

Accidents and complications in Endodontics caused by sodium hypochlorite: literature review

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ABSTRACT

This review shows the accidents and complications that can be caused by inappropriate use of sodium hypochlorite (NaOCl) during the endodontic treatment. This solution has been used since 1920 in concentrations of 0.5% to 5.25% as an antimicrobial irrigant to assist the mechanical preparation of root canals, it is clinically proven to be a lubricant, antiseptic and solvent of body tissue. However, serious accidents, such

as skin and intraoral mucosa burns, laryngeal edema, upper airway obstruction, paresthesia, bleeding and others, may occur when used inadvertently. Thus, careful technique, storage and handling must be taken, in order to prevent these undesirable complications. Furthermore, the professional must be able to identify and solve problems when it occurs.

Keywords: Sodium hypochlorite. Accident. Irrigant. Endodontics.

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Introduction

One of the aims of endodontic therapy is the maintenance of the dental element in the oral cavity. Bacteria in the root canals often result in infection and apical periodontitis.

The use of chemicals in order to reduce or eliminate bacteria has always been present in Endodontics. The chemical methods (auxiliary chemical substances) along with mechanical methods (action of instruments) and physical (irrigation and aspiration) form a single, simultaneous, continuous and inseparable process, which is the chemical-mechanical preparation of the root canal¹.

A lot of substances such as hydrogen peroxide, saline solution, water, sodium hypochlorite (NaOCl), chlorhexidine gluconate and water electrochemically activated have been used during and immediately after the biomechanical preparation of the root canal to remove the debris and necrotic pulp, in addition to aid in the elimination or reduction of microorganisms that can not be only achieved by mechanical instrumentation.²

It is essential that chemicals substances selected as endodontic irrigants have properties such as antimicrobial activity and ability to dissolve organic tissues, in addition to help in the debridement of the root canal system and not be toxic to the tissues³.

Thus the NaOCl has been elected as an irrigating solution in various concentrations ranging from 0.5% to 5.25% for endodontic use by most professionals. A solution of NaOCl at 0.5% (Dakin's solution) was used for the first time in 1920 by Crane in order to promote sterilization and debridement of the root canal. Since then, it has become the most commonly irrigant used in Endodontics². This is due to the mechanism of action of this solution which can promote cellular biosynthetic alterations, cellular metabolism, phospholipid destruction, as well as for its excellent properties: ability to dissolve organic tissues, be antimicrobial, has an alkaline pH, promote whitening, be deodorant and have low surface tension⁴. Besides being cheap, available and easy to store.²

However, it is toxic to the vital tissues causing hemolysis, ulcers, inhibition of neutrophil migration, damage to endothelial cells and fibroblasts, facial nerve damage and necrosis when the irrigant is extruded from the periapical area during irrigation of the root canal⁵⁻⁹.

The NaOCl also has an unpleasant odor and causes staining when it is in contact with the tissues.¹⁰

Wong¹¹ describes the endodontic treatment as a routine procedure performed in the dental clinic with few complications reported. However, NaOCl accidents have been reported because of accidental injection of NaOCl stored in empty anesthetic cartridges and also by the leakage of NaOCl to periapical tissues during the root canal irrigation.¹²⁻¹⁵

The hypersensitivity or allergic reactions,¹⁶ contact with the eyes,¹⁷ facial hematoma,¹⁸ severe palatal tissue necrosis,¹⁹ heavy bleeding, emphysema,^{5,12,20-23} impairment of airways,²⁴ hemolysis, skin ulceration, localized swelling,^{25,26} gingival necrosis,²⁷ immediate pain, paresthesia, facial weakness,⁹ diffuse pain and lip burning,⁷ sinus, erythema,²⁸ secondary infection and ulcer.⁶ All these situations have been reported in the literature as complications caused by the inadvertent handling of NaOCl.

Regardless of the reason or cause, an accident with sodium hypochlorite is a scary event and precautions must be taken to prevent it.²⁹ Some of these may include: use of plastic bib to protect the patient's clothing, use of eye protection for both patient and operator, use of a rubber dam to isolate the tooth being treated, use of needles for root canal irrigation with side exit, use of irrigation needle calibrated 2 mm short of the working length and avoid excessive pressure during irrigation.²⁴

Within this context, this study aims at conducting a literature review in order to present accidents and complications caused by NaOCl during endodontic treatment and how to prevent and solve them.

Literature review

Spangberg, Engström and Langeland³⁰ claimed that one of the concerns of the endodontists is to promote disinfection of the root canal system, since microorganisms can remain in branches and in irregularities, as well as inside the dentinal tubules. Therefore, cleaning the root canal depends not only on the mechanical action of the instruments, but also on the action of irrigating solutions that lubricate the root canal during the cutting action of endodontic instruments, assisting in the removal of smear layer, decontaminating through its germicide potential and acting as a solvent in exudate and pre-dentin.

Knowing that the components of such formulations may cause more or less irritation to the periapical tissues, it is worth noting the need for care and attention of the dentist when handling different concentrations of NaOCl. Due to the fact that it is highly irritating when extravasated to the vital tissues, we highlight in this literature review four main points regarding accidents and complications of using NaOCl. We believe that this division facilitates understanding of the study. Taking into account the high number of researches, we decided that only those publications with the best reported and solved clinical cases should comprise this review. As a result, the researches selected are all in vivo studies. This review comprises researches published between 1973 and 2012. MEDLINE, PubMed, BBO, Lilacs, Scielo, Library of the College of Dentistry of Piracicaba (FOP-UNICAMP) and the Library of the Ingá College (UNINGÁ) were used as source of research.

Inadvertent injection of sodium hypochlorite in the soft tissue

NaOCl accidents have been commonly reported as a result of accidental injection of this solution stored by dentists in empty anesthetic cartridges.^{5,12,14,19,21,27,31,32,33} Usually, this type of accident can cause: severe pain, necrosis of palatine mucosa,^{19,31,32} gingival necrosis,^{27,31} diffuse pain, swelling, lip burning, hematoma^{7,14,21} and bleeding²¹.

Treatment options for this type of accident included surgical debridement, free gingival graft,^{5,19} saline solution irrigation, antibiotics and anti-inflammatory.^{7,14,21,27,34}

Gursoy, Bostanci and Kosger¹⁹ reported a case of an adult male patient sent to the university hospital 15 days after an inadvertent injection of NaOCl in the palatal mucosa. In the anamnesis, the patient reported that immediately after the solution injection, he felt an intense pain that persisted for 2 days. During the intraoral test, it was found a whitish-yellow necrotic tissue area in the palatal mucosa, with a purple, swollen area surrounding it. An intraoral radiography showed no sign of bone resorption. Possible treatment options include surgical debridement and free gingival graft. However, as the mucosa began to heal after 15 days and the patient had no further complications, no surgical intervention proved to be necessary. After 30 days, there was tissue repair without scarring.

Accidental extrusion of NaOCl beyond the apical foramen

During root canal irrigation, NaOCl may accidentally leak beyond the apex reaching the apical tissues.^{12,24,35} This accident can happen in cases of teeth with incomplete root formation, wide apical foramen, apical root resorption, exaggerated foraminal extensions, when the apical constriction was destroyed during the biomechanical preparation of the root canal, when an extreme pressure is performed during irrigation⁶ or when the irrigation gauge is incompatible with the diameter of the root canal and it is inadvertently trapped, which blocks the reflux of the solution.¹²

These accidents may be associated with an extreme reaction of acute pain, swelling, tissue damage, hematoma,^{8,12,24,36} hemorrhagic ecchymosis⁶, chemical burn, extensive tissue necrosis and paresthesia. It can affect adjacent innervation causing, for example, weakness of the facial nerve and infraorbital trigeminal, loss of lip and cheek function, trismus, necrosis and ulceration of alveolus around the teeth.^{9,24}

According to Becker, Cohen, Borer;¹² Mitchell, Baumgartner, Sedgley;³⁶ Desai and Himel³⁷, the accident can be avoided by careful observation of the root diameter in order to use irrigation needles compatible with the canal diameter, observe the initial diameter of the apical foramen in order not to extend it disproportionately, or use an irrigation system that provides control of the solution flow in the root canal.

Treatment options for this type of accident include placing the patient in an upright position in order to relieve some of the head pressure, applying cold compress to relieve the pain and burning sensation, followed by hot compress to stimulate local systemic circulation, leave the root canal open in order to allow drainage of any exudate, analgesic and antibiotic administration.^{4,6,9,12} In more severe cases, there may be a need for urgent hospitalization, intravenous steroids, surgical drainage and debridement.^{9,24}

Witton et al⁹ described a case of endodontic treatment in which NaOCl was being used as a root canal irrigating solution and during the procedure, there was extrusion of it through the foramen into the surrounding tissues. The patient, who immediately complained of pain and swelling in the face, was taken to the hospital where physical examinations were performed. The examinations revealed loss of sensation in the infraorbital

nerve as well as weakness of the buccal facial nerve, resulting in slope right corner of the mouth, without evidence of intraoral soft tissue damage and trismus. The patient was treated with antibiotics and analgesics, followed by evaluation at regular intervals in the clinic every week. In one month, it was observed that the weakness of the facial nerve was significantly improved and about 3 months after the accident, both the par-esthesia and facial weakness were completely resolved.

Complications caused by NaOCl swallowing or inhalation

The use of NaOCl for root canal irrigation without complete isolation of the teeth can lead to leakage of the solution into the oral cavity, causing the patient to ingest or inhale it. It may result in irritation of the throat, dysphonia and drooling. In more severe cases, the upper airway can be compromised due to glottic edema.^{24,35}

This accident can be avoided if the rubber dam is used to isolate the tooth, and minor adaptation defects should be corrected with a caulking agent for optimal sealing. The treatment proposed for more severe cases is the immediate hospitalization with tracheal intubation.²⁴

Ziegler³⁸ presented a case of a 15-month girl who arrived at an emergency department with acute laryngotracheal bronchitis and excessive salivation as a result of ingestion of a high concentration of NaOCl. A similar clinical picture can occur if NaOCl is ingested during endodontic treatment, depending on the concentration and the volume ingested. Nasal optical fiber and tracheal intubation followed by decompression surgery are performed in order to manage the airway swelling appearing within three hours after NaOCl exposure during root canal treatment.

Complications caused by NaOCl overflow

Accidental NaOCl overflow is probably the most common accident that occurs during root canal irrigation. Even when spilled in low amounts in the patient's clothing it will rapidly and irreversibly bleach the affected area. Patients should wear a plastic protector and the dentist should be careful when handling the NaOCl near the patient.^{6,24}

Another accident commonly caused by NaOCl overflow during endodontic treatment is when the solution is sprinkled in the patient's eyes, causing inju-

ries, burns, or even loss of epithelial cells in the outer layer of the cornea, followed by instant severe pain, profuse burning and erythema.^{6,24} Treatment includes flushing the eye with large quantities of water or sterile saline solution and immediately taking the patient to an ophthalmologist. The prophylactic measure suggested is the use of eye protection during endodontic treatment for operators and patients.²⁴

Damaged skin caused by NaOCl overflow can be avoided by immediately washing the affected area with water at low pressure in order to prevent the NaOCl to spread. Allergic reactions are also reported when there is NaOCl spill during endodontic treatment. It is important for professionals to recognize the symptoms of allergy, such as hives, swelling, shortness of breath, bronchospasm and hypotension. In these situations, the patient should be urgently referred to a hospital.

Discussion

A successful endodontic therapy, related to effective cleaning and disinfection of the root canal, faces a complex anatomy which hinders its execution. Thus, in order to contribute to a better cleaning of the root canal system auxiliary chemicals substances are used for irrigation.

The NaOCl is an effective endodontic irrigating solution used at different concentrations ranging from 0.5 to 5.25%.^{6,39} According to Grossman,⁴⁰ it is the most widely used irrigant due to its ability to dissolve organic tissues as well as its antimicrobial properties, in addition to its non-specific ability to oxidize, hydrolyze and act osmotically in the tissue fluids. However, NaOCl can cause hypersensitivity as well as serious complications if it is inadvertently used,¹⁶ since it is toxic to the vital tissue, causing hemolysis, ulcers, inhibition of neutrophil migration, damage to the endothelial cells and fibroblast.⁵⁻⁹

Treatments for NaOCl complications during endodontic treatment have been described in the literature.^{6,20} However, according to Becking³¹, only some of these complications have been recorded. The most commonly reported complication is the accidental NaOCl leakage into the periapical tissues, in teeth with open foramen or when the apical constriction was broken during root canal preparation, or due to root resorption, or even because the root of the tooth may be within the maxillary sinus.^{8,14,15}

In the majority of cases reviewed, the postoperative patient who suffered this accident had severe and immediate pain, followed by gradual formation of edema and profuse bleeding and bruising. However, the majority of patients had complete resolution within a few weeks and only some of them suffered long paresthesia or scar tissue.

Another accident commonly reported in the endodontic literature is the NaOCl injection in the buccal or palatal mucosa caused by improper storage of this solution into anesthetic cartridge. According to Gursoy, Bostanci and Kosger,¹⁹ 0.1 to 0.2 mL of injected NaOCl is sufficient to cause necrosis tissue. All authors who reported^{5,7,12,13,14,19,21,27,31,32,33} this type of accident are against this form of NaOCl storage and claim that should the dentist insist on this form of storage, the cartridges must be properly identified and stored far from the cartridges containing anesthetic.

When adverse reactions occur, right conduct includes changing the irrigating solution, preventing additional reactions, calming the patient and establishing adequate analgesia. Prophylactic antibiotic therapy, corticosteroids and antihistamines should be considered to prevent infections resulting from the damage in specific cases. For immediate relief of pain, a local anesthetic should be considered. Cold compresses should be used to minimize swelling in the affected area.²⁹

Additionally, our literature review shows that the first procedure to be performed when an accident with NaOCl occurs is reassuring the patient by telling

him that cure will occur within a few days or weeks, and that symptoms are completely relieved in most cases. Afterwards, the NaOCl toxic effect must be neutralized in water or saline solution, application of ice packs in the first and second day to minimize the edema, followed by application of warm compresses to promote the liquefaction of the hematoma. According to Mehra, Clancy and Wu,¹⁸ pain should be controlled with analgesics and antibiotic therapy for two reasons: the possibility of root canal infection to diffuse into the periapical tissues with NaOCl irrigation and the presence of a significant amount of necrotic tissue and empty space that can promote a secondary infection. The most severe cases must be identified by the dentist and sent to the hospital for surgical intervention.

Conclusion

Sodium hypochlorite is an efficient irrigation solution commonly used in endodontic therapy. However, it can be highly toxic, causing serious consequences if improperly handled. It has advantages and disadvantages which should be considered according to its applicability in clinical cases. Some necessary cares should be taken to achieve treatment success when using the NaOCl and, in case of incident, the patient must be warned about the consequences and told that the recovery will occur within a short period of time. Thus, we should closely follow the problem until all signs and symptoms are resolved, making the patient feel calm and comfortable.

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