Risks and Management of Sodium Hypochlorite in Endodontics

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Abstract

Aim: The aim of this article is to provide the dental practitioner about the potential inadvertent effects of sodium hypochlorite and its management on encountering a dental emergency.

Summary: As a major objective of root canal treatment is to disinfect the entire root canal system which requires the elimination of pulpal contents and sources of infection by using mechanical instrumentation, chemical irrigants in conduction with intra canal medicaments. However, there remains a risk of extrusion of these irrigants beyond and into the surrounding tissues which causes severe complications.

Conclusion: This article discusses the use of sodium hypochlorite with its inadvertent effects. Complications with the use of sodium hypochlorite can be avoided by the use of specialized needles, avoiding excessive pressure, not wedging the needle tip in the canal. Early recognition and management of inadvertent effects of sodium hypochlorite remains vital for the patient’s safety.

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

Introduction

Endodontic emergencies are associated with pain and swelling which requires immediate diagnosis and treatment. The main causative factors for these emergencies are pulp and peri-radicular pathosis, traumatic injuries, procedural complications; were sodium hypochlorite accidents can occur. The impetus behind a successful root canal treatment relies on a thorough debridement of tissue remnants, bacteria and toxins from the root canal system. For a proper clean canal, mechanical preparations alone are insufficient, as reviewed by Haapasalo et al. [1]. Several studies shows that instrumentation alone were not 100 % effective to debride and clean the canals but has to be in conjunction with irrigants [2-6]. Uninstrumented areas were reported in 65% of instrumented oval canals, according to Wu and Wesselink [7]. The morphology of the canals makes it difficult for a complete debridement of root canals, as residual pulp tissue and bacteria may persist in the irregularities of the canal. Therefore, irrigants should support and compliment endodontic preparations by flushing out dentinal debris, dissolving organic tissues, disinfecting the canal and providing lubrication during instrumentation without irritating the surrounding tissues. Hydrogen peroxide, chlorhexidine, saline are some of the irrigants used; among which sodium hypochlorite is the commonly used effective antimicrobial and tissue dissolving irrigant. Concentrations of sodium hypochlorite ranges from 0.5%-5.2%, which is applied to the canals during and after mechanical preparation. Effective concentration range of sodium hypochlorite is from 2.6%-5.25% [8, 9].

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.

Rationale behind using sodium hypochlorite

- 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).
- Haemostatic property (Table 4).

Drawbacks

The negative property or drawback of sodium hypochlorite is that it can cause soft tissue inflammation if passed outside the confines of root canals [10-27]. Acute inflammation followed by necrosis results when sodium hypochlorite comes into contact with vital tissue. It causes 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].

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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...
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.

Heggars 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% H₂O₂, 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, hemorrhage, and in some cases the development of secondary infection and paraesthesia [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:** (review of literature represented in Table 5)

**Extrusion beyond the root apex**

During root canal irrigation, accidental extrusions can occur. Even minute quantities if extruded causes 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
Sodium hypochlorite reacts with the proteins and fats of oral mucosa which might lead to secondary infections. The patient must be monitored with immediate treatment if swallowed.

Management: Gentle irrigation of the affected eye with normal saline or tap water and then refer to the ophthalmologist.

Recommendations

### Extrusion Of Irritant

| Complication             | Author                                                                 | Study                                                                 |
|--------------------------|------------------------------------------------------------------------|----------------------------------------------------------------------|
| Extrusion Of Irritant     | Aranda M, Sahil C, Figueiredo R, and Escoda C [37]                     | Complications following an accidental sodium hypochlorite extrusion: A report of two cases Accidental injection with sodium hypochlorite: Report of a case Effects of sodium hypochlorite on soft tissues after its inadvertent injection beyond the root apex. |
| Damage to eye             | Ingram TA [40], AG Becking [41], Khodabukus, R., Tailouzi, M [42]     | RESPONSE OF THE HUMAN EYE TO ACCIDENTAL EXPOSURE TO SODIUM HYPOCHLORITE Complications in the use of sodium hypochlorite during endodontic treatment: report of three cases CHEMICAL EYE INJURIES 1: PRESENTATION, CLINICAL FEATURES, TREATMENT AND PROGNOSIS |
| Damage to oral mucosa     | G. Markose, CJ Cotter, WS Hislop [43], RF de Sermeño, LAB da Silva, HH Herrera [44], Lin J., Messer HH [45] | Severe tissue damage and neurological deficit following extravasation of sodium hypochlorite solution during routine endodontic treatment. Severe facial edema following root canal treatment. The chemical reactions of irrigants used for root canal debridement. |

### Allergic reactions

Sodium hypochlorite allergic reactions results in urticaria, oedema, shortness of breath, bronchospasm and hypotension.

Management: Refer immediately to intensive care unit following first aid management with administration of intravenous steroids and antihistamines [50].

### Signs and Symptoms

#### 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 leuk lock 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 6)

- 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.
- Recommend warm, moist compress after 24 hours (15 minutes interval).
- Prescribe Acetaminophine based narcotic analgesics for 7 days.

- Prescribe Antihistamines [50].
clinical practice, it's essential to recognize and manage these complications. Needle into the canal and most importantly avoid excessive pressure of 2 mm reduction from the working length, and avoiding wedging of treatment, use of Leur lock needle for irrigation, maintain a minimum be avoided and by the use of a sealed rubber dam isolation during causing tissue destruction. So, to prevent this, injudicious use should but, when in contact with vital tissues it becomes a potential irritant

### Table 6: Management of NaOCl

| Author                      | Year | Findings                                                                                                                                 |
|-----------------------------|------|------------------------------------------------------------------------------------------------------------------------------------------|
| Veeresh et al. [51]         | 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. [52]         | 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. [53]        | 2015 | A patient with NaOCl extrusion followed perforation during root canal 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. [54]        | 2014 | A patient with NaOCl apical extrusion followed root canal returned in 24 hours with extreme pain, burning sensation in maxillary region with oedema and was managed by amoxicillin 500mg orally for 7 days then dexamethasone 4mg I.M. for 3 days. Symptoms subsided after 8 months. |

### Conclusion

To conclude, sodium hypochlorite is an effective antibacterial agent but, when in contact with vital tissues it becomes a potential irritant causing tissue destruction. So, to prevent this, injudicious use should be avoided and by the use of a sealed rubber dam isolation during treatment, use of Leur lock needle for irrigation, maintain a minimum of 2 mm reduction from the working length, and avoiding wedging of needle into the canal and most importantly avoid excessive pressure during irrigation.

Although a safe root canal irrigating solution, its use may also lead to life-threatening complications [51-55]. So, to ensure best safe, long lasting clinical practice, it’s essential to recognize and manage these complications.

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