



ARTICLE REVIEW

Sodium hypochlorite irrigation accident, a literature review

Accidente por irrigación de hipoclorito de sodio, una revisión de la literatura

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ABSTRACT

Sodium hypochlorite is a substance of great application in endodontics, with a cost-benefit ratio. Despite its antimicrobial capacity to eliminate bacteria and dissolve organic tissue debris found in canals, its extrusion beyond the apical foramen leads to tissue destruction and necrosis, which can endanger the patient's health. In order to describe sodium hypochlorite irrigation accidents, a literature review was carried out. Among the most common symptoms are acute pain, inflammation, redness, hematomas, profuse bleeding, facial nerve weakness and secondary infection, sinusitis and cellulitis. Treatment includes removal of agent debris, pain control by administration of analgesics and local anesthesia, use of extraoral cold compresses for inflammation, antibiotics in cases where secondary infection is present, and surgical care if necessary.

Keywords: Sodium Hypochlorite; Accidents; Endodontics.

RESUMEN

El hipoclorito de sodio es una sustancia de gran aplicación en endodoncia, con una relación costo-beneficios. A pesar de su capacidad antimicrobiana para eliminar las bacterias y disolver los restos de tejido orgánico que se encuentran en los conductos, su extrusión más allá del foramen apical conduce a una destrucción y necrosis del tejido, lo cual puede poner en peligro la salud del paciente. Con el objetivo de describir los accidentes por irrigación de hipoclorito de sodio, se realizó una revisión de la literatura. Entre los síntomas más comunes se encuentran dolor agudo, inflamación, enrojecimiento, hematomas, hemorragia profusa, debilidad del nervio facial e infección secundaria, sinusitis y celulitis. El tratamiento incluye retirar los restos del agente, controlar el dolor mediante la administración de analgésicos y anestesia local, el uso de compresas frías extraorales para la inflamación, antibióticos en casos donde exista infección secundaria y de ser necesario la atención quirúrgica.

Palabras clave: Hipoclorito De Sodio; Accidentes; Endodoncia.

INTRODUCTION

Bacteria are the main cause of pulpal and periapical diseases, therefore, during endodontic treatment, the aim is to eliminate these bacterial populations by means of a complete disinfection, in addition to preventing reinfection in the root canal system and periapical tissues. Root canal disinfection is determined and limited by the techniques, instruments and irrigants that are available, therefore the focus should be on combating the bacteria present in the root canals.⁽¹⁾

Root canal treatment or endodontics is one of the most performed procedures in the area of dentistry to preserve dental vitality and functionality.⁽²⁾ This procedure seeks to prevent and treat the presence of diseases at the pulp level that affect the teeth.⁽³⁾ Within this treatment, different difficulties may arise that may impair the result, for example, a different anatomy of the canal, iatrogenic perforations, poor conformation of the apical stop, among others.⁽⁴⁾

One of the main objectives of root canal treatment is to provide complete decontamination of the root canal system preventing infection from spreading to the periapical tissues. Root canal asepsis is achieved by a series of sequential steps that are of paramount importance such as mechanical instrumentation and chemical irrigation.⁽⁵⁾

Successful endodontic treatment requires a combination of chemical and mechanical factors to decontaminate the root canal system, including the use of an appropriate irrigant.⁽⁶⁾ Correct shaping and effective cleaning of root canals is of great importance for successful endodontics, the complex anatomy of root canals can cause difficulties for proper disinfection, thus, it is evident that the use of various instrumentation techniques is not sufficient for disinfection.⁽⁷⁾

When a patient needs a root canal treatment, it should be performed with all the attention and professionalism of the operator in order to achieve the expected result and avoid an infectious process secondary to the initial pathology or the formation of a periapical problem that aggravates the patient's situation.⁽⁸⁾

Root canal cleaning is indispensable for the success of root canal treatment, since treatment failure is associated with the ineffective elimination of microorganisms from the root canals.⁽⁹⁾ Within the cleaning procedure it is important to talk about irrigation, which is performed using antimicrobial substances that aim to eliminate organic debris, bacteria and the smear layer.⁽¹⁰⁾

There are large areas of root canal dentin that could remain intact with mechanical instrumentation, requiring chemical means to clean and disinfect the root canal system. There are different useful chemical products, such as irrigants, disinfectants, rinses and medications that should be administered between visits, which together with the instrumentation guarantee the success of endodontic treatments.⁽⁷⁾

The techniques that make it possible to achieve the objective of adequate disinfection are mechanical instrumentation and chemical irrigation, procedures that complement each other to clean and disinfect the canals. Mainly, irrigation seeks to remove all loose, necrotic or contaminated tissues and debris from the canal before pushing them into the periapical tissues, in addition, they provide lubrication and debridement.⁽⁷⁾

Currently, there are several irrigation techniques for the removal of smear, as well as different chemicals for this procedure. Irrigation is a very important step since it continues with the elimination of bacteria from the root canals, and also destroys the residual pulp, obtaining an antibacterial and disinfectant function.⁽¹¹⁾

There are different irrigant solutions in endodontics for active disinfection during canal preparation. Among the most common substances for irrigation are sodium hypochlorite (NaClO), chelating agents such as EDTA, citric acid or chlorhexidine. The professional must know the most important characteristics of these solutions in order to determine the most suitable for disinfection.⁽¹¹⁾

Mechanical instrumentation of root canal systems is 65 % effective. Uninstrumented root canal surfaces can harbor tissue debris or microorganisms that can lead to low effectiveness of endodontic treatment. For this reason, endodontic irrigants are used in combination with instrumentation to ensure effective debridement of the root canal system.⁽¹²⁾

When selecting an irrigant solution, a number of requirements must be met: strong microbial action against a broad spectrum of microorganisms, inactivation of bacterial virulence factors, disruption or removal of biofilm, dissolution of pulp tissue debris, removal of accumulated hard tissue debris and the smear layer, among others.⁽¹³⁾

The effectiveness of chemical debridement is closely related to the ability of the irrigating substance to infiltrate the entire canal space, with the apical third of the canal being the most difficult place to irrigate due to the greater degree of anatomical complexity. Thus, it is important to implement fluid exchange at the end of the canal, bringing the tip of the needle closer to the working length of the instrumented canal.⁽⁵⁾

Complications occurring in root canal treatment are very common within dentistry. These difficulties can occur at any stage of endodontic treatment: diagnosis, treatment planning, canal opening, instrumentation, irrigation and obturation. In addition, the subsequent restoration is of great importance for the success and longevity of the treated tooth.⁽⁴⁾

Among the different irrigants, the use of NaClO as a solution for irrigation in endodontic treatments is very common, because it has the ability to dissolve necrotic and vital pulp tissue, also, it is a disinfectant against gram-positive and gram-negative broad spectrum bacteria, fungi, spores and viruses.⁽¹⁴⁾

It is worth mentioning that NaClO causes biosynthetic alterations in cell metabolism and destruction of phospholipids, forms chloramines that interfere in cell metabolism and causes an oxidative action with irreversible enzymatic inactivation in bacteria and degradation of lipids and fatty acids.⁽¹⁴⁾

The use of NaClO is indicated within the field of endodontics; however, the cytotoxic results of accidents should be noted, especially if it comes in contact with vital soft tissues outside the root canal system. Among the most common effects are hemolysis, ulceration, and tissue necrosis.⁽¹⁴⁾

METHODS

A literature review was conducted on sodium hypochlorite accidents in endodontics at the Regional Autonomous University of Los Andes between January and April 2023.

For the information search, a formula was structured using the terms "Sodium hypochlorite", "Irrigation", "Duct treatment", "Hypochlorite extrusion", "Hypochlorite accident" and their English translations, connected by means of the Boolean operators AND and OR.

The year of publication (2017-2023) and language (Spanish, English and Portuguese) were used as filters. The information search was performed in the PubMed/MedLine, Scopus and SciELO databases; the syntax of the search formula was adapted each database.

After eliminating duplicates, reading titles and abstracts and reading full texts, 27 articles were selected for the development of the present investigation.

DEVELOPMENT

First of all, when talking about NaClO irrigation, it is important to emphasize that this chemical product is very effective, economical, easily accessible and available. It is also important to note that the ideal concentration of NaClO is a subject of great controversy for specialists in root canal treatment; it is estimated that the concentration should be between 0,5 % and 5,25 %.⁽¹⁵⁾

NaClO is the most commonly used irrigant in endodontic treatments due to its high antimicrobial capacity to eliminate bacteria and dissolve the remains of organic tissue found in the canals. The effectiveness of NaClO is determined by the concentration to be used, the time of contact with the root canals and the area of exposed tissue.^(16,17)

Different studies have shown better bactericidal effects at higher concentrations, however, the greater cytotoxicity it produces should be taken into account. On the other hand, there are studies that claim that the use of 1% NaClO as an irrigant is adequate, since higher concentrations may not provide any additional effect.⁽¹⁸⁾

Despite its advantages, the high proteolytic activity of NaClO can cause damage to the patient's vital tissues, hemolysis and ulceration that alter neutrophil migration, damage to fibroblasts and endothelial cells, along with cell membrane disruption due to the alkaline pH (11-12,5) and its hypertonic character.⁽¹⁶⁾

Extrusion of sodium hypochlorite beyond the root canal into the periapical tissues causes a chemical burn-like effect leading to tissue necrosis, which may be localized or generalized.⁽¹⁹⁾

Therefore, despite the very frequent and widespread use of NaClO as the main irrigation solution during the chemical-mechanical preparation of root canals, care should be taken during its use as a slow irrigation with simultaneous aspiration and final irrigation with abundant saline solution, thus minimizing the occurrence of extravasation and damage of periapical tissues.⁽⁵⁾

The NaClO accident, known as hypochlorite extrusion, is rare. This accident is generally characterized by complications such as edema, ecchymosis, tissue necrosis, pain, and paresthesia.⁽¹⁶⁾

A NaClO accident can be defined as an inadvertent injection beyond the apical foramen, this situation can even endanger the patient's life. Among the most common features are severe pain, swelling of the surrounding mucosa, inflammation of the subcutaneous tissue and skin in subsequent hours.⁽¹⁴⁾

Hypochlorite accident commonly occurs when the substance is extruded beyond the apex, this happens especially when a conventional 30 G open-ended needle is used. Different studies have shown that 42 % of professionals of the American Board of Endodontics have had at least one sodium hypochlorite accident in their career, for this reason, it is of great relevance to know the main characteristics of this accident.⁽²⁰⁾

Extrusion of irrigation substances beyond the apical foramen can occur during the process of instrumentation in teeth with open apices, through resorption sites or external perforation along the cavity walls, ligation of the irrigation needle tip into a root canal and the use of too much irrigation pressure. This leads to tissue destruction and necrosis.⁽⁵⁾

The accident with sodium hypochlorite causes immediate acute symptoms and sequelae that can be of great severity. Among the problems that occur as mentioned above are pain despite anesthesia, profuse bleeding through the ducts, and inflammation that may appear within minutes or hours after the accident.⁽²¹⁾

Accidents created by extrusion of sodium hypochlorite through root apices are relatively rare and are rarely fatal, however, they create substantial morbidity when they do occur. Among the problems that occur as mentioned above are pain despite anesthesia, profuse bleeding through the canals and inflammation that can appear within minutes or hours after the accident.⁽²¹⁾

Accidents created by extrusion of sodium hypochlorite through root apices are relatively rare and are rarely fatal, however, they create substantial morbidity when they do occur. Three types of reported accidents are described: careless iatrogenic injection, extrusion into the maxillary sinus, and extrusion of hypochlorite beyond the root apex into the periapical area.⁽⁵⁾

Clinical picture

According to Guivarc'h et al.,⁽²¹⁾ the symptoms after hypochlorite accident turn out to be acute and of sudden onset. Intense pain is systematic, the inflammation is wide and diffuse, it extends intraorally and extraorally, beyond the site of the affected tooth. It can produce difficulties in opening the ipsilateral eye. When the extrusion involved the maxillary sinus, it presents different effects, for example, irrigation flowing through the nostrils together with the taste of NaClO in the throat. Generally, there is a burning sensation in the maxillary sinus, in addition, a sinus pistaxis and sinus congestion may occur. These symptoms turn out to be not so severe due to the fact that being extruded in an open space allows a better evacuation.

Faras et al.,⁽²²⁾ mention that the sequence of signs and symptoms seems to follow a typical pattern. According to Hulsmann's criteria, the diagnosis of NaClO accident includes the following features: acute pain, swelling and redness, bruising, progressive swelling affecting the infraorbital area or the angle of the mouth depending on the site of NaClO injection, profuse bleeding, facial nerve numbness or weakness, and secondary infection, sinusitis and cellulitis.

Treatment

Treatment when there is a hypochlorite accident is determined by the extent and rapidity of soft tissue inflammation. However, urgent hospitalization and administration of intravenous steroids and antibiotics may be required. In addition, surgical drainage or debridement may be required depending on the extent and character of the inflammation and tissue necrosis.⁽²³⁾

In cases where there is accidental extrusion of sodium hypochlorite into the periapical area, the solution should be removed as soon as possible by negative aspiration with the same irrigation syringe. The area should then be irrigated with plenty of saline solution, which will reduce the exposure time of the nerve to the irrigating substance.⁽⁵⁾

Nonsurgical management may be sufficient when treating damage caused by NaClO misuse. However, surgical intervention should be considered if the harmful effects progress, depending on the level of injury and response to treatment. This is in order to achieve decompression, facilitate drainage and improve prognosis.⁽²³⁾ Treatment should include timely referral to a maxillofacial unit.⁽²⁴⁾

Gómez Palma et al.,⁽²⁵⁾ recommends informing the patient about the cause, severity and seriousness of the problem, pain control (analgesics, local anesthesia) and the use of extraoral cold compresses for inflammation. After the first day, hot compresses and mouth rinses should be used to stimulate systemic circulation, antibiotics in cases of secondary infection, antihistamines if necessary, endodontic therapy with saline or chlorhexidine for irrigation. Similar recommendations are issued by other authors.⁽²⁶⁾

In most cases of hypochlorite accidents the symptoms were reduced in a period of two weeks. However, in more severe cases the symptoms took more than three weeks to disappear. Additionally, in most cases the healing period varies between two and three weeks, but there are cases with more complex lesions and healing periods ranging between one and two months.⁽¹⁹⁾

Risk factors and precautions

It is important to mention that the predisposing factors for an accident with sodium hypochlorite (NaClO) are diseases that cause periapical resorption, inadequate selection of the type of syringe and needle with which irrigation is performed and poor determination of the root length to be worked.⁽²⁶⁾

Another of the most common causes for sodium hypochlorite accident to occur is a misinterpretation of the working length. For this reason, that each of the steps to perform an endodontics should be carefully analyzed to work properly and achieve the expected result.⁽²⁷⁾

Other recommendations that should be taken into account is to control the insertion depth, for this you can bend the needle to the indicated length or place a rubber stopper. Lateral exit needles can be used to avoid direct extrusions towards the apex. In the same way, during irrigation the needle should be withdrawn and intruded regularly to provoke agitation and prevent the needle from getting stuck.⁽²⁵⁾

It is of great importance to mention that the introduction of the irrigation needle into the canal should always allow reflux between the injector cannula and the canal during irrigation, otherwise the reflux is obstructed thus forcing extravasation of the irrigating substance through the apical foramen.⁽⁵⁾

Prior knowledge of the determinants that cause the accident of sodium hypochlorite during irrigation are a point of great importance to avoid this problem: properly identify the root anatomy and the possible changes that can be observed by diseases that alter the apical third, shape of the canal, type of exit and needle gauge, correct selection of the needle and length at which irrigation should be performed.⁽²⁶⁾

Therefore, and based on what has been stated by several authors, a sequence of clinical care is described to avoid accidents with sodium hypochlorite: adequately prepare the access, use needles designed for endodontic purposes and have a good control of the working length; the irrigant should be directed to the canal with a low and constant pressure, leaving space for reflux by gently withdrawing the needle from the canal.

CONCLUSIONS

Sodium hypochlorite irrigation accidents have a low incidence, however, the causes and symptomatology are well defined. Despite this, there is no consensus on a specific protocol, leaving the diagnosis and therapy of choice to the dentist's knowledge.

Conflict of interest

The authors declare that there is no conflict of interest.

Authors' contribution

All authors participated in the conceptualization, formal analysis, project management, writing - original draft, writing - revision, editing and approval of the final manuscript.

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