

## Anatomy of Sodium Hypochlorite Accidents

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### Abstract

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Sodium hypochlorite (NaOCl) in various concentrations is the most widely used endodontic irrigant, but it can be an irritant to vital tissues. There are several reports about the complications of irrigation with NaOCl during root canal therapy. Most of the complications are the result of accidental extrusion of the solution from the apical foramen or accessory canals or perforations into the periapical area. This article is a review and comparison of all reported NaOCl accidents in the literature.

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**Omid Mehdipour, DDS**  
International Student Program

**Donald J. Kleier, DMD**  
Professor and Chairman

**Robert E. Averbach, DDS**  
Professor of Endodontics

Division of Endodontics  
University of Colorado  
School of Dental Medicine  
Aurora, Colorado

The impetus behind root canal cleaning and shaping is the elimination of tissue remnants, bacteria, and toxins from the root canal system. This is generally accepted to be a major factor in the success of root canal treatment. Mechanical procedures alone are insufficient for total canal cleaning. Residual pulpal tissue, bacteria, and dentin debris may persist in the irregularities of canal systems. Therefore, irrigating solutions should support and complement endodontic preparation. These irrigants should flush out dentin debris, dissolve organic tissue, disinfect the canal system, and provide lubrication during instrumentation, without irritating the surrounding tissues. Some of the irrigants currently used include hydrogen peroxide, physiologic saline, water, sodium hypochlorite (NaOCl), chlorhexidine, and electrochemically activated water.

Because of its physicochemical and antibacterial properties, NaOCl is one of the most popular irrigants. A 0.5% solution of NaOCl was used effectively during World War I to clean contaminated wounds.<sup>1</sup> In 1920, Crane described the use of Dakin's solution (NaOCl buffered with sodium bicarbonate) for root canal debridement and sterilization. Since then NaOCl has become a popular and effective intracanal irrigant.<sup>2</sup> It is an inexpensive, readily available, and easily used chemical that usually rates well in research.<sup>3,4</sup>

A variety of NaOCl concentrations ranging from 0.5% to 5.25% have been advocated, as well as a variety of temperatures. The longer the solution can remain in contact with tissue, the higher the temperature of the solution, and the higher the concentration, the greater the ability of NaOCl to dissolve the tissue.<sup>5-7</sup> The optimum concentration for use clinically is still a matter of controversy. Consequently, the clinician must decide on the concentration and temperature of the NaOCl and the potential consequences of this choice.<sup>5,8,9</sup>

### Advantages of NaOCl

The ability of NaOCl to dissolve organic soft tissue of the pulp and predentin is a result of oxidation. The powerful oxidative activity of hypochlorite not only dissolves the pulpal and dentinal tissue but also acts as a

potent antimicrobial agent.<sup>3</sup> It is well recognized to be effective against a broad range of pathogens: gram-positive and gram-negative bacteria, fungi, spores, and viruses including the human immunodeficiency virus.<sup>10</sup>

NaOCl, especially when used in high concentrations, is known to be effective in dissolving organic tissue remnants and disinfecting the canal system.<sup>4</sup> Effective concentrations of NaOCl range from 2.6% to 5.25%. The dilution of NaOCl was suggested because it has been proved that concentrations over 0.5% are cytotoxic.<sup>11</sup>

Compared with a chlorhexidine gel, NaOCl not only has a higher capacity to kill microorganisms but is also more able to remove cells from the root canal.<sup>12</sup> Water is not effective in removing dentine debris from grooves in the apical portion of root canals.<sup>13</sup>

## Disadvantages of NaOCl

Acute inflammation followed by necrosis results when NaOCl comes into contact with vital tissue. It causes severe inflammation and cellular destruction in all tissues except heavily keratinized epithelium.<sup>5</sup> The cytotoxic effect of 5.25% NaOCl on vital tissues, resulting in hemolysis, is well documented, and its use warrants proper care. The clinical efficacy of NaOCl relates to its nonspecific ability to oxidize, hydrolyze, and osmotically draw fluids out of tissues.<sup>5</sup>

The severity of the reaction depends on the concentration of the solution, its pH, and the duration of exposure. NaOCl has a pH of 11 to 12.5, which causes injury primarily by oxidation of proteins. In high concentrations, severe necrotic changes could be observed.<sup>14</sup> The higher concentrations also have some irritating effects on the periodontal ligament.<sup>15</sup> One report cites periodontal side effects of NaOCl with lower concentrations.<sup>16</sup> However, when confined to the canal space as an intracanal endodontic irrigant, clinical toxicity of NaOCl is no greater than the clinical toxicity of normal saline solution.<sup>6</sup>

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NaOCl causes 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 tissue. This characteristic causes immediate swelling and often profuse bleeding through the root canal when NaOCl is not used properly as an endodontic irrigant.<sup>17</sup>

There is only 1 report of hypersensitivity to NaOCl, which can easily be detected by skin patch testing.<sup>18</sup> There are reports about the effects of improper use of NaOCl, including inadvertent injection into the maxillary sinus<sup>19</sup> or splashing solution into the eyes.<sup>20</sup> The extrusion of NaOCl can cause facial nerve weakness in addition to other soft-tissue damage.<sup>21</sup> In addition to its toxicity to

vital tissues, NaOCl has an unpleasant odor and causes damage if it comes into contact with clothing.<sup>22</sup>

There are 2 reports of inadvertently injecting NaOCl instead of anesthetic solution. One resulted in severe palatal tissue necrosis,<sup>23</sup> and the second involved edema in the pterygomandibular space and peritonsillar and pharyngeal areas because of mandibular block injection with NaOCl instead of anesthetic solution. In the second case, the patient was admitted to an intensive care unit for probable airway obstruction and given opioid analgesic intravenously for pain reduction.<sup>24</sup> Damage to permanent tooth follicles, peripheral tissue, and oral mucosa have been reported during careless NaOCl use in pediatric endodontics.<sup>25</sup> There are only a small number of cases in the literature that have reported postoperative skin complications, long-term paresthesia, and altered nerve sensations arising from the use of NaOCl as an endodontic irrigant.<sup>26</sup>

**The clinician must decide on the concentration and temperature of the NaOCl and the potential consequences of this choice.**

There are 23 reported cases of NaOCl accidents in the literature (Table 1).<sup>14,19,21,26-41</sup> Almost all of the cases have similar sequelae including severe pain, edema, and profuse hemorrhage both interstitially and through the tooth. The reports mentioned several days of increasing edema and ecchymosis accompanied by tissue necrosis and paresthesia; in some cases, secondary infections have been observed. Most of the cases had complete resolution within a few weeks but a few were marked by long-term paresthesia or scarring. Remaining residual paresthesia indicates some permanent damage to the nerve endings in the affected area.<sup>36</sup>

## NaOCl Accident Management

Proper management of a NaOCl accident is important for achieving the best outcomes. The following lists some important factors for managing a NaOCl accident:

- Early recognition of the problem; the patient should be informed of the cause and nature of the accident (Table 2)
- Immediate irrigation of the canal with normal saline to dilute the NaOCl
- Allow bleeding response to flush the irritant out of the tissues
- Reassure patient
- Provide patient with both verbal and written home care instructions
- Monitor the patient

After the NaOCl accident has been recognized and the patient has been informed, the authors recommend a treatment that focuses on palliative care, including cold and warm compresses, saline rinses, pain control,

**Table 1—Case reports of sodium hypochlorite accident**

Author	Tooth	Age	Sex	Diagnosis	Considerations	Dilution (%)	Healing
Witton et al (2005) <sup>21</sup>	7	43	F	CAP RCT by GP and had RCT 2 days earlier	Sinus tract on buccal radiographically normal	Unknown	6 months
Witton et al (2005) <sup>21</sup>	15	44	F	Unknown	Radiographic PA normal	Unknown	3 months
Gernhardt et al (2004) <sup>27</sup>	21	49	F	External root resorption, Irreversible pulpitis	PDL widening and PA normal	5.25	2 months
Hales et al (2001) <sup>28</sup>	12	78	F	Irreversible pulpitis AAP	Normal radiographic appearance	5.25	3 months
Hülsmann and Hahn (2000) <sup>29</sup>	11	55	M	Unknown	Incorrect working length determination	3	1 week
Mehra et al (2000) <sup>30</sup>	H	51	F	Had RCT 2 weeks before	Unknown	Unknown	Unknown
Kavanagh and Taylor (1998) <sup>31</sup>	4	37	M	Lead to extraction	Air fluid level in right maxillary sinus in radiograph	Unknown	Unknown
Tosti et al (1996) <sup>32</sup>	12	49	F	Deep caries and RCT	Unknown	Unknown	1 month
Tosti et al (1996) <sup>32</sup>	7	46	F	Unknown	Unknown	Unknown	Unknown
Cymbler and Ardakani (1994) <sup>33</sup>	9	39	F	Extensive decay	PA radiolucency	2	6 weeks
Califkkan et al (1994) <sup>34</sup>	9	32	F	3+ to skin scratch allergy test	Mid-root fracture	1	10 days
Linn & Messer (1993) <sup>35</sup>	13	38	F	Perforated root	Paresthesia for 3 months	Unknown	6 weeks
Ehrich et al (1993) <sup>19</sup>	3	22	M	Exposed by caries	Taste of chlorine in the throat	5.25	Unknown
Joffe (1991) <sup>36</sup>	11	81	F	Unknown	Unknown	5.25	3 months
Gatot et al (1991) <sup>14</sup>	8	32	F	Retreatment	Scar on right cheek, right eye pain, blurry vision	5.25	Unknown
Becking (1991) <sup>37</sup>	18	42	F	Perforation at buccal and into CEJ	Necrosis from incisor to molar and anesthesia of mental nerve	Unknown	2 months
Becking (1991) <sup>37</sup>	15	31	F	Irreversible pulpitis	Chlorine smell and taste in throat	Unknown	2 weeks
Becking (1991) <sup>37</sup>	20	29	M	Unknown	Anesthesia of mental nerve	Unknown	1 month
Neaverth and Swindle (1990) <sup>38</sup>	10	52	F	Calcified coronal half of canal	Tooth extracted	Unknown	3 weeks
Sabala and Powell (1989) <sup>39</sup>	13	58	M	Persistent pain	Percussion positive, broken instrument 3 mm to apex	5.25	Unknown
Reeh and Messer (1989) <sup>26</sup>	8	44	F	Retreatment	Fistula and erythema to infraorbital area	1	Paresthesia for 15 months
Grob (1984) <sup>40</sup>	10	52	F	Underfilled RCT Retreatment	Apex perforated	3	Hyperesthesia for 4 years
Becker et al (1974) <sup>41</sup>	6	23	F	Deep caries and pulp exposure	Normal PA	5.25	1 month

CAP indicates chronic apical periodontitis; GP, general practitioner; RCT, root canal treatment; PA, periapical; PDL, periodontal ligament; AAP, acute apical periodontitis; H, maxillary left primary canine; CEJ, cemento enamel junction.

prophylactic antibiotics, steroid therapy, and monitoring (Table 3). It is important to reassure the patient throughout treatment because of the amount of time it will take for the inflammation to resolve.

### Avoiding NaOCl Accidents

The following steps can help clinicians avoid NaOCl accidents:

- Adequate access preparation
- Good working length control

- Irrigation needle placed 1 mm to 3 mm short of working length
- Needle placed passively and not locked in the canal
- Irrigant expressed into the root canal slowly
- Constant in and out movements of the irrigating needle into the canal space
- “Flowback” of solution as it is expressed into the canal should be observed
- Use side delivery needles that are specifically designed for endodontic purposes

**Table 2—How to recognize a NaOCl accident**

- Immediate severe pain (for 2-6 minutes)
- Ballooning or immediate edema in adjacent soft tissue because of perfusion to the loose connective tissue
- Extension of edema to a large site of the face such as cheeks, periorbital region, or lips
- Ecchymosis on skin or mucosa as a result of profuse interstitial bleeding
- Profuse intraoral bleeding directly from root canal
- Chlorine taste or smell because of injected NaOCl to maxillary sinus
- Severe initial pain replaced with a constant discomfort or numbness, related to tissue destruction and distension
- Reversible or persistent anesthesia
- Possibility of secondary infection or spreading of former infection

**Table 3—How to treat a NaOCl accident**

- Remain calm and inform the patient about the cause and nature of the complication.
- Immediately irrigate with normal saline to decrease the soft-tissue irritation by diluting the NaOCl.
- Let the bleeding response continue as it helps to flush the irritant out of the tissues.
- Recommend ice bag compresses for 24 hours (15-minute intervals) to minimize swelling.
- Recommend warm, moist compresses after 24 hours (15-minute intervals).
- Recommend rinsing with normal saline for 1 week to improve circulation to the affected area.
- For pain control
  - Initial control of acute pain could be achieved with anesthetic nerve block.
  - Acetaminophen-based narcotic analgesics for 3 to 7 days (NSAID analgesic should be avoided to decrease the amount of bleeding into the soft tissues).
- Prophylactic antibiotic coverage for 7 to 10 days to prevent secondary infection or spreading of the present infection.
- Steroid therapy with methylprednisolone for 2 to 3 days to control inflammatory reaction.
- Daily contact to monitor recovery.
- In severe cases such as respiratory distress, accessing the local emergency service via 911 is appropriate.
- Reassure the patient about the lengthy resolution of the inflammatory reaction.
- Provide the patient with both verbal and written home care instructions.
- Monitor the patient for pain control, secondary infection, and reassurance.

## Discussion

NaOCl is tissue cytotoxic. When it comes into contact with tissue, it causes hemolysis and ulceration, inhibits neutrophil migration, and damages endothelial and fibroblast cells.<sup>14,42</sup> Incorrect determination of working length, lateral perforation, and wedging of the irrigating needle are the most common procedural accidents associated with adverse NaOCl reactions.<sup>29</sup>

The optimal clinical concentration of NaOCl is still controversial. A 1% concentration of NaOCl provides tissue dissolution and an antimicrobial effect, but the concentration reported in the literature has been as high as 5.25%.<sup>43,44</sup> Evidence demonstrates that high concentrations of NaOCl have enhanced antimicrobial activity.<sup>45</sup> Irrigation time may increase the antimicrobial effect of endodontic irrigants without affecting the surrounding tissues. It has been found that 0.5% NaOCl had nearly

the same bactericidal effect as 5.25% NaOCl when used for 30 minutes.<sup>46</sup>

After a NaOCl accident, early and aggressive treatment is advocated to reduce potentially serious complications. The use of antibiotics is recommended because there is a possibility of tissue necrosis and infection.<sup>47</sup> Steroids also may be useful.

Depending on the degree of injury, some cases might require surgical intervention. The aim of any surgical procedure should be to provide decompression and facilitate drainage, and to create an environment conducive to healing. The other advantage of surgery is meticulous debridement of grossly necrotic tissue and direct irrigation of affected sites.<sup>25</sup>

## Conclusion

NaOCl is an effective antibacterial agent but can be highly irritating when it comes in contact with vital tissue. Most of the reported complications occurred because of incorrect determination of endodontic working length, iatrogenic widening of the apical foramen, lateral perforation, or wedging of the irrigating needle. If a perforation or open apex exists, then great care should be exercised to prevent a NaOCl accident or an alternative irrigation solution should be considered.

## References

1. Dakin HD. The use of certain antiseptic substances in treatment of infected wounds. *Br Med J*. 1915;2:318-320.
2. Crane AB. *A Practicable Root Canal Technique*. 1st ed. Philadelphia, Pa: Lea & Febiger; 1920:69.
3. Mentz TC. The use of sodium hypochlorite as a general endodontic medicament. *Int Endod J*. 1982;15:132-136.
4. Ayhan H, Sultan N, Cirak M, et al. Antimicrobial effects of various endodontic irrigants on selected microorganisms. *Int Endod J*. 1999;32:99-102.
5. Thé SD, Maltha JC, Plasschaert JM. Reactions of guinea pig subcutaneous connective tissue following exposure to sodium hypochlorite. *Oral Surg Oral Med Oral Pathol*. 1980;49:460-466.
6. Nakamura H, Asai K, Fujita H, et al. The solvent action of sodium hypochlorite bovine tendon collagen, bovine pulp, and bovine gingiva. *Oral Surg Oral Med Oral Pathol*. 1985;60:322-326.
7. Pashley EL, Bridson NL, Bowman K, et al. Cytotoxic effects of NaOCl on vital tissue. *J Endod*. 1985;11:525-528.
8. Harrison JW, Svec TA, Baumgartner JC. Analysis of clinical toxicity of endodontic irrigants. *J Endod*. 1978;4:6-11.
9. Lamers AC, van Mullem PJ, Simon M. Tissue reactions to sodium hypochlorite and iodine potassium iodide under clinical conditions in monkey teeth. *J Endod*. 1980;6:788-792.
10. Resnik L, Veren K, Salahuddin SZ, et al. Stability and inactivation of HTLV-III/LAV under clinical and laboratory environments. *JAMA*. 1986;255:1887-1891.
11. Spangberg L, Engström B, Langeland K. Biologic effect of dental materials. 3. Toxicity and antimicrobial effect of endodontic antiseptics in vitro. *Oral Surg Oral Med Oral Pathol*. 1973;36:856-871.
12. Vianna ME, Horz HP, Gomes BP, et al. In vivo evaluation of microbial reduction after chemo-mechanical preparation of human root canals containing necrotic pulp tissue. *Int Endod J*. 2006;39:484-492.
13. van der Sluis LW, Gambarini G, Wu MK, et al. The influence of

- volume, type of irrigant and flushing method on removing artificially placed dentine debris from the apical root canal during passive ultrasonic irrigation. *Int Endod J*. 2006;39:472-476.
14. Gatot A, Arbelle J, Leiberman A, et al. Effects of sodium hypochlorite on soft tissues after its inadvertent injection beyond the root apex. *J Endod*. 1991;17:573-574.
  15. Tanomaru Filho M, Leonardo MR, Silva LA, et al. Inflammatory response to different endodontic irrigating solutions. *Int Endod J*. 2002;35:735-739.
  16. Watts A, Paterson RC. Atypical lesions detected during a study of short-term tissue responses to three different endodontic instrumentation techniques. *Endod Dent Traumatol*. 1993;9:200-210.
  17. Rutberg M, Spangberg E, Spangberg L. Evaluation of enhanced vascular permeability of endodontic medicaments in vivo. *J Endod*. 1977;3:347-351.
  18. Kaufman AY, Keila S. Hypersensitivity to sodium hypochlorite. *J Endod*. 1989;15:224-226.
  19. Ehrlich DG, Brian JD Jr, Walker WA. Sodium hypochlorite accident: inadvertent injection into maxillary sinus. *J Endod*. 1993;19:180-182.
  20. Ingram TA 3rd. Response of the human eye to accidental exposure to sodium hypochlorite. *J Endod*. 1990;16:235-238.
  21. Witton R, Henthorn K, Ethunandan M, et al. Neurological complications following extrusion of sodium hypochlorite solution during root canal treatment. *Int Endod J*. 2005;38:843-848.
  22. Serper A, Ozbek M, Calt S. Accidental sodium hypochlorite-induced skin injury during endodontic treatment. *J Endod*. 2004;30:180-181.
  23. Gursoy UK, Bostanci V, Kosger HH. Palatal mucosa necrosis because of accidental sodium hypochlorite injection instead of anesthetic solution. *Int Endod J*. 2006;39:157-161.
  24. Herrmann JW, Heicht RC. Complications in therapeutic use of sodium hypochlorite. *J Endod*. 1979;5:160-163.
  25. Onça O, Hoffgör M, Hilmio lu S, et al. Comparison of antibacterial and toxic effects of various root canal irrigants. *Int Endod J*. 2003;36:423-432.
  26. Reeh ES, Messer HH. Long-term paresthesia following inadvertent forcing of sodium hypochlorite through perforation in maxillary incisor. *Endod Dent Traumatol*. 1989;5:200-203.
  27. Gernhardt CR, Eppendorf K, Kozlowski A, et al. Toxicity of concentrated sodium hypochlorite used as an endodontic irrigant. *Int Endod J*. 2004;37:272-280.
  28. Hales JJ, Jackson CR, Everett AP, et al. Treatment protocol for the management of a sodium hypochlorite accident during endodontic therapy. *Gen Dent*. 2001;49:278-281.
  29. Hülsmann M, Hahn W. Complications during root canal irrigation—literature review and case reports. *Int Endod J*. 2000;33:186-193.
  30. Mehra P, Clancy C, Wu J. Formation of facial hematoma during endodontic therapy. *J Am Dent Assoc*. 2000;131:67-71.
  31. Kavanagh CP, Taylor J. Inadvertent injection of sodium hypochlorite to the maxillary sinus. *Br Dent J*. 1998;185:336-337.
  32. Tosti A, Piraccini BM, Pazaggia M, et al. Severe facial edema following root canal therapy. *Arch Dermatol*. 1996;132:231-233.
  33. Cymbler DM, Ardakani P. Sodium hypochlorite injection into periapical tissues. *Dent Update*. 1994;21:345-346.
  34. Califlkkan MK, Türkün M, Alper S. Allergy to sodium hypochlorite during root canal therapy: a case report. *Int Endod J*. 1994;27:163-167.
  35. Linn JL, Messer HH. Hypochlorite injury to the lip following injection via a labial perforation. Case report. *Aust Dent J*. 1993;38:280-282.
  36. Joffe E. Complication during root canal therapy following accidental extrusion of sodium hypochlorite through the apical foramen. *Gen Dent*. 1991;39:460-461.
  37. Becking AG. Complications in the use of sodium hypochlorite during endodontic treatment. Report of three cases. *Oral Surg Oral Med Oral Pathol*. 1991;71:346-348.
  38. Neaverth EJ, Swindle R. A serious complication following the inadvertent injection of sodium hypochlorite outside the root canal system. *Compend Cont Educ Dent*. 1990;11:474-481.
  39. Sabala CL, Powell SE. Sodium hypochlorite injection into periapical tissues. *J Endod*. 1989;15:490-492.
  40. Grob R. [An incident with sodium hypochlorite—only my error?]. *Schweiz Monatsschr Zahnmed*. 1984;94:661-662.
  41. Becker GL, Cohen S, Borer R. The sequelae of accidentally injecting sodium hypochlorite beyond the root apex. Report of a case. *Oral Surg Oral Med Oral Pathol*. 1974;38:633-638.
  42. Kozol RD, Gillies C, Elgebaly SA. Effects of sodium hypochlorite (Dakin's solution) on cells of the wound module. *Arch Surg*. 1988;123:420-427.
  43. Harrison JW. Irrigation of the root canal system. *Dent Clin North Am*. 1984;28:797-808.
  44. Spangberg L. Instruments, materials, and devices. In: Cohen S, Burns RC, eds. *Pathways of the Pulp*. 9th ed. St Louis, Mo: Mosby; 1980:545-546.
  45. Yesilsoy C, Whitaker E, Cleveland D, et al. Antimicrobial and toxic effects of established and potential root canal irrigants. *J Endod*. 1995;21:513-515.
  46. Gomes BP, Ferraz CC, Vianna ME, et al. In vitro antimicrobial activity of several concentrations of sodium hypochlorite and chlorhexidine gluconate in the elimination of *Enterococcus faecalis*. *Int Endod J*. 2001;34:424-428.
  47. Marais JT, Williams WP. Antimicrobial effectiveness of electro-chemically activated water as an endodontic irrigation solution. *Int Endod J*. 2001;34:237-243.

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