# Sodium hypochlorite accident—complications, management and potential prevention: a report of three cases

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**Background:** Sodium hypochlorite (NaOCl) is a powerful irrigant for endodontic treatment. But, when extruded beyond the root apex, it becomes cytotoxic to patient's tissues causing NaOCl accidents. The complications include ulceration to the soft tissues and irritation of nerves causing long term symptoms. Being under- or poorly-reported, this report presents cases for complications of NaOCl accident. Complying to the suggested criteria for well-reported NaOCl accidents, the report aims to help—with others—in clarifying the full picture of the situation Accordingly, a standardized plan for its prevention and management would be possible.

**Case Description:** The current report presents three cases of females with post-NaOCl accident symptoms after performing endodontic treatment for a maxillary anterior tooth. The three patients presented after days of the accident with a deep ulcer in the buccal vestibule related to the treated tooth. Each case suffered from a further different complication in the form of: paresthesia of the infraorbital nerve in the first case, transient partial facial palsy beside the sensory deficit in the second case, and necrosis and deepening of the oral ulcer in the third patient. The cases received roughly the same treatment of oral ulcer debridement and dressing application, followed by antibiotic and analgesic prescription. Vitamin B12 supplements were prescribed in case of neural deficits and warm fomentations were advised in case of extraoral swelling. In all cases, post-operative instructions included strict hygiene of the intraoral lesion and daily repeated saline irrigation. The oral ulcers healed within 8 weeks while the neurological deficits were improving by the fourth month.

**Conclusions:** This report emphasizes on the importance of using packs, complying to strict hygiene and prescribing vitamin B12 supplements in improving and accelerating healing of prolonged post-NaOCl accident symptoms. The report may also help anticipate the prognosis of NaOCl accidents with different severities and presentations. Showing the severity of the complications, the report further highlights on the importance of the accident's prevention, so that all these sequelae would be avoided.

**Keywords:** Case report; facial palsy; infraorbital anaesthesia; sodium hypochlorite accident (NaOCl accident); postoperative trigeminal anaesthesia

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## Introduction

Sodium hypochlorite (NaOCl) is ranked as the most acceptable irrigant used in root canal treatment (1). It is preferred due to its rapid oxidizing action that dissolves organic soft tissues; providing profound debridement and root canal disinfection (1,2). However, this oxidative power serves as a double-edged weapon; where any unintentional contact of the solution with the patient's vital tissues or extrusion beyond the apical foramen would cause acute inflammation, dissolution, and necrosis of the tissues. Such a condition is named NaOCl accident (2).

It typically manifests as severe acute pain, profuse bleeding through the root canal, and acute diffuse swelling intra- or extra-orally; with or without delayed (hours or days) appearance of facial hematomas. Some cases further show symptoms of chemical burn in the form of mucosal and bone necrosis that may be accompanied by purulent discharge. Chemical irritation to the nerves was also reported. Consequently, sensory and/or motor defects occur depending on the affected nerve; where Trigeminal nerve affection causes residual anaesthesia or paresthesia; while facial nerve affection causes facial palsy. Furthermore, trismus, ophthalmologic symptoms and life-threatening Ludwig's angina were reported as well (2).

### Highlight box

**Key findings**

- Neural deficits secondary to sodium hypochlorite (NaOCl) accidents are suggested to be more probable in patients having systemic neurological comorbidities.

**What is known and what is new?**

- It was known that mucosal ulcers secondary to NaOCl accidents heal within 2 months while neurological defects take several months for healing.
- The report presents follow-up data for cases with deep necrotic intraoral ulcer with secondary infection, sensory and motor dysfunction.
- It showed oral ulcers require strict hygiene measures at home for proper healing.

**What is the implication and what should change now?**

- Vitamin B12 supplements are recommended as an adjunctive therapy in cases of neurological deficits.
- In cases of oral ulceration, surgical debridement is recommended to be followed by applying post-debridement pack to the defect.
- Strict prolonged post-operative hygiene using repeated daily saline mouthwash is a pivotal step in treatment of oral ulceration secondary to NaOCl accidents.

All the aforementioned data was obtained from case reports of accidents and its management techniques. Although the published case reports seem plentiful (3), when a systematic review was performed attempting to combine the data to draw a clear picture of the disease prevention and management, the authors were challenged with uneven overviews of the reported data. Unsystematic methods of reporting and missing important pieces of information represented obstacles to drawing sound conclusions with confidence. Therefore, they concluded a list of criteria that should be reported in case reports concerning NaOCl accidents (2). Case reports with ample data and standardized reporting methods are expected to enable universal guidelines for preventing and managing NaOCl accidents (2).

Fulfilling this list of criteria, we—herein—present three cases of NaOCl accidents with different complications; together with their management and follow-up data. We present this article in accordance with the CARE reporting checklist (available at https://fomm.amegroups.com/article/view/10.21037/fomm-23-41/rc).

## Case presentation

### *Case 1*

A 50-year-old female patient complained of severe burning sensation at her upper lip and; complete loss of sensation of the right corner of the mouth and the skin of the right side of the nose. The complaints started after root canal treatment procedure of the maxillary right first premolar. An undergraduate student performed the procedure for the diabetic patient with proper rubber dam isolation and using 3% NaOCl irrigant. After the canals were completely cleaned and shaped, they were flushed with a wedged needle. Instantaneously, the patient complained of severe pain that was diagnosed as NaOCl accident. Although, the immediate management steps are unknown to the authors, it was known that the procedure was aborted on the spot and the tooth was temporized.

Three days after the procedure, the patient was referred to the Oral Medicine department for the management of a recently discovered intraoral ulcer. Extraoral examination revealed a unilateral diffuse oval tense swelling at the right infraorbital region that was extremely painful. Otherwise, the infraorbital branch of the maxillary nerve showed complete anaesthesia. Also, the buccal and mandibular branches of the facial nerve showed impaired function;

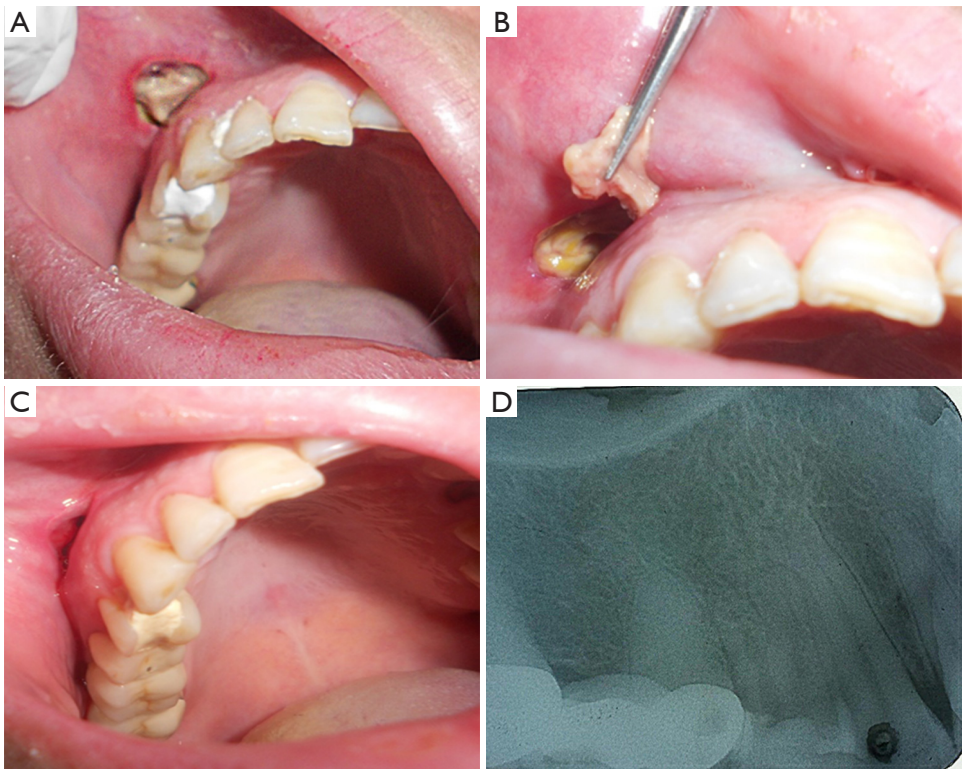


**Figure 1** Clinical photographs of case 1. (A) At the time of presentation: the necrotic ulcer had dimensions of 7 mm height and 8 mm width, and was surrounded by inflammatory halo; (B) the necrotic tissue forming a membrane that was cleared away through debridement; (C) post-operative picture after 4 weeks of follow-up; (D) periapical radiograph of the affected premolar.

where the patient was unable to puff her right cheek or show her right teeth with a wide smile.

Furthermore, intraoral examination (*Figure 1*) revealed perforation and necrosis of the mucosa of the buccal vestibular fold related to the maxillary right first and second premolars (*Figure 1A*). Periapical radiograph of the affected premolar showed intact roots with slight widening of the periodontal membrane space periapically (*Figure 1D*).

On the day of presentation, the vestibular perforation was thoroughly debrided to remove the necrotic tissues; and irrigated by saline followed by applying a Eugenol-containing dressing in the ulcer (*Figure 1B*). For the swelling, amoxicillin clavulanate (augmentin 1 g, GlaxoSmithKline, UK) was prescribed twice daily for 1 week; together with applying warm fomentation over the swollen area extraorally three times daily and irrigating the intraoral vestibular perforation by saline at home. For the pain, paracetamol (paracetamol 500 mg, ElNour Pharmaceutical Chemicals Co., Egypt) was prescribed thrice daily for 1 week. Lastly, for the anaesthesia, vitamin B12 intramuscular supplements (Depovit B12—1,000 µg/1 mL, Amriya Pharm. Ind., Alexandria, Egypt) were prescribed twice weekly to help neural regeneration and healing.

After 1 month (on week 4), the intraoral ulcer was almost healed (*Figure 1C*); however, the infraorbital swelling and the pain persisted 2 more weeks (week 6). On the other hand, the sensory and motor neural deficits were gradually being healed but not completely reversed after 4 months (week 18).

### *Case 2*

A 65-year-old female patient was referred to the Oral Medicine clinic. The patient had history of controlled hypertension and unclear history of neurological motor weakness of the lower limbs. One week earlier, the maxillary right first premolar was endodontically treated by an undergraduate student to be used as an abutment for an overdenture. The patient reported: "*I felt acute severe pain during the last appointment of root canal treatment after the dentist had applied certain material.*" Nonetheless, the canals were obturated at the same visit. When she returned

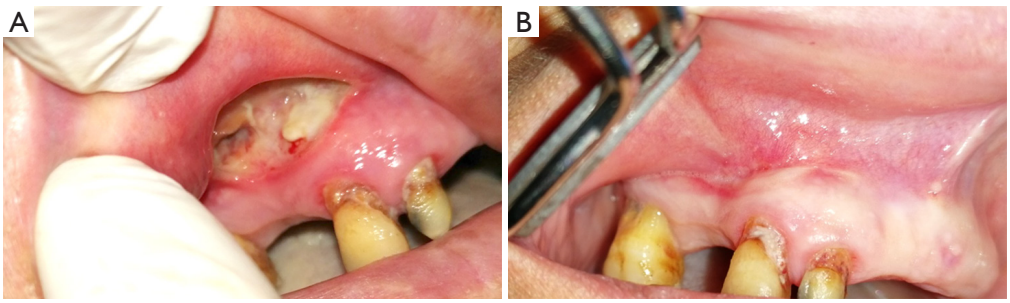


**Figure 2** The clinical pre- and post-operative presentation of case 2. (A) The ulcer at the time of first presentation appearing as an ovoid deep ulcer of dimensions (19.5 mm width × 9.2 mm height) was located at the buccal vestibule apical to the upper right first premolar. The ulcer had a regular edge, freely moving base and was surrounded by a very thin erythematous halo; (B) post-operative clinical picture of the healed ulcer after 6 weeks of follow-up.

home, the patient reported having a facial swelling that she managed by an antibiotic. Afterwards, she complained of persistent paresthesia in the right side of the upper lip, the skin of the right side of the nose and the right cheek.

One week later (on week 1), during routine preoperative examination at the removable prosthodontics clinic, a painless intraoral ulcer was detected. So, Oral Medicine department was consulted. Extraorally, paresthesia in the infraorbital nerve was detected with no other signs of swelling or hematoma. Intraorally, an ovoid deep ulcer of dimensions (19.5 mm width × 9.2 mm height) was found at the buccal vestibule apical to the upper right first premolar. The ulcer had a regular edge, freely moving base and was surrounded by a very thin erythematous halo (*Figure 2A*).

Although the patient did not even recognize the presence of any intraoral abnormality, she could clearly link the start of the paresthesia to the time of the last visit of the endodontic treatment. Therefore, the differential diagnosis list included mishaps that the endodontist may have performed. As a necrotic ulcer the list included chemical burn due to iatrogenic placement of a chemical irritant in the vestibule. However, direct contact of a caustic chemical to the mucosa would not cause paresthesia to the whole infraorbital branch of the maxillary nerve (4). Together with the history of acute pain and swelling during that last visit of endodontic treatment, the case was diagnosed as NaOCl accident; causing chemical burn to the overlying mucosa and chemical irritation to the infraorbital nerve.

Although the immediate management of the accident together with the duration of the lesion were not exactly known to the authors, management started as soon as the case was detected exactly as the protocol followed for case 1. The ulcer was debrided under local anaesthesia with copious saline irrigation, followed by dressing application. Post-operative instructions included daily irrigation of the lesion at home using saline with vitamin B12 and antibiotic prescription. However, due to absence of pain in this case, analgesics were not prescribed.

During the follow-up period, it took 6 weeks for the ulcer to heal after the debridement procedure (*Figure 2B*); while, after 3 months of the accident (week 12), the paresthesia was greatly reduced but not completely healed.

### *Case 3*

A 46-year-old anemic female patient presented with severe burning sensation in the inner side of the upper lip. The complaint started after the last visit of endodontic treatment of the maxillary 2 central incisors. The incisors were being endodontically treated for preparing them to be abutments to an overdenture. Just before obturation, the undergraduate student flushed the canals with 3% NaOCl using a wedged large needle. Although using proper isolation by rubber dam, the patient felt immediate severe pain. Consequently, the student flushed the canals with saline, dried them and finished the obturation.

One week later, the patient presented with a deep ulcer in the depth of the upper labial vestibule at the midline of 23 mm width × 20 mm height whose floor was covered by a pseudomembrane. The ulcer was debrided and irrigated using saline, followed by prescribing antibiotics and analgesics. However, the patient was not instructed about the hygiene of the lesion. After 1 more week (week 2), the patient presented with a much bigger ulcer measuring 30 mm width × 25 mm height and having a floor that is covered by a foul-smelling yellowish green necrotic

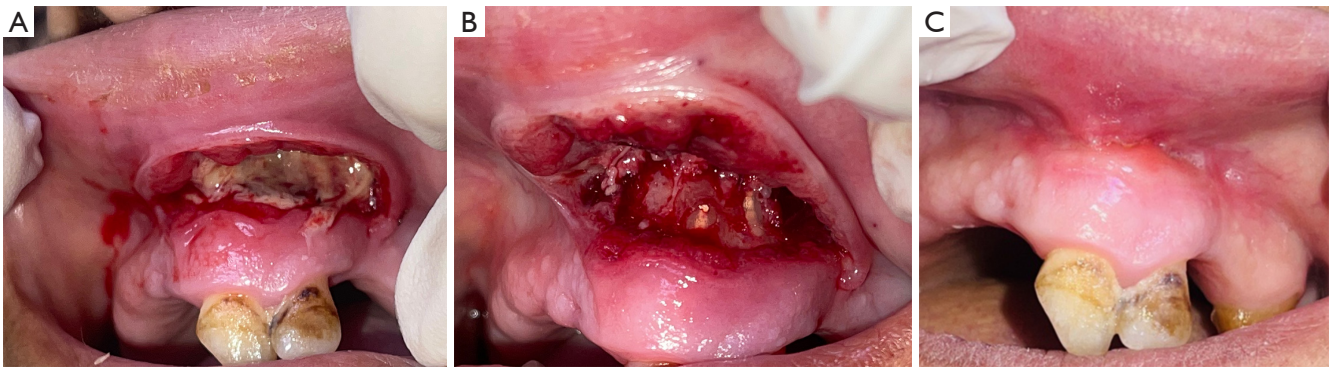


**Figure 3** Clinical photographs of case 3. (A) Pre-operative presentation showing the ulcer with the necrotic floor and thick edges; (B) the clinical picture after debriding the necrotic pseudomembrane where the roots of the teeth were directly seen with no bony plate covering them and the perforations in the roots clearly appearing as pale pink colored areas; and (C) post-operative clinical picture of the healed ulcer after 8 weeks of follow-up.

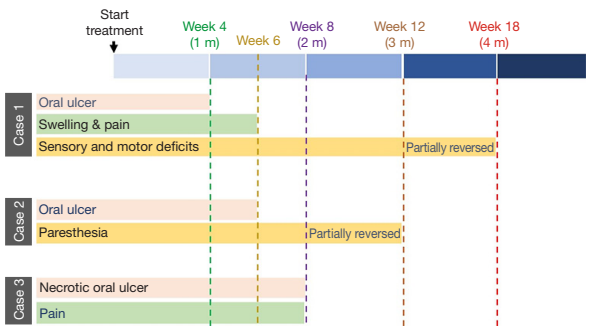


**Figure 4** The timeline of the three cases showing the time of relief of each symptom in the three cases.

pseudomembrane. Furthermore, the edges of the ulcer became raised and thick. Luckily, there was no associated extraoral manifestations (*Figure 3A*).

Although the clinical picture of a necrotic ulcer with raised edges was suggestive to malignancy, the history indicated a chemical burn due to NaOCl accident superimposed by secondary infection that was attributed to improper management. Therefore, the case was managed as the previous cases through debridement under local anaesthesia and copious irrigation using saline, followed by applying the dressing. After debridement, the roots of the teeth were directly seen in the floor of the ulcer with no overlying bone. Moreover, perforations in the roots were seen showing the color of the gutta-percha (*Figure 3B*). Afterwards, an antibiotic and analgesic were prescribed. And above all, clear post-operative instructions were given to the patient about the repeated daily saline irrigation.

Even with strict hygiene measures and extreme reduction in pain, a second session for debridement was performed at week 3, followed by a dramatic improvement and gradual reduction in the lesion's size till complete healing after 2 months (8 week). After complete healing and resolution of symptoms, the teeth were re-assessed: to keep them and continue the primary plan of using them as abutments to the overdenture, or to extract them. As the bone support was not adequate for the teeth to serve as abutments due to the fenestration observed during debridement, the teeth were extracted (*Figure 3C*).

The timeline of all the cases is clarified in *Figure 4*.

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patients for publication of the case report and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

## Discussion

To date, no other irrigant has exceeded NaOCl (2). As efficient as it is when confined to the intracanal space, NaOCl may cause severe damage outside it (1). Although complications of NaOCl accident are considered rare conditions based on the relatively scarce reports directed to insurance companies and published in literature, they are believed to occur much more frequently but are rather

under-reported; and if published, not well-reported (2).

Therefore, we are presenting three different cases of NaOCl accidents; each with a different complication. The three, hereby, presented cases were females, suffering from necrotic intraoral ulcers as prolonged postoperative sequelae of NaOCl accidents during endodontic treatment of a maxillary anterior tooth. Most NaOCl accidents are reported to occur in females and maxillary teeth due to the lower bone density in females compared to males; and the thin cortical bone supporting the buccal roots of maxillary teeth (2).

Classically, NaOCl accidents present in the form of severe instantaneous pain. Afterwards, the symptoms differ greatly from one accident to another. Most cases have no further symptoms (5), while others manifest as extraoral swelling caused by emphysema and ecchymosis of the face (6-15). Less commonly reported sequalae include sensory and/or motor deficits (6,8,15) and intraoral soft tissue necrosis (14,16-18).

The common clinical presentation of the herein three reported cases is the deep oral ulcer in the vestibule of the related tooth. This clinical presentation is seen in a roughly typical picture in two previous reports (16,18). However, to the best of our knowledge, no previous report presented a massive picture similar to the third presented case. In one of the previous reports (18), the irrigant leaked through the rubber dam; while in the other (16), NaOCl was accidently injected directly into the mucosa instead of infiltration anaesthesia. The condition of the first report presented as an isolated necrotic chemical burn with no other manifestations (18), while the second case suffered from lip paresthesia beside the necrotic ulcer (16).

In both cases (16,18), a typical chemical burn arose due to direct contact of a highly alkaline solution (pH 11–13) with the mucosal surface (11). However, this justification does not fit the condition of our cases where it was associated with neurological manifestations involving the whole branch of the affected nerve; rather than only the terminal branches distal to the burn. Adding up with the fact that in the third case, root perforations were seen by the naked eye after debridement with no bone coverage. This indicates that in the herein reported cases the irrigant diffused from inside the root outwards to the mucosa; not vice versa.

As for the complications, the first two presented cases suffered from neurological deficits. Neural deficits are believed to be caused by hypochlorite damage rather than edema; as edema caused generally by dental abscesses do not cause sensory or motor deficits (6). Interestingly, the first presented case had history of diabetes mellitus which is proven to cause diabetic neuropathy (19); while the second case had neurological weakness of the lower limbs. Therefore, an insult to an already diseased nerve would be expected to cause more damage.

Ideally, the effective concentration of NaOCl irrigant ranges between 0.5% to 5.25% (20). However, the optimal concentration has not reached consensus yet (21). In all the presented cases, NaOCl concentration was not higher than the effective range (3%). So, the concentration did not contribute in the causes of the accidents.

Classically, the irrigant is delivered inside the root canals using a syringe and a needle (22). This technique is named as traditional needle irrigation (21). The needle should have small diameter; optimally 30-gauge (22). For safe irrigation, the needle should be 1–2 mm short of the working length. This is meant to keep the balance between flushing the canal as close to the apical foramen as possible on one side and preventing the irrigant's extrusion on the other side (23). The needle should also be moved in and out while dispensing the irrigant to allow for the outflow of the debris, continuously refresh the canal and prevent the needle's locking in the canal (20). Other safer equipment includes side-vented needles, EndoActivator, ultrasonic devices and Vibringe, among others (22).

Some NaOCl accidents occur due to operator's faults. These include improper irrigation technique, inaccurate working length and active irrigation (9). Such faults were documented in the first and third cases. Undergraduate students lack confidence and clinical experience; and therefore, higher risk of NaOCl accidents occurs as reported in the herein discussed cases (3).

On the other hand, other tooth- and bone-related factors increase the risk of the accident in the concerned tooth. A higher risk is linked to perforated roots—as in the third case—open apex, fractured roots, roots having lateral canals, roots with overlying fenestration and teeth with periradicular lesions (causing less surrounding bone density with or without fenestration) (9).

Fenestration is the condition in which the bone covering the root is lost while maintaining intact marginal bone. In this bone defect, the root surface is merely covered with periosteum and mucosa (24). Having the highest frequency of occurrence in the buccal region of the upper teeth especially in females, fenestrations justify the higher risk of NaOCl accidents reported in this region (24). This describes how the accident occurred in the third presented

case; where the irrigant leaked from the perforations in the roots directly to the overlying mucosa.

Knowing the risk factors of the accident, pre-endodontic evaluation would be the ideal solution for spotting the tooth- and bone-related predisposing factors. By doing so, the occurrence of the accident can be aborted (3). However, such evaluation necessitates performing cone-beam computed tomography (CBCT) for every tooth before endodontic treatment; which carries the risk of high dose of exposure to ionizing radiation, beside its high expense. Therefore, benefits must outweigh the risks before CBCT is performed. Risk is recommended to be assessed on a case-by-case basis (25).

Unfortunately, the cases—presented in this report—are reported by the post-accident management team, rather than the dentists who were performing the endodontic treatment. Therefore, the detailed information about the procedure, the equipment used and immediate management is lacking. However, the cases were managed afterwards following the proposed guidelines (26).

Despite the lacking standardized data and the presence of some debatable details, efforts were made to propose an outline for the management strategy (26). The guidelines state that upon diagnosis of a NaOCl accident, the degree of injury should be evaluated based on the degree of pain, extra- and intra-oral examinations. Accordingly, some accidents should be given higher levels of attention; including those manifesting as severe prolonged pain, diffuse swelling, necrotic ulcerations intraorally and/or neurological deficits (26). Therefore, the accidents presented in the current report were included the category of cases requiring high attention levels.

Management of the accidents should be tailored to each patient based on their symptoms (27). In all cases, immediate management is proven to improve its prognosis and healing period greatly (6). In cases of severe tissue damage, medications as intravenous analgesics, antibiotics and/or corticosteroids may be recommended to reduce the inflammation. Lastly, surgical interventions may be necessary in the form of incision and drainage, followed by necrotic tissue debridement (26,27).

Topical ointments and dressings are also recommended according to the case (27). Dressing materials are commonly applied to intraoral wounds to promote healing and prevent infection (28). Among the types of dressings available in market, eugenol-containing dressings provide superior results (29). In the presence of a deep pouch-like ulcer in the vestibule; where food impaction and secondary infection is highly expected, the lesion was packed with a dressing material covered by sterile gauze; just like extraction sockets.

In the presented cases, debridement, eugenol-containing packs, and—most importantly—regular saline irrigation had a huge impact on the healing enhancement.

Fortunately, both cases presenting with neural deficits responded to the vitamin supplements by gradually improving during the few months of follow-up. Despite not being commonly reported in literature, when paresthesia and anesthesia are reported, normal sensation is restored after several months or years (8). Furthermore, permanent paresthesia was also reported in few cases (8). However, motor nerve affection was reported in one case who suffered from isolated facial nerve weakness and infra-orbital nerve paresthesia. The sensory deficit resolved after 1 month while the motor one stayed for longer (6).

The rate of response to treatment is reported to differ according to the condition. Cases of pain and swelling heal within 1 month, while mucosal damage resolves within 2 months with or/without scarring. The longest healing time is needed for neurological defects, where it takes several months (26). The results of the presented cases roughly corroborate the previously reported healing timeline; where swelling and pain resolved within 6 weeks, mucosal damage healed within 8 weeks maximally and neurological deficits improved slowly through months period.

Afterwards, the guidelines recommend that the patient should be re-assessed after 24 hours and after 1 or 2 weeks. Each time, complete evaluation of the damage and the healing process is performed. After 1 day, warm saline rinses and warm compresses are advised for 1 week to stimulate microcirculation. When healing is satisfactory, the definitive treatment options of the tooth should be discussed: continuing the endodontic treatment versus extraction (26).

## Conclusions

NaOCl accident may have delayed and prolonged sequalae in the form of a necrotic ulcer in the buccal vestibule of the affected tooth associated with sensory deficit, with or without a motor deficit. Neural deficits are suggested to be more probable in patients having systemic neurological comorbidities. However, vitamin B12 supplements are recommended for faster and better restoration of neural function. Furthermore, in cases of oral ulceration, the report emphasizes on the importance of applying post-debridement pack to the defect and on complying to strict

hygiene until complete healing. Lastly, proper pre-operative case assessment is expected to avoid the occurrence of the accidence from start.

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## Footnote

*Reporting Checklist:* The authors have completed the CARE reporting checklist. Available at https://fomm.amegroups.com/article/view/10.21037/fomm-23-41/rc

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*Conflicts of Interest:* All authors have completed the ICMJE uniform disclosure form (available at https://fomm.amegroups.com/article/view/10.21037/fomm-23-41/coif). The authors have no conflicts of interest to declare.

*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patients for publication of the case report and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.



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