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Sodium Hypochlorite Accident in Endodontics: An Update Review

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Abstract

Sodium hypochlorite accident is a very serious complication that might occurs if sodium hypochlorite extrudes into the periodontal tissues. Although Sodium hypochlorite is more frequently used as endodontic irrigant. Its accident is uncommon to be encountered in the dental clinic. In this review article the sodium hypochlorite accident was investigated from different perspectives based on online review of the published papers on the same topic. Frequency, causes, clinical manifestations, complications, management and prevention were collectively reviewed in this paper.

Keywords: Sodium hypochlorite; Sodium hypochlorite accident; Root canal irrigant; Sodium hypochlorite complication

Introduction

Sodium hypochlorite (NaOCl) was initially reported as an effective endodontic irrigant in 1920 **[1].** Because of its antimicrobial activity, low viscosity, ability to dissolve the tissues, lubrication action and availability it is considered to be the most frequently used endodontic irrigant [2-7] Therefore; it is used as an adjunct to mechanical debridement of the root canal system.

On the other hands, the main disadvantages of NaOCl are cytotoxicity [8]. In addition, it does not remove the smear layer without chelating agent. [6] It also alters the properties of dentin due to the dissolving action of NaOCl to the organic material such as dentin collagen [9,10]. Due to the release of chlorine, it is very toxic to vital tissues [11-13], that might lead reversible or irreversible tissue damage [14,15].

The NaOCl accident occurs when there is a considerable amount of irrigant extruded beyond the root canal space leading to tissue necrosis and induces a massive acute inflammatory response with its associated sequelae [15]. The reported cases of sodium hypochlorite accident have shown variety of associated complications, causes and different approaches for management.

The purpose of this article is to gather the scattered pieces of information about the NaOCl accident throughout the published literature, and to formulate a more decent image of sodium hypochlorite accident etiology, incidence and distribution, complication, management, and prevention.

Action Mechanism of NaOCl

Because of the dynamic balance of sodium hypochlorite; hypochlorous acid (HOCL-), hopchlorite ions (OCL-), and hydroxyl group (OH+) will be constantly released [16].

In the presence of the above mentioned molecules different kinds of reactions occur when the sodium hypochlorite get exposed to the organic components of any cellular structure. First is the saponification reaction in which the lipids will be degraded into glycerol and lead to soap formation. Second is the neutralization reaction by which amino acids will be neutralized by the action of NaOCl neutralizes amino acids forming water and salt. The last type of reaction is the chloramination in which amino acids will be degraded and hydrolyzed [16].

The alkalinity (pH>11) of sodium hypochlorite which is similar to the calcium hydroxide is also playing a major role in its antimicrobial and cytotoxicity activities. The high pH of NaOCl will lead to disruption of the cytoplasmic membrane and the cellular metabolism [16,17].

Etiology

Injecting the sodium hypochlorite through the canal into the surrounding periodontal tissue is the cardinal cause of the massive tissue destruction that occurs with NaOCl accident cases. The most frequently reported misshapes that lead to NaOCl accident are root perforations, incorrect working length, and forcing the irrigation needle into narrow root canal space [15]. Other factors are also involved in the development of NaOCl accident which includes the anatomical variations, concentration of the irrigant and hypersensitivity to NaOCl.

Although the high concentration NaOCl is more efficient as antimicrobial agent, it is going to be more cytotoxic [18]. More NaOCl accidents were reported when higher concentrations of NaOCl were used. These results seem to agree with reports in the literature describing the direct relationship between the concentration and the toxicity [18,19].

It was hypothesized that sodium hypochlorite accident would occur more likely when NaOCl had direct access to a soft-tissue space, such as the buccal or infraorbital, rather than simply contacting periapical tissue [18]. In fact, this might occur more frequently when the anatomic apex of a tooth naturally fenestrated through the overlying alveolar bone or when the alveolar bone had been perforated by a disease process. The above mentioned hypothesis is supported by the increased reported cases which are associated with teeth encased in thinner cortical plate [18].

The etiology of NaOCl accident that was reported in the literature was referring to the toxic effects of sodium hypochlorite rather than to its allergic effects. Sodium hypochlorite allergic action was reported in the literature long time ago [20,21]. Another case was reported later

in which the patient developed the symptoms of allergic reaction such as hypotension and difficulty of breathing after the use of 0.5 sodium hypochlorite irrigant [22]. Allergy skin scratch test was performed which showed a positive result to NaOCl.

Incidence and distribution

Sodium hypochlorite accidents were most frequently reported in the maxillary teeth (73%) compared with the mandibular teeth (21%) [18]. There was a significant difference in the region of NaOCl accident, (70%) were occurred in the molar or premolar region, whereas (30%) in the incisor or canine regions [18]. Mandibular premolar and molar teeth are encased in a denser cortical plate, and their apices are located more centrally within the body of the mandible. In contrast to this, the buccal roots of maxillary premolar and molar teeth have only a thin covering of cortical bone, which probably predisposes these teeth to NaOCl accidents [23].

Among the cases when sex was recalled, accidents were reported more frequently for females (69%) than for males (31%). This could be due to decreased bone thickness and density of the female patient [18].

Clinical manifestation

When NaOCl accident occurs the patient usually developed a rapid intra and extra oral swelling which might be edematous, hemorrhagic or both due to the acute inflammatory process [12]. The swelling might extends beyond the site of the affected tooth [13,14]. The most path gnomonic sign is the sudden pain which will be felt during irrigation of the root canal space [6,15]. Ecchymosis and bruising might also develop inta-orally and/or extra-orally due to bleeding into the interstitial tissues [8,12]. Moreover, the adjacent mucosa might get necrotized due to the chemical burn of NaOCl [24]. Tissue necrosis may appear within minutes or might occur hours or days later [8,25].

The upper airway might be affected in some cases. This could happen if the submental and sublingual spaces will be involved [26]. The signs of upper air way obstruction include stridor, elevation of the floor of the mouth, labored breathing and declining oxygen saturation [26].

If the reaction was due to allergic reaction to NaOCl the clinical manifestation will includes the usual symptoms of allergy. These might include hypotension, shortness of breath, edema, wheezing and urticaria [22].

Complications

Scar formation

When tissue necrosis occurred due to the chemical burn of NaOCl, secondary intention healing process might happen that will lead to scar formation [27].

Sinusitis

Involvement of the maxillary sinus during endodontic therapy most probably leads to acute sinusitis. Hence, congestion of the maxillary sinus is cardinal sign if the sinus was affected by the irrigant [28].

In the reported cases of affected sinuses with NaOCl the symptoms are ranging from nothing more than smell and taste of sodium hypochlorite to heavily congested sinuses and severe pain [28,29].

Neurological complications

Parasthesia of the affected tissues might also develop due to involvement of the sensory nerves by the chemical burn of the sodium hypochlorite [30].

If the motor nerves were affected by NaOCl accident then the motor function of the supplied muscles will be affected also [31].

Fortunately, the affected nerves usually will restore their normal function, but in different period of time that might extends to several months [30].

Upper airway obstruction

Life threatening air way obstruction has been reported assequelae of NaOCl extrusion. In the reported case of the upper air way obstruction due to NaOCl accident the cellulitis and swelling spread rapidly to involve the submental and sublingual spaces and resulting in elevation of the floor of the mouth. Then the patient started to exhibit signs of upper airway obstruction [26].

Upper air way obstruction could results also if the solution was inhaled or ingested [30,14].

Management

Unfortunately, low level evidences are available for the management of sodium hypochlorite accident complications such as expert opinion or case reports. Thus, there is no standard treatment protocol has been documented; this could be because these complications are rare and uncommon.

The first step for management is to explain the case to the patient. This step plays a crucial role in dealing with the consequences of this kind of accident. Also, documents all the details of the incident including irrigation needle type, the use of rubber dam, working length, volume and concentration of NaOCl. Take clinical pictures to support these notes.

Usually conservative and palliative management of NaOCl accident is advocated [32]. However, treatment will be determined by the severity of the case [33].

Pain could be managed using long acting local anesthetic and analgesic such as non steroidal anti-inflammatory drugs and paracetamol. Flexible prescription by alternating ibuprofen and paracetamol at four hours interval might be effective for severe pain management [1].

It is recommended to prescribe a prophylactic antibiotic to prevent the secondary infection that might develop due to tissue necrosis or hematoma in the affected tissues [31].

The use of steroids might be also recommended to control the process of acute inflammation [33,34]. Several clinical studies reported that administration of dexamethasone is effective in minimizing postoperative pain and swelling after endodontic therapy or flare-up cases [35-37].

Advice the patient to use cold compression for the first day to control the swelling. Surgical drainage might be also needed to relief the congested tissue [31].

In case of upper airway obstruction urgent intervention and hospitalization is recommended. Intubation and administration of intravenous steroids and antihistamines will be necessary [26].

In the cases of maxillary sinus involvement it might be necessary to drain the sinus surgically [28]. However if the sinus doesn't become congested, irrigation of the sinus through the root canal using distilled water or saline might be enough [29].

Prevention

As mentioned before, these complications are rare. Nonetheless, the risk of accident could be minimized by implementation of the preventive measures when performing endodontic therapy.

Control of Substances Hazardous to Health Regulations (COSHH) is recommending that the exposure of the patient to NaOCl must be kept as low as reasonable practicable. So the use of rubber dam is a must to isolate the tooth for root canal treatment [21].

It is very important that clinician must investigate thoroughly the presence of any predisposing risk factor that might lead to development of NaOCl accident such as perforations, resorption, immature apices or any other conditions [29].

The side vented needle is advocated for root canal. The end vented needles carry risks of irrigant extrusion [15,38]. The needle must not binds to the walls of the canal, but to be kept loose while irrigating. Moreover, it should be kept in at least two mm distance from the apical terminus [15]. The irrigant should be introduced with low pressure to prevent forcing it beyond the apex [15]. Even though, the use of negative pressure irrigation system such as EndoVac system to the full (WL) was principally proven to minimize the risk of extrusion of root canal irrigant [39].

Care should be taken in the management of teeth with immature root and open apices to prevent the irrigant from seepage beyond the root apex. It has been suggested to limit the use of NaOCl irrigation to the coronal 2/3 of the root with open apex [18].

It is very important to be aware of the possibility of sodium hypochlorite allergic reactions and take measures to prevent occurrence.

The questions usually asked in a medical history report are:

Are you sensitive to household bleach?

Did you experience any sensitivity when swimming in a chlorinated pool?

Are you allergic to Intravenous Pyelogram dye? (Dye contains iodine).

Some authors said that this allergy may indicate that the patient is more likely to be allergic to other substances such as chlorine, [40] and eventually will be susceptible for NaOCl accident. Allergy skin scratch test is recommended particularly in cases with expected NaOCl allergy before endodontic treatment [38].

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