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Tissue-space emphysema, tissue necrosis, and infection following use of compressed air during pulp therapy: case report

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Abstract

The intraoperative development of tissue-space emphysema in a child undergoing restorative treatment under general anesthesia is presented. Emphysema development seems to be concomitant with the use of compressed air around patent root canals, complicated by tissue destruction due to movement of canal irrigants/medicaments into the periapical tissues and by secondary infection. Several recommendations for the prevention of tissue-space emphysema are presented including the use of a rubber dam, judicious use of compressed air, and maintenance of canal irrigants and medicaments within the root canal. Treatment recommendations vary from palliative care with follow up in cases of facial emphysema to immediate medical attention in cases of pharyngeal or mediastinal emphysema.

Introduction

Tissue-space emphysema is defined as the passage and collection of gas between the tissue space or fascial planes (McGrannahan 1965). Tissue-space emphysema following dental procedures is apparently a relatively uncommon occurrence although numerous reports can be found in the literature. Tissue space and mediastinal emphysema have been reported following surgical extractions (LeRoy and Bregman 1968; Cardo et al. 1972), endodontic therapy (Lloyd 1975; Hirschmann and Walker 1983; Falomo 1984), periodontal therapy (McClendon and Hooper 1961; Feinstone 1971) and restorative procedures (Duncan and Ferrillo 1967; Fisher 1976; Quisling et al. 1977; Rosenberg et al. 1979; Geffner 1980; Levy 1981; Kullaa-Mikkonen and Mikkonen 1982; Madden and Averett 1987). These cases are subsequent to the use of air-driven handpieces and air-water (triplex) dental syringes. Characteristic of these reports is rapid swelling, erythema and crepitus, which may be pathognomonic of tissue-space emphysema (Hayduk et al. 1970). Less commonly reported sequelae are difficulty in swallowing (Lloyd 1975) and difficulty in breathing (Madden and Averett 1987) depending on the tracking of the emphysema. Pain is generally absent or delayed. Emphysema resolved within a week with only palliative treatment in most of these reported cases. In several cases, the patients were given prophylactic antibiotics to prevent infection (Duncan and Ferrillo 1967; Fisher 1976; Geffner 1980; Levy 1981; Kullaa-Mikkonen and Mikkonen 1982; Falomo 1984). Only two cases of infected emphysema have been reported (Feinstone 1971; Cardo et al. 1972). Hospitalization for observation was deemed necessary in several cases.

Case reports describing the sequelae of accidental contact of root canal irrigants or medicaments with periapical tissues is much less frequently reported in the literature than tissue-space emphysema.

Becker et al. (1974) describe a case of injection of sodium hypochlorite beyond the root apex in a patient. Pain was an immediate reaction followed by edema, ecchymosis, and tissue necrosis. Hemorrhage through the canal was reported and lasted 6 min. Most of the swelling had subsided after one week; however the ecchymotic appearance remained for three more weeks. Immediate and severe pain followed by edema and trismus was a finding in a case where a 1.8 ml carpule of 5.25% sodium hypochlorite inadvertently was placed in a syringe and used for mandibular block anesthesia (Herrmann and Heicht 1979).

The inflammatory potential of commonly used root canal medicaments including formocresol is well known (Schilder and Amsterdam 1959). These medicaments may cause tissue damage and necrosis if forced beyond the root apex.

The following report describes a case of infected tissue-space emphysema in a pediatric patient secondary to the use of compressed air, sodium hypochlorite and formocresol during pulpal therapy of a carious maxillary right primary central incisor.

Case Report

A healthy, 22-month-old male of East Indian descent had restorative dentistry under general anesthesia at British Columbia's Children's Hospital. After nasoendotracheal intubation, packing the throat, taping the eyes, and placing a hood which covered the head and eyes, the oral cavity of the patient was examined, radiographs exposed, and a rubber dam placed. During preparation of the carious maxillary right primary central incisor, the pulp was exposed. An access preparation was made using an air-driven, high-speed handpiece (40 PSI) and the pulp tissue removed in toto without hemorrhage, the canal rinsed with water from the triplex syringe and flushed with a stabilized 1% sodium hypochlorite irrigation solution (Hygeol™ — Wampole Inc., Perth, Ontario, Canada). A one-inch, 27 gauge needle was inserted into the canal and approximately 4 ccs of the sodium hypochlorite expressed. Paper points were used in an attempt to dry the canal: however a clear fluid continued to seep from the canal. A paper point soaked in formocresol (Buckley's Formocresol™ — Germiphene Co. Ltd., Brantford, Ontario, Canada) was placed in the canal for approximately 30 sec. The clear fluid continued to seep from the canal. In a further attempt to dry the canal, air from a triplex syringe at 65–70 PSI was directed into the canal. A ballooning of the lip was noticed at each attempt using the air syringe. Due to the ballooning of the lip and the fact the canal could not be dried, the tooth was extracted and an absorbable gelatin sponge (Gelfoam® — The Upjohn Co. of Canada, Don Mills, Ontario, Canada) placed in the socket for hemostasis.

A swelling of the right cheek extending to the lateral border of the nose and causing closure of the right eye was apparent at extubation. The right eyelid was glossy and bulging as was the left eyelid (to a lesser degree). Crepitus was elicited on palpation of the periorbital swelling. Total time from start to finish of general anesthesia was 63 min. The patient was taken to postanesthetic recovery and later discharged on a seven-day regimen of amoxicillin (125 mg tid).

Three days later, the child was admitted to the hospital after the swelling failed to resolve (Fig 1). He was placed on intravenous cefuroxime (600 mg q8h, Zinacef® — Glaxo Canada, Ontario, Canada). Over several days the periorbital swelling subsided, leaving an area of induration below the right eyelid approximately 1.5 cm x 1 cm extending to the lateral border of the nose. Culture and sensitivity tests were negative. Maxillary and ethmoid antra radiographs eight days following the dental general anesthesia were unremarkable. After six days in hospital, the patient was discharged on cefaclor (150 mg tid, Ceclor®— Eli Lilly Canada Ltd., Scarborough, Ontario, Canada). Diagnosis at this time was infection/cellulitis secondary to dental manipulation.

Fig 1. Clinical presentation of cellulitis.

The patient returned to the hospital again 28 days after the dental general anesthesia with a three-day history of fever, pain, and increased swelling anterior to the right maxillary antrum in the infraorbital area and purulent nasal discharge. A Water's view radiograph revealed mucosal thickening of the right maxillary antrum with opacification of the anterior air cells of the right ethmoid antrum. The left ethmoid and maxillary antra were clear. A diagnosis of an abscess in the infraorbital area anterior to the right maxilla was made. The following day, the child was taken to the operating room and examined by an otorhinolaryngologist under general anesthesia. Examination of the nose revealed chronic ulceration and some necrotic mucosa in the nasal vestibule and lateral nasal wall anterior to the inferior turbinate, consistent with a chemical burn. Purulent discharge emanated from the lateral nasal wall just anterior to the inferior turbinate and appeared to connect to the right premaxillary space. Compression of the area resulted in expression of pus into the nasal vestibule through a fistulous tract. The nasal mucosa was debrided.

Culturing of the purulent nasal discharge from the operation revealed gram-positive cocci, specifically *Staphylococcus aureus*. The patient was discharged the same day on cloxacillin (Novocloxin™ — Novopharm Ltd., Scarborough, Ontario, Canada).

Six weeks following the examination and debridement under general anesthesia, examination revealed swelling detectable only on palpation and crusting inside the right nostril with at least some air entry.

Discussion

Tissue-space emphysema may occur at any one of several steps in an endodontic procedure.

If no rubber dam is used in a procedure it is possible, as described by McClendon and Hooper (1961), that compressed air from either an air-driven handpiece or an air-water syringe could dissect through gingival and loose connective tissues to the fascial planes of the face via the gingival crevice. Although it is possible an adequate seal was not achieved with the rubber dam, this portal of air entry is unlikely.

Another possible entry point for air might be at the time of access preparation of teeth for endodontic treatment using the air-driven handpiece. In necrotic teeth it seems plausible the handpiece air-water coolant spray

might result in tissue-space emphysema if directed into empty canals. However, in this case, in which the pulp was present, it seems unlikely a significant amount of air could penetrate past the pulp.

The most likely cause of the tissue-space emphysema in this case was from the compressed air of the air-water syringe directed into the empty canal. The close proximity of the maxillary primary central incisors to the buccal bone in children generally (and in this case specifically), and the presence of the periapical resorption in the involved tooth (Fig 2), suggest that the air entered the fascial tissue planes of the child's face through a perforation in the buccal bone at the apex of the central incisor, and progressed to the periorbital area.

Fig 2. Preoperative (intraoperative) anterior periapical view.

Complicating this tissue-space emphysema, it seems, was the presence of sodium hypochlorite and/or formocresol in the periapical tissues. Both these chemicals have proven highly irritating to soft tissue (Schilder and Amsterdam 1959; Becker et al. 1973) and may have been responsible for the observed tissue destruction if carried apically by compressed air.

The secondary infection of the necrotic infraorbital tissues by *S. aureus* is likely from one of two routes. The *S. aureus* may have been carried apically from the oral cavity resulting in the periorbital infection or, a sterile abscess may have formed in the infraorbital area which eventually tracked to the nasal cavity, resulting in secondary infection of the necrotic infraorbital tissue. The latter route is more likely because *S. aureus* is usually found in low numbers in the oral cavity as compared to the nose or nasopharynx (Rosan 1988). The possibility that the culture was contaminated by *S. aureus* at the time of collection in the nasal vestibule also exists.

Based on the experience described in this case report and reports from the literature, we have several recommendations for prevention. Whenever possible, use a rubber dam with a tight seal around the teeth to reduce the possibility of emphysema as well as infection. When preparing an endodontic access cavity, switch off the air coolant on the air-driven high speed handpiece to minimize air being directed into the canal, especially when the canal is empty and the root apex is patent.

To prevent apical movement of air and bacteria, do not direct the dental air-water syringe into a canal once patency of the root canal is established. A case of fatal air embolism secondary to the use of compressed air to dry a mandibular anterior tooth canal in a child has been reported (Rickles and Joshi 1963).

When using canal irrigants, ensure the syringe needle fits loosely within the canal before expressing the irrigant to prevent forcing the irrigant beyond the apical foramen. Measuring the needle length and comparing it to the root length on a radiograph will also help ensure the irrigant is not deposited beyond the canal apex. Canal medicaments must similarly be contained within the root canal.

The use of clear plastic drapes is recommended to permit intraoperative observation of the patient in procedures under general anesthesia.

The pain associated with tissue emphysema can be treated palliatively with analgesics. Close follow-up by the practitioner must follow.

If air tracks in an inferior direction, respiratory embarrassment through pharyngeal emphysema and mediastinal emphysema may create a medical emergency (McClendon and Hooper 1961). If the emphysema occurs while the patient is under general anesthesia, nitrous oxide should be immediately terminated and 95% oxygen administered (Levy 1981) to prevent enlargement of the air mass.

Infection represents a potential problem and the patient should be covered prophylactically with antibiotics. As demonstrated by this case, antibiotics are not always effective, so drainage of a localized infection may be required. Any infection of the face, whether of primary or secondary origin, must be given special attention because the infection may extend directly to the cavernous sinuses (Miller and Keane 1983).

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