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## Accidental sodium hypochlorite injection instead of anaesthetic solution – a literature review



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Sodium hypochlorite (NaOCl) in various concentrations is the most widely used root canal irrigant, but it can be an irritant to vital tissue. There are several reports about complications of root canal irrigation with NaOCl. Most of them are the result of accidental extrusion beyond the apex. The inadvertent injection of NaOCl instead of local anaesthetic solution is an extremely rare misuse and results in severe problems. The consequences of the inadvertent injection of sodium hypochlorite, precautions to avoid such accidents and also treatment options are discussed. Sodium hypochlorite is highly irritating when introduced into oral tissues. To avoid inadvertent injection of sodium hypochlorite during root canal treatment, NaOCl solutions should be prepared in special syringes, which are clearly distinguishable from syringes used for other solutions or anaesthetics. Lower concentration NaOCl solutions should be preferred to higher or full-strength solutions.

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### ■ Introduction

Mechanical instrumentation alone fails to achieve complete cleaning of the root canal due to the complexity of the root canal system<sup>1,2</sup>. Root canal irrigation is an integral part of root canal preparation procedures to enhance cleaning and disinfection of the root canal system. Sodium hypochlorite (NaOCl) solutions have been used in dentistry for almost 100 years<sup>3</sup> and as an important adjunct in root canal treatment for over 60 years<sup>4</sup>. During the first World War a 0.5% solution of sodium hypochlorite was used to clean contaminated wounds<sup>5</sup>. In 1920, Crane described the use of the so-called Dakin's solution (NaOCl buffered with

sodium bicarbonate) for root canal debridement and disinfection<sup>6</sup>.

At present, sodium hypochlorite is the most widely used root canal irrigant<sup>2,7</sup>. NaOCl possesses an excellent tissue dissolving capability as well as a pronounced antimicrobial efficiency against a broad spectrum of pathogens: Gram-positive and Gram-negative bacteria, fungi, spores, and viruses including the human immunodeficiency virus<sup>8–18</sup>. In addition, NaOCl has the ability to inactivate or neutralise lipopolysaccharides<sup>19–21</sup> and has the unique property to disrupt or to remove biofilms<sup>22–24</sup>. It is distinctly more effective in rendering biofilm bacteria nonviable and in physically removing the biofilm than other commonly used irrigants<sup>22</sup>.

In contrast to these advantageous properties, NaOCl has been shown to exert manifold toxic effects such as haemolysis, skin ulcerations, inhibition of neutrophil migration, damage to endothelial and fibroblast cells, facial nerve demyelination and tissue necrosis<sup>25–29</sup>. In direct contact with vital tissues, NaOCl entails acute inflammation followed by necrosis of the tissues concerned. NaOCl causes severe inflammation and cellular destruction in all tissues except heavily keratinised epithelium<sup>30</sup>. The cytotoxic effect of NaOCl on vital tissues resulting in haemolysis is well documented, and its use warrants proper care. The clinical efficacy of NaOCl relates to its nonspecific ability to oxidise, hydrolyse and osmotically draw fluids out of tissues<sup>30</sup>. Sodium hypochlorite promotes vascular permeability in blood vessels, probably as a result of damage to the vessels as well as the release of chemical mediators, such as histamine, from involved tissues. These properties cause immediate swelling and often profuse bleeding. NaOCl has a pH of approximately 11 to 12 and induces injury primarily by oxidation of proteins<sup>27</sup>. During root canal therapy, NaOCl solutions are used in concentrations varying from 0.5% to 6.15%<sup>2,27,31–33</sup>. The tissue-dissolution capability, the antimicrobial efficiency as well as the toxicity of NaOCl are dependent on the concentration of the solution, its pH, osmolarity, nature of contact and the duration of exposure<sup>7,10,11,34,35</sup>. It also needs to be taken into account that the biocompatibility is inversely proportional to the concentration of NaOCl in the solution<sup>12,34,36</sup>.

## ■ Literature review and discussion

Clinical complications have been described in the literature when inadvertent injection of NaOCl into periapical tissues, the maxillary sinus and the oral mucosa occurred. A literature search on the subject of NaOCl accidents revealed only two reports of hypersensitivity or allergic reactions to NaOCl<sup>37,38</sup> but several reports revealed different complications during root canal irrigation with NaOCl. Most of them described accidental extrusion of NaOCl through the apical foramen, accessory canals or perforations into the periapical tissues or the maxillary sinus<sup>25–27,29,39–61</sup> resulting in severe pain,

oedema, and profuse haemorrhage, both interstitially and through the tooth. Increased oedema and ecchymosis accompanied by tissue necrosis and paraesthesia occurred after several days. Secondary infection was observed only in some cases. Most of the cases had complete resolution within a few weeks but a few were marked by long-term paraesthesia or scarring. NaOCl is caustic if accidentally extruded into periapical tissues or injected into vital tissues.

Certainly, the inadvertent injection of NaOCl instead of local anaesthetic solution is an extremely rare misuse. Emphysema may develop within a short space of time. Furthermore, oedema and paraesthesia may result due to the tissue-dissolving capability of NaOCl. An even more serious development is ecchymosis, which is associated with severe pain, profuse interstitial bleeding, and haemorrhage under the skin. Only four cases of unintentional injection of NaOCl have been published up to the writing of this report, and in three cases the NaOCl injection resulted in swelling, pain, haematoma and tissue necrosis<sup>62–64</sup>. One case involved oedema in the pterygomandibular space and peritonsillar and pharyngeal areas following mandibular block injection with sodium hypochlorite. The patient was admitted to an intensive care unit for probable airway obstruction and given an opioid analgesic intravenously for pain reduction<sup>65</sup>.

NaOCl accidents are very rare in endodontic practice<sup>66</sup>. Only few case reports have been published describing these accidents and their sequelae. Keeping NaOCl solutions in anaesthetic syringes is a common procedure to simplify root canal irrigation. Despite proper labelling, NaOCl and anaesthetic cartridges may be mistaken for each other. Even though the risk of mixing up the different syringes is considerably high in daily practice, the accidental injection of NaOCl seems to be an extremely rare incident, but always associated with severe local responses followed by marked necrosis of the surrounding tissues. The caustic effects of NaOCl occur because of its alkaline pH of about 11 to 12 and hypertonicity that causes injury primarily by oxidation of proteins<sup>25,38,67</sup>. Already small amounts of injected NaOCl solution into the vestibular mucosa could result in swelling, massive tissue necrosis and ecchymosis (Figs 1–5).

**Fig 1** Massive swelling of the right cheek shortly after accidental injection of 0.5 ml of NaOCl solution (3%) into the vestibular region of the apex of tooth 45.



**Fig 2** Intraoral situation 1 day after the accident.



**Fig 3** Extraoral ecchymosis 2 days after the accident: the marked area is still numb.



**Fig 4** Intraoral situation 8 days after the accident.



**Fig 5** Extraoral ecchymosis 8 days after the accidental injection of NaOCl.

In case of a NaOCl accident, the decision for surgical intervention should be considered very carefully. Reports in the literature mentioned cases with several days of increasing oedema and ecchymosis accompanied by tissue necrosis and paraesthesia. Most of them showed complete resolution without surgical intervention within a few weeks, but long-term paraesthesia was described as well.

Management of complications related to NaOCl during root canal treatment has already been described in detail<sup>27,68,69</sup>. Any kind of intervention should depend on the nature and severity of the sodium hypochlorite accident. First, cold compresses should be used to treat the initial swelling after a NaOCl incident. Warm compresses and warm mouth rinses should be performed to stimulate the microcirculation after 1 day. Local anaesthesia and the prescription of analgesics for 3 to 7 days may be helpful to reduce the acute pain. Certainly, acetaminophen-based narcotic analgesics should be preferred and non-steroidal anti-inflammatory drugs (NSAID) should be avoided to decrease the

amount of bleeding into the soft tissues. To control inflammatory reactions, the use of anti-inflammatory drugs like methylprednisolone for a period of 2 to 3 days as well as the prophylactic antibiotic coverage with penicillin or penicillin derivatives for a period of 7 to 10 days should be considered to prevent wound infection. In case of an existing penicillin allergy, alternative antibiotics could be prescribed. Macrolids, chinolons or glycopeptides could be an alternative. The patient should be informed that healing will take some days or even weeks, and that symptoms resolve completely in most cases<sup>28,38,70</sup>.

The accidental injection of NaOCl instead of anaesthetic solution is preventable in daily practice. NaOCl prepared in standard dental syringes without any further labelling is a potentially dangerous practice. NaOCl for root canal irrigation should only be stored in labelled containers and irrigation syringes that are easily identified and carefully checked before injecting patients<sup>66</sup>. It seems reasonable to use lower concentration NaOCl solutions in view of the toxicity



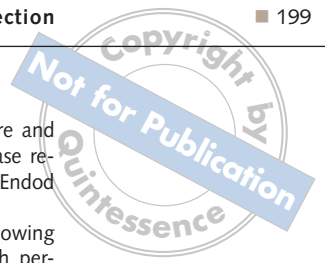
of highly concentrated sodium hypochlorite solutions. Currently there is no convincing scientific evidence for using NaOCl at higher concentrations or at 'full strength' (5.25%)<sup>2,7,71</sup>. Instead of using higher concentration solutions, the effectiveness of NaOCl can be increased by heating up less concentrated solutions to 45 to 60°C<sup>2,72</sup>. Additionally, the tissue dissolving ability of NaOCl can also be increased by sonic or ultrasonic activation, based on more active stream pattern and temperature increase<sup>73,74</sup>.

## ■ Conclusions

- Sodium hypochlorite solutions for root canal irrigation should be prepared in special syringes, which are clearly distinguishable from those used for local anaesthesia, or in unequivocally and easily discernible labelled syringes.
- Always inspect the anaesthetic solution prior to injection regarding colour and bubbles.
- Lower concentration NaOCl solutions should be preferred to higher or full-strength solutions.

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