control inflammatory reaction.
- Daily contact to monitor recovery.
- Reassure the patient and provide with both verbal and written homecare instructions.
- Monitor the patient periodically.

Conclusion

Sodium hypochlorite, being an effective antibacterial agent, can also be highly irritating when extruded or when it comes in contact with vital tissues. Most of the reported complications occurred due to the errors the different steps in root canal treatment. In summary, this review discusses the advantages, disadvantages, potential complications, prevention and management of sodium hypochlorite accidents in endodontic dental practice. Although very rare, the correct recognition and immediate primary management is essential to ensure best long lasting safe clinical practice.

References

1. Haapasalo M, Endal U, Zandi H, Coil JM (2005) Eradication of endodontic infection by instrumentation and irrigation solutions. Endod Topics 10: 77-102.
2. Hülsmann M, Stryga F (1993) Comparison of root canal preparation using different automated devices and hand instrumentation. J Endod 19: 141-145.
3. Hülsmann M, Schade M, Schäfers F (2001) A comparative study of root canal preparation with HERO 642 and Quantec SC rotary NiTi instruments. Int Endod J 134: 538-546.
4. Hülsmann M, Gressmann G, Schäfers F (2003) A comparative study of root canal preparation using FlexMaster and HERO 642 rotary NiTi instruments. Int Endod J 36: 358-366.

5. Versümer J, Hülsmann M, Schäfers F (2002) A comparative study of root canal preparation using ProFile .04 and Lightspeed rotary NiTi instruments. Int Endod J 35: 37-46.

6. Hülsmann M, Herbst U, Schäfers F (2003) Comparative study of rootcanal preparation using Lightspeed and Quantec SC rotary NiTi instruments. Int Endod J 36: 748-756.

7. Wu MK, Wesselink PR (2001) A primary observation on the preparation and obturation of oval canals. Int Endod J 34: 137-141.

8. Baumgartner JC, Ibay AC (1987) The chemical reactions of irrigants used for root canal debridement. J Endod 13: 47-51.

9. Grossman LI (1981) Preparation of the root canal. In: Endodontic practice, 10th ed. Philadelphia: Lea and Febiger 200-236.

10. Sen BH, Safavi KE, Spangberg LS (1999) Antifungal effects of sodium hypochlorite and chlorhexidine in root canals. J Endod 25: 235-238.

11. Ferguson JW, Hatton JF, Gillespie MJ (2002) Effectiveness of intracanalnirrigants and medications against the yeast Candida albicans. Endod 28: 68-71.

12. Ruff ML, McClanahan SB, Babel BS (2006) In vitro antifungal efficacy of four irrigants as a final rinse. J Endod 32: 331-333.

13. Valera MC, Silva KC, Maekawa LE, Carvalho CA, Koga-Ito CY, et al. (2009) Antimicrobial activity of sodium hypochlorite associated with intracanal medication for Candida albicans and Enterococcus faecalis inoculated in root canals. J Appl Oral Sci 17: 555-559.

14. Spratt DA, Pratten J, Wilson M, Gulabivala K (2001) An in vitro evaluation of the antimicrobial efficacy of irrigants on biofilms of root canal isolates. Int Endod J 34: 300-307.

15. Clegg MS, Vertucci FJ, Walker C, Belanger M, Britto LR (2006) The effect of exposure to irrigant solutions on apical dentine biofilms in vitro. J Endod 32: 434-437.

16. Ozok AR, Wu MK, Luppens SB, Wesselink PR (2007) Comparison of growth and susceptibility to sodium hypochlorite of mono- and dual-specie biofilms of Fusobacterium nucleatum and Peptostreptococcus (micromonas) micros. J Endod 33: 819-822.

17. Giardino L, Ambu E, Savoldi E, Rimondini R, Cassanelli C, et al. (2007) Comparative evaluation of antimicrobial efficacy of sodium hypochlorite, MTAD, and Tetraclean against Enterococcus faecalis biofilm. J Endod 33: 852-855.

18. Grossman LI, Meiman BW (1941) Solution of pulp tissue by chemical agents. J Am Dent Assoc 28: 223-225.

19. Moorer WR, Wesselink PR (2003) 110th year Nederlands Tijdschrift voor Tandheelkunde. 2. Root canal treatment, intra-canal disinfectants and bacterial culture: past and present. Ned Tijdschr Tandheelkd 110: 178-180.

20. Okino LA, Siqueira EL, Santos M, Bombana AC, Figueiredo JA (2004) Dissolution of pulp tissue by aqueous solution of chlorhexidinediglucanate and chlorhexidinediglucanate gel. Int Endod J 37: 38-41.

21. Naenni N, Thoma K, Zehnder M (2004) Soft tissue dissolution capacity of currently used and potential endodontic irrigants. J Endod 30: 785-787.

22. Clarkson RM, Moule AJ, Podlich H, Kellaway R, Macfarlane R, et al. (2006) Dissolution of porcine incisor pulps in sodium hypochlorite solutions of varying compositions and concentrations. Aust Dent J 51: 245-251.

23. Reis So MV, Vier-Pelisser FV, Darcie MS, Smaniotto DGR, Montagner F, et al. (2011) Pulp tissue dissolution when the use of sodium hypochlorite and EDTA alone or associated. Rev Odonto Cienc 26: 156-160.

24. Hafez AA, Cox CF, Tarim B, Otsuki M, Akimoto N (2002) An in vivo evaluation of hemorrhage control using sodium hypochlorite and direct capping with a one- or two-component adhesive system in exposed nonhuman primate pulps. Quintessence Int 33: 261-272.

25. Murina MA, Sergienko VI, hupkin DI (1989) [The direct and indirect antiaggregation action of sodium hypochlorite on thrombocyte-enriched blood plasma]. Biull Eksp Biol Med 108: 702-704.

26. Murina MA, Savel'eva EL, Roshchupkin DI (2006) [Mechanism of action of biogenic chloramines and hypochlorite on initial aggregation of blood platelets].Biofizika 51: 299-305.

27. Pashley EL, Bridsong NL, Bowman K, Pashley DH (1985) Cytotoxity effects of NaOCl on vital tissue. J Endod 11: 52-58.

28. Thé SD, Maltha JC, Plasschaert JM (1980) Reactions of guinea pig subcutaneous connective tissue following exposure to sodium hypochlorite. Oral Surg Oral Med Oral Pathol 49: 460-466.

29. Tanomaru Filho M, Leonardo MR, Silva LA, Aníbal FF, Faccioli LH (2002) Inflammatory response todifferent endodontic irrigating solutions. Int Endod J 35: 735-739.

30. Kozol RA, Gillies C, Elgebaly SA (1988) Effects of sodium hypochlorite (Dakin's solution) on cells of the wound module. Arch Surg 123: 420-423.

31. Heggers JP, Sazy JA, Stenberg BD, Strock LL, McCauley RL, et al. (1991) Bactericidal and woundhealin properties of sodium hypochlorite solutions: the 1991 Lindberg Award. J Burn Care Rehabil 12: 420-424.

32. Zhang W, Torabinejad M, Li Y (2003) Evaluation of cytotoxicity of MTAD using the MTT-tetrazolium method. J Endod 29: 654-657.

33. Barnhart BD1, Chuang A, Lucca JJ, Roberts S, Liewehr F, et al. (2005) An in vitro evaluation of the cytotoxicity of various endodontic irrigants on human gingival fibroblasts. J Endod 31: 613-615.

34. Hauman CH, Love RM (2003) Biocompatibility of dental materials used in contemporary endodontic therapy: a review. Part 1. Intracanal drugs and substances. Int Endod J 36: 75-85.

35. Ehrich DG, Brian JD Jr, Walker WA (1993) Sodium hypochlorite accident: inadvertent injection into the maxillary sinus. J Endod 19: 180-182.

36. Brown DC, Moore BK, Brown CE Jr, Newton CW (1995) An in vitro study of apical extrusion of sodium hypochlorite during endodontic canal preparation. J Endod 21: 587-591.

37. Tegginmani VS, Chawla VL, Kahate MM, Jain VS (2011) Hypochlorite accident–A case report. Endodontology 89-94.

38. Laverty DP (2014) A case report of accidental extrusion of sodium hypochlorite into the maxillary sinus during endodontic retreatment and review of current prevention and management. Journal of Restorative dentistry 2: 96-100.

39. Hatton J, Walsh S, Wilson A (2015) Management of the sodium hypochlorite accident: a rare but significant complication of root canal treatment. BMJ Case Reports.

40. Aguiar BA, Gomes FA, Ferreira CM, de Sousa BC, Costa FWG (2014) Hypochlorite-induced severe cellulitis during endodontic treatment: case report. RSBO 11: 199-203.