CASE REPORT

Toxicity of concentrated sodium hypochlorite used as an endodontic irrigant

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Abstract

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Aim To present a clinical case that illustrates the toxicity of concentrated sodium hypochlorite (NaOCl) on vital tissues.

Summary The severe clinical consequences of extruding concentrated NaOCl into the periradicular tissues during root canal irrigation are described. After diagnosis of external resorption in tooth 34, endodontic treatment was initiated. Following irrigation with a concentrated NaOCl solution, a rapidly developing swelling and haematoma were visible. During the next few days, an extensive bruise and local necrosis of the oral mucosa developed. After healing of the involved tissues, the canal was prepared and obturated. At this time, no clinical symptoms remained.

Key learning points

- The use of concentrated NaOCl as a root canal irrigant might cause severe clinical problems when extruded into vital tissues.
- The present report confirms the known toxicity of NaOCl to soft tissues following inadvertent extrusion.
- To avoid extrusion, it is always prudent to confirm the length and integrity of the root canal system before irrigating with concentrated solutions.

Keywords: endodontic irrigants, external resorption, root canal irrigation, sodium hypochlorite, toxicity.

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Introduction

During canal preparation and cleaning of infected teeth, special attention must be given to the elimination of bacteria and their toxins from the root canal system. This is known to be a

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major factor in preventing the development of periapical lesions and thus in the success of root canal treatment (Shih *et al*. 1970, White *et al*. 1997). Considering the size and form of conventional endodontic instruments, it is obvious that mechanical procedures alone are insufficient for proper canal cleaning. Residual pulpal tissue, bacteria and dentine debris may persist in the irregularities of canal systems. Various investigations have demonstrated that a thorough and complete debridement of the root canal system with all its ramifications and anatomical irregularities is impossible with mechanically driven or hand instrumentation (Esposito & Cunningham 1995, Versümer *et al*. 2002). Therefore, endodontic preparation should be supported by irrigating solutions (Yeşilsoy *et al*. 1995). These irrigants should flush out dentine debris, dissolve organic tissue, disinfect the canal system and provide lubrication during instrumentation, without causing irritation to surrounding tissues (Cheung & Stock 1993, Yeşilsoy *et al*. 1995). One of the most popular irrigants is sodium hypochlorite (NaOCl) because of its physico-chemical and antibacterial properties (Shih *et al*. 1970, Türkün & Çengiz 1997). NaOCl, especially when used in high concentrations is known to be effective in dissolving organic tissue remnants and disinfecting the canal system (Ayhan *et al*. 1999). However, there are also some disadvantages. Various investigations have shown that NaOCl might irritate the periodontal and periapical tissues (Spångberg *et al*. 1973). In high concentrations, severe necrotic changes could be observed (Gatot *et al*. 1991). This paper presents a report on the destructive effect of concentrated NaOCl solution on soft tissues following inadvertent extrusion during endodontic irrigation. This case serves to remind clinicians of the potential damage to oral tissues following over-extension of a potent and potentially toxic irrigant solution.

Report

A 49-year-old female patient was referred to the Department of Operative Dentistry and Periodontology in the Dental School of the Martin-Luther-University, Halle-Wittenberg, Germany, by an oral surgeon for treatment of tooth 34. The patient reported that in the previous 2 weeks she occasionally experienced mild pain but no swelling, especially when wearing her removable partial prosthesis. However, she described an increase of pain within the last few days. Clinical examination of the soft tissues in the left mandibular region showed no signs of scarring and fistulae. Tooth 34 was restored with an adequate porcelain fused to metal crown and supported a partial removable prosthesis. In contrast to the neighbouring teeth, the first premolar was slightly sensitive to vertical and horizontal percussion and palpation, but there was no pathological mobility. Tooth 34 responded to cold sensitive tests with a delayed reaction and increased intensity, whereas the adjacent teeth responded within normal limits. Probing depths around the tooth were in a physiological range of 3 mm, with bleeding on probing on the distal aspect of the crown margin. The initial radiograph showed no periapical lesion but an irregular periodontal ligament space of the premolar compared to the anterior teeth. Moreover, the radiograph showed a lucency superimposed on the root canal (Fig. 1). Therefore, despite a positive sensitivity test, the diagnosis was made of irreversible pulpitis in combination with external inflammatory root resorption.

After discussion on possible treatment risks, including the different dangers of irrigation solutions, root canal treatment of the premolar was initiated. Following access cavity preparation under local anaesthesia, vital pulp tissue was extirpated and the root canal system was examined with a size 20 H-file (VDW, München, Germany). Following initial negotiation, no signs of perforation could be detected. In order to aid the initial debridement of the root canal system, the canal was copiously irrigated using 5.25% NaOCl (Histolith, Lege Artis, Dettenhausen, Germany) in combination with a frontal open irrigation needle (Endoneedle, Dr J. Bouquet, 0.35 mm × 25.0 mm, Vedefar, Dilbeek, Belgium) without

Figure 1 Diagnostic radiograph at the beginning of treatment showing an irregular translucency superimposed on the root canal.

excessive pressure. Two minutes later, the patient reported a diffuse pain and burning sensation in the lower lip and the left mandibular region. Immediately, the rubber dam was removed. At this time, a pronounced swelling of the lower lip was visible (Fig. 2), and intraoral examination showed a diffuse swelling of the buccal mucosa near the treated premolar (Fig. 3). Within the next few minutes, the patient developed a clearly visible bruise on the left cheek. To remove the remaining NaOCl, the root canal and the adjacent soft tissues were immediately irrigated with physiological sterile saline. After drying the canal, it was decided to place an anti-inflammatory and antibiotic material (Ledermix, Lederle, Münster, Germany) using a lentulo filler. The access cavity was sealed with the temporary filling material Cavit G (Espe, Seefeld, Germany). In the meantime, the extraoral swelling had increased and a blue-violet colour was visible. Intraorally, a necrotic perforation of the buccal mucosa adjacent to the premolar could be observed (Fig. 4). The patient was referred immediately to an oral surgeon.

The following day the extraoral swelling and haematoma had spread to the submandibular region and the necrotic destruction of the intraoral mucosa had increased (Figs 5 and 6). There was no disturbance of mental nerve function. To avoid super-infection of the soft

Figure 2 Marked swelling of the lower lip a few minutes after irrigation with highly concentrated NaOCl.

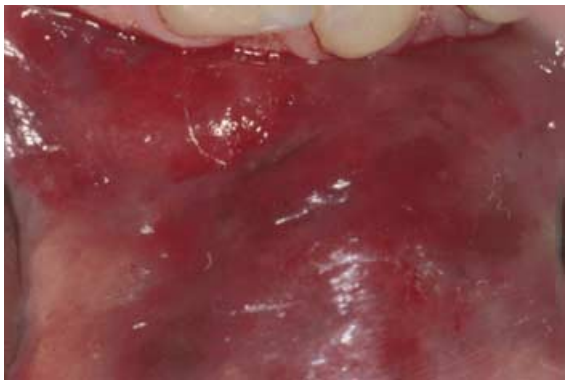

Figure 3 Intraoral view showing a diffuse swelling buccal to the first premolar after irrigation with NaOCl.

Figure 4 Half an hour after irrigation. A small perforation of the buccal mucosa is visible.

tissues, antibiotic therapy was initiated. Because of potential allergic reactions, Doxycyclin (100 mg; Ratiopharm, Ulm, Germany) was administered daily for 10 days by the oral surgeon. For analgesia, Ibuprofen (400 mg; Heumann, Nürnberg, Germany) was prescribed, to be taken as required. Four days later, the definite working length was established 1 mm short of the radiographic apex (Fig. 7). The first radiograph showed

Figure 5 Four days later. Enlarged haematoma on the left side reaching the submandibular region.

Figure 6 Increased necrotic perforations of the buccal mucosa after 4 days.

Figure 7 Radiograph taken to establish the correct working length 1 mm from the radiographic apex.

an H-File penetrating a perforation (Fig. 8). Obviously, this perforation was the reason for the inadvertent extrusion of the NaOCl solution. However, the size of the perforation was too small for penetration by the irrigating needle. The canal was prepared to a size 45 using the step-back technique and irrigated copiously using only 0.2% chlorhexidine gluconate (Glaxosmithkline, Bühl, Germany). Calcium hydroxide powder was mixed with sterile saline to form a paste and placed into the canal using a lentulo filler. The access cavity was sealed with temporary filling material (Cavit G, Espe, Seefeld, Germany).

After 14 days, the extra- and intraoral swellings and symptoms had completely resolved. The premolar was not painful on vertical or horizontal percussion. At this time, the intracanal dressing was changed. At the next appointment, six weeks after the first session, the tooth remained totally asymptomatic. Following rubber dam placement and irrigation with 0.2% chlorhexidine gluconate, the canal was dried with paper points (Roeko, Langenau, Germany). Finally, root canal filling was performed with gutta-percha (Roeko, Langenau, Germany) and AH-plus (Dentsply DeTrey, Konstanz, Germany) using cold lateral condensation (Fig. 9). After reduction of the vertical height of the root filling, the apical part of the access cavity was sealed with a glass ionomer cement (Ketac Molar, Espe, Seefeld, Germany) in order to close the perforation. Finally, the coronal part of the access cavity was restored with a composite resin (Tetric, Vivadent, Schaan, Liechtenstein) in combination with the corresponding adhesive system (Excite, Vivadent, Schaan, Liechtenstein) used as

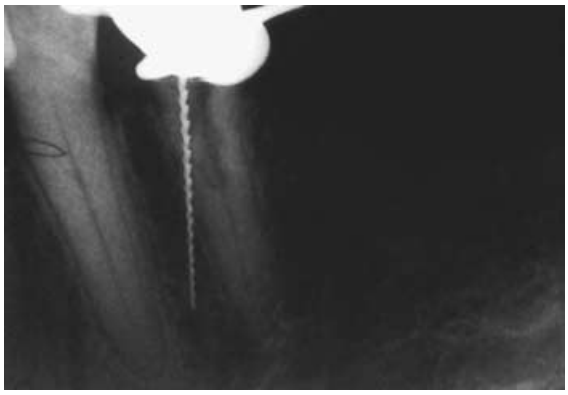

Figure 8 Radiograph showing the H-File penetrating the perforation.

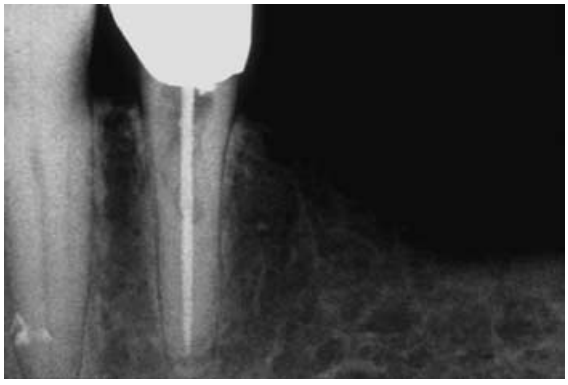

Figure 9 Final radiograph taken after obturation of the root canal.

recommended. The patient was recalled after 2 months when clinical examination revealed no problems.

Discussion

The initial radiographic examination (Fig. 1) of the premolar showed no periapical lesions, but a radiolucency superimposed on the canal and with an irregular outline was visible. A second radiograph (Fig. 8), taken in a disto-eccentric position, showed the perforation. Therefore, taking the clinical parameters into account, despite the positive sensitivity test, the diagnosis was made of irreversible pulpitis in combination with external inflammatory root resorption. A possible explanation for the resorptive defect in this case might be trauma from occlusion and the anchorage of the removable prosthesis. External root resorption linked with occlusal trauma has been reported previously, associated with a mandibular premolar (Rawlinson 1991). It has been suggested that the periodontal ligament or the cementum contains a potent collagenase inhibitor that normally prevents root resorption (Lindskog & Hammarström 1980). It is possible that the repeated high loads from the occlusion and the partial removable prosthesis anchored at tooth 34 had caused localized necrosis of the periodontal ligament, resulting in resorption. Furthermore, the tooth was restored with a crown, possibly leading to partial pulp necrosis and subsequently to external inflammatory resorption via infected dentine tubules.

The visible radiolucency, seen in the initial radiograph, was obviously superimposed on the canal. However, it may have been interpreted as internal inflammatory resorption, a possible differential diagnosis. This type of resorption is known to be an uncommon form of pulpal disease with an incidence of 0.1–1.6% of all pulpal symptoms (Bakland 1992). Usually, this pathological process is associated with chronic pulp inflammation because of dental trauma or bacterial infection (Andreasen 1985). In these cases, the sound and vital pulp is subsequently replaced by extensive inflammatory tissues (Tronstad 1988, Bakland 1992). However, the irregular outline and the absence of any root filling material in this radiolucency (Fig. 9) reinforce the diagnosis of external root resorption. This type of resorption is usually progressive until root canal treatment is instituted (Barclay 1993). Therefore, the external inflammatory resorption might finally reach the root canal, leading to perforation of the tooth. Furthermore, because of this inflammatory process the adjacent bone is often affected (Cvek 1992). In the present case, this osseous lesion is located on the buccal side, possibly leading to the destruction of the buccal bone wall. In view of this and the extensive swelling and haematoma, the extrusion of the NaOCl solution was obviously directly into soft tissues.

Successful root canal treatment is primarily based on the removal of microbial infection from the often very complex canal system. Irrigants should aid in reducing the microbial flora of infected canals and support the dissolution of the involved organic and inorganic tissues. Clearly, the use of the best possible irrigant during chemo-mechanical preparation is of great clinical importance. NaOCl has been recommended as an irrigant solution in treatment of infected root canals, because of its well-known bactericidal properties (Shih *et al*. 1970, Siqueira *et al*. 1997). Therefore, the use of NaOCl is recommended for endodontic treatment, particularly at higher concentrations, because it has greater antibacterial effect than diluted solutions (Yeşilsoy *et al*. 1995, Ayhan *et al*. 1999). However, higher concentrations have an increased toxicity and can irritate periapical and periodontal tissues (Kozol *et al*. 1988, Gatot *et al*. 1991, Tanomaru Filho *et al*. 2002). This is also associated with lower concentrations of NaOCl (Watts & Paterson 1993). The effect of this toxicity on periodontal soft tissues is dramatically shown in the present case and suggests that NaOCl should be used with caution in endodontic therapy. Therefore, it is important to prevent inadvertent extrusion of concentrated NaOCl. Perhaps, before irrigation a radiograph with instruments inserted to approximately 1–3 mm short of the radiographic apex should be taken to confirm the length and integrity of the root canal system. Another possibility would be the use of an apex locator to detect possible perforations before irrigating (Alhadainy 1994). The use of a premeasured rubber stop on the irrigation needle, the confirmation of coronal outflow during irrigation and a gentle irrigation pressure at all times are clinical measures to avoid inadvertent extrusion of irrigants.

In the light of the present report and the results of previous investigations describing the inflammatory potential of NaOCl on soft tissues (Tanomaru Filho *et al*. 2002), it seems reasonable to assume that lower concentrations or alternative irrigants such as chlorhexidine gluconate or electro-chemically activated water might be preferable endodontic irrigants (Delany *et al*. 1982, Marais 2000, Gomes *et al*. 2001, Marais & Williams 2001). It is known that the concentration is one important factor for antimicrobial effectivity of NaOCl. Irrigation time may also increase the bactericidal effect of endodontic irrigants without affecting the surrounding tissues. Studies focusing on this found that 0.5% NaOCl had nearly the same bactericidal effect as 5.25% NaOCl when used for 30 min (Gomes *et al*. 2001).

Alternative solutions for root canal irrigation are chlorhexidine gluconate or electrochemically activated water. Delany *et al*. (1982) tested chlorhexidine gluconate and reported that it could also be effective as an antibacterial agent when used as an endodontic irrigant. Further investigations compared the antimicrobial efficacy of NaOCl and chlorhex-

idine gluconate. They observed that chlorhexidine was as effective, or possibly even more effective in its antimicrobial activity than NaOCl (Ohara *et al*. 1993, Kuruvilla & Kamath 1998), without having the reported disadvantages (Southard *et al*. 1989, Leonardo *et al*. 1999). However, chlorhexidine has none of the tissue-dissolving activity of NaOCl. Therefore, to combine the positive effects of both solutions, the clinician could use lower concentrations of NaOCl alternating with chlorhexidine gluconate as endodontic irrigant (Estrela *et al*. 2003). Another alternative irrigant might be the recently introduced electro-chemically activated water solution (Marais 2000). The cleaning efficacy of this solution in root canals is considered to be equal or even superior to NaOCl (Marais 2000). However, further investigations focusing on the antimicrobial properties of electro-chemically activated water observed nearly no antimicrobial effect (Marais & Williams 2001). Nevertheless, because of its lack of toxicity to periodontal tissues, it could be a suitable alternative to NaOCl, especially in high-risk scenarios. Furthermore, it would always be wise to confirm the length and integrity of the root canal system before irrigating with any concentrated solutions.

Conclusion

This case report demonstrates that concentrated NaOCl might cause severe consequences when inadvertently extruded into periradicular tissues. To avoid this, an initial radiograph should be taken to verify the correct length of the canal, and to confirm root canal integrity, an apex locator could be used. Finally, the use of lower concentrations of NaOCl in combination with chlorhexidine or the use of electro-chemically activated water may be a safe and effective alternative, particularly for high-risk scenarios.

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