

Subcutaneous emphysema during root canal therapy: endodontic accident by sodium hypochlorite

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Summary

Introduction. Cervicofacial subcutaneous emphysema is defined as the abnormal introduction of air in the subcutaneous tissues of the head and neck. It is mainly caused by trauma, head and neck surgery, general anesthesia, and coughing or habitual performance of Valsalva manoeuvre. The occurrence of subcutaneous emphysema after dental treatment is rare, and diffusion of gas into the mediastinum is much rarer, especially when the procedure is a nonsurgical treatment. Presented here is a case of subcutaneous emphysema that occurred after sodium hypochlorite irrigation during endodontic treatment, and the description of its etiologies and prevention during nonsurgical endodontic treatment.

Endodontic success can be essentially achieved via good debridement of a root canal, and an ideal endodontic irrigant is effective in removing the smear layer, opening the dentinal tubules, and producing a clean surface for closer obturation.

Case report. A 60-years-old woman had an abnormal swelling and pain during an endodontic treatment accompanied by her dentist to the emergency room and was referred to our observation for complaining of severe pain, ecchymosis and severe swelling on the left side of her face. The aforementioned symptoms appeared after sodium hypochlorite irrigation and aggressive use of air spray for drying the root canal during the en-

dodontic treatment of the upper left lateral incisor.

Discussion. An extrusion during an inappropriate endodontic treatment may occasionally be reported and can cause tissue damage. NaOCl is one of the best and most commonly used irrigating solutions because of its efficacy, but it can also negatively affect the periapical tissues.

Conclusion. Determining the correct working length, even when performing an intraoperative periapical radiograph and confirming the root canal integrity, could help avoid these kinds of accidents.

Key words: subcutaneous emphysema, root canal therapy, sodium hypochlorite.

Introduction

Debridement of the root canal system is essential for endodontic success, and it is composed of mechanical instrumentation and the use of antimicrobial irrigating solutions. Root canal irrigants are ideally used for flushing out debris, dissolving organic tissue, killing microbes, destroying microbial products and removing the smear layer. These objectives can be achieved with irrigating solutions reaching the working length of the canal without extruding the periapical tissues (1-3). Sodium hypochlorite solution (NaOCl) is the most commonly used irrigating solution for its strong antimicrobial and proteolytic activity. NaOCl in concentrations ranging from 0.5 to 5.25% is commonly used for irrigating root canals. A better bactericidal activity can be reached by increasing the concentration of NaOCl, but its damaging activities can also be intensified. In fact, NaOCl at high concentrations can cause damage to vital tissues, such as haemolysis, ulceration, inhibition of neutrophil migration, damage to endothelial and fibroblast cells, facial nerve weakness and necrosis after extrusion during inappropriate endodontic treatment (4, 5) These toxic effects can occur because of the solution alkalinity (pH 10.8-12.9) and hypertonicity, which can oxidate proteins and lipid membranes (6). When some of these effects occur, subcutaneous emphysema can appear. Subcutaneous emphysema is obtained when gas or air is in the layer beneath the skin. Since the air is generally emitted from the chest cavity, subcutaneous emphysema usually occurs on the chest, neck and face. It has a characteristic crackling feel to the touch, also known as subcutaneous crepitation. These situations can occur after an infection, trauma

or a surgical procedure. In the odontostomatological environment, emphysema can arise after the irrigating solution's extrusion during inappropriate endodontic treatment and even after repair of facial fractures, periodontal surgery, temporomandibular joint surgery and the extraction of teeth such as a mandibular third molar (7). Anaphylactic reactions to local anaesthesia, haematoma and infection are usually included in the differential diagnosis (8).

The paper investigates tissue damage after NaOCl solution extrusion during root canal treatment and examines how to treat these kinds of accidents.

Case report

A 60-years-old woman had an abnormal swelling and pain during an endodontic treatment accompanied by her dentist to the emergency room and was referred to our observation for complaining of severe pain, ecchymosis and severe swelling on the left side of her face (Fig. 1). The aforementioned symptoms appeared after sodium hypochlorite irrigation and aggressive use of air spray for drying the root canal during the endodontic treatment of the upper left lateral incisor.

The woman's medical history was performed. She reported several episodes of hypersensitivity to different drugs, asthma and previous thyroid cancer. First,

an allergic episode was excluded. The extraoral examination revealed that the patient had difficulty opening the left eye, with swelling and an ecchymosis affecting even the upper labial region, the mandibular region and the contralateral infraorbital region. There was also evidence of an issue on the left cheek. Paresthesia of the dental nerves was not diagnosed, but the patient was referred upon altered sensation of the left upper lip region.

Intraoral examination revealed that the affected tooth had its own crown destroyed by decay processes. The part was slightly sensitive to vertical and horizontal percussion and palpation with a mobility of grade 2 was reported (Fig. 2).

There was evidence of periapical swelling. A CT of the head and the maxillary district was prescribed (Figg. 3-5).

The whole condition was diagnosed as air emphysema resulting from sodium hypochlorite solution extravasation during the endodontic treatment. Antibiotic and antiseptic therapy (ceftriaxone) and analgesic and antiedema therapy (betamethasone) were prescribed. Symptoms and the overall conditions of the patient improved three days afterwards (Fig. 6).

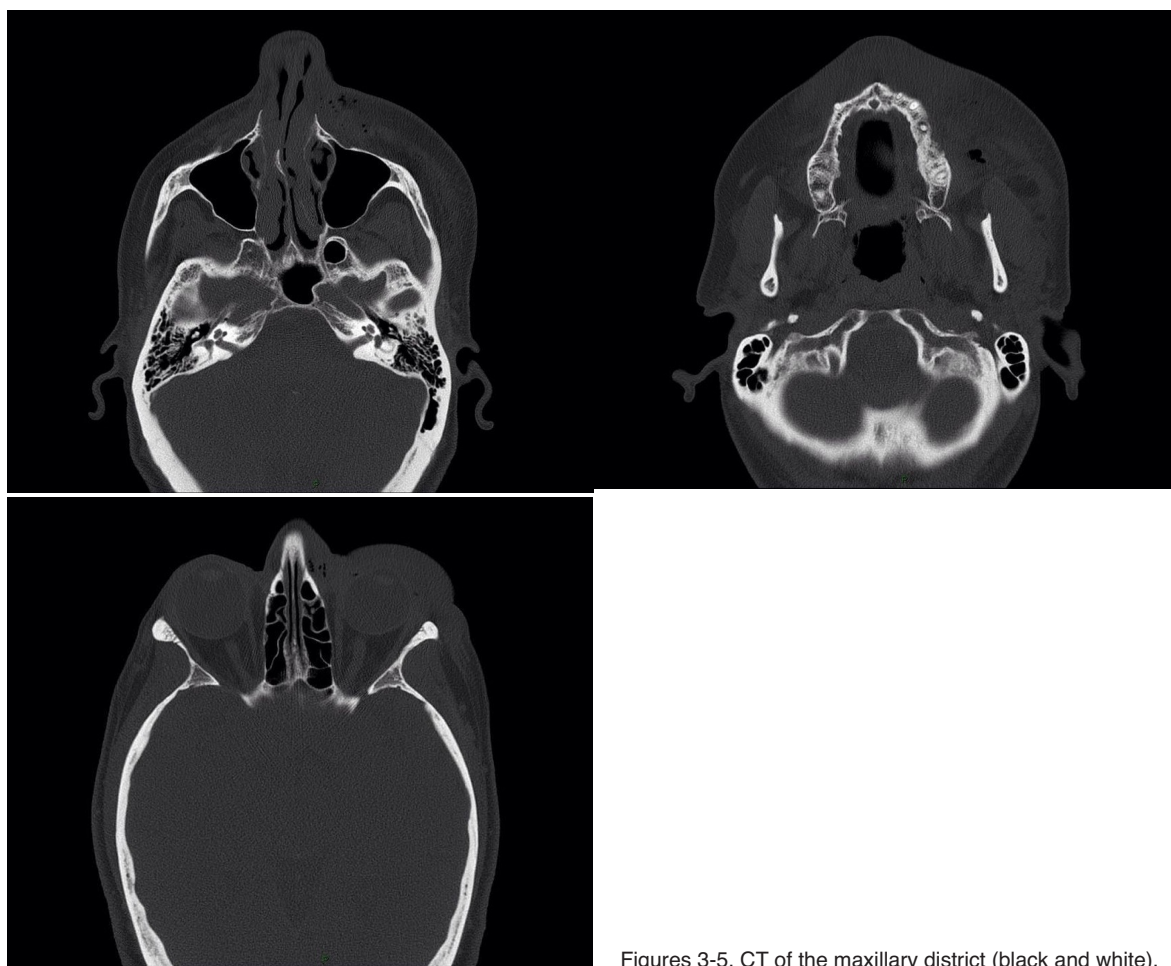
A panoramic radiograph was then prescribed. After one month, extraction of the upper left lateral incisor was done, the ecchymosis and the swelling appeared to be fully resolved and the patient's eye opening had returned back to normal (Fig. 7).



Figure 1. Woman with ecchymosis and severe swelling on the left side of the face immediately after the endodontic accident.



Figure 2. The intraoral situation.



Figures 3-5. CT of the maxillary district (black and white).



Figure 6. The situation after three days of pharmacological therapy.



Figure 7. The extraoral situation after one month: the ecchymosis and swelling appeared fully resolved.

The subject gave informed consent, and the study was therefore performed in accordance with the ethical standards of the Declaration of Helsinki (as revised in Brazil 2013).

Discussion

Surgical procedures are not the only cause for development of subcutaneous emphysema, as cases have been described during restorative, crown and endodontic procedures. Emphysema also has been reported during oral laser surgery. Air can be introduced into the soft tissue spaces by several routes, but it usually passes through the dentoalveolar membrane or a root canal (9).

In accordance with recent studies, the efficacy of the sodium hypochlorite solutions depends on its concentration. A previous study evaluated the efficacy *in vitro* of three different concentrations of NaOCl against *Enterococcus faecalis* (10). This study demonstrated the higher efficacy of the highest concentration used (5.25%). The correlation between concentration and antimicrobial action is confirmed as well. The efficacy of sodium hypochlorite antimicrobial action also depends on its pH, its osmolarity, its flow through the root canals, its quantity and time of persistence in the canals (11).

Alongside its antimicrobial activity, sodium hypochlorite is an extremely cytotoxic chemical solution (11). In fact, when it gets into contact with vital tissues, NaOCl causes a whole series of diseases such as haemolysis, ulceration, inhibition of neutrophil migration, damage to endothelial and fibroblast cells, facial nerve weakness, and necrosis. These toxic effects can occur because of this solution alkalinity (pH 10.8-12.9) and the hypertonicity of oxidating proteins and lipid membranes (12, 13).

Human tissues exposed to NaOCl solution can be affected by subcutaneous emphysema, which is a condition characterized by the presence of air in the tissues under the skin due to oxygen liberation into the same tissues.

When subcutaneous emphysema occurs, the patients report severe pain, ecchymosis and swelling. Some patients report temporary nerve paresthesia as well. The swelling can occur in different areas according to the tooth involved. If the sodium hypochlorite extravasation occurs in an upper tooth, the swelling can affect the maxillary upper part, comprising the eye, the maxillary sinus, the wing of the nose and the cheek. Otherwise, if the tooth involved is mandibular, the swelling can extend to the cheek, the angle of the mandible and, in the worst cases, the ear and the neck.

Most of these cases arise because of incorrect determination of the working length or canal anatomical anomalies such as reabsorption or open-apex, lateral perforation and iatrogenic widening of the apical foramen. Many subcutaneous emphysema cases are caused by use of positive pressure irrigation with a

wide-gauged and apical-opened needle (14).

Professionals in this line of work must be careful about how far the irrigating needle is placed into the canal. This can prevent irrigation accidents. Any needle should either be bound in the canal or applied in the proximity of the working length. A gentle flow rate should be used to avoid extravasation. Using a Luer-Lock lateral-opened needle is also advised (15, 16). Recent studies have suggested the use of an EndoVac irrigation system to obtain safe irrigation throughout the working length. Nielsen and Baumgartner's study in fact pinpoints the use of an EndoVac system resulting in statistically significant more debris removal at 1 mm from the working length than needle irrigation with a downturn in extravasation accidents (17).

It is important to know the working length and to be certain about the integrity of the root canal system before irrigating with any concentrated solution (17).

Some advantages in the decontamination of the root canal system can be provided also by laser devices, which have been described by the Authors of previous studies. In fact, the use of KTP laser and a 980-nm diode laser revealed statistically highly significant differences ($P \leq 0.01$) compared to traditional endodontic procedures in the reduction of the load of *Enterococcus faecalis* biofilms (higher than 96 and 93%, respectively) (18, 19).

Although providers perform an adequate endodontic therapy, if a subcutaneous emphysema arises, professionals should first and foremost apply an ice-pack on the involved part. Second, they should administer antibiotics, analgesics and cortisone-based therapy, if needed. These actions will help to control the inflammatory reaction (20).

Conclusion

This paper report investigates a case in which extrusion of NaOCl caused severe tissue damage when unintentionally injected beyond the root canal foramen. Side effects include pain, ecchymosis and swelling of the face. Determining the correct working length, even when performing an intraoperative periapical radiograph and confirming the root canal integrity, could help avoid these kinds of accidents. Lower concentrations of NaOCl may be helpful, and using a negative-pressure system of irrigation, such as an Endo-Vac, could help to properly perform endodontic treatment.

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