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Subcutaneous emphysema after treatment of a symptomatic invasive cervical resorption of a mandibular first molar: a case report

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Teeth presenting external and internal resorption are uncommon, and affected teeth are often only discovered by chance. In most cases, these teeth are symptom-free. In rare cases, the differential diagnosis between external and internal resorption is very difficult, especially for teeth pretreated elsewhere with inadequate documentation of the clinical situation, as in the case presented. Resorption lacunae can also present a challenge for treatment. Invasive cervical resorption affecting the endodontium requires different therapeutic techniques in terms of position and timing. Presented is treatment of a case of pretreated, invasive cervical resorption with irreversible pulpitis. Root canal treatment was performed by filling the initial perforating resorption using MTA, and treatment of the cervical defect occurred later.
Compared with incidents such as extrusion of H_2O_2 or NaOCl into the periradicular tissues during root canal irrigation, air inclusion in the tissue is comparatively less dramatic. However, this should be taken seriously. The present case report describes the treatment of a symptomatic invasive cervical resorption, with the occurrence of massive subcutaneous emphysema during the final cervical composite restoration.

Introduction

Resorption

Various terms and classifications[1-5] have been suggested for the different types of resorption of the hard tooth tissue. The classification is dependent on location, pattern and aetiology. The clinician who is seldom confronted with this clinical picture may be irritated by the sometimes-synonymous terms of the same clinical situation when it comes to diagnosis and treatment planning.

The exact aetiology of resorption is not conclusively clarified. Two factors precondition its occurrence: damage to the protective tissue (predentine including the layer of odontoblasts, or precementum with cementoblasts), and a stimulus[2,4,6,7]. As long as the mineralised root tissue is covered by predentine, precementum, and odontoblasts or cementoblasts and protected from being colonised by macrophages, osteoclasts and giant cells, no resorption will occur. Nevertheless, if the periodontal tissue and/or the pulp tissue is injured or irritated by mechanical or chemical noxae, the organic surface layer of the inner or outer root surface may be damaged. This damage can be triggered by mechanical factors such as trauma, surgery (e.g. periodontal surgery), high pressure applied during orthodontic treatment on impacted teeth, or by

tumours. Chemical damage related to bleaching therapy has also been described as a causative factor[8-10]. In addition, there must be a stimulus such as inflammatory irritation or pressure. Depending on the location or the origin of the damage (predentine or precementum), an internal or external resorptive lesion may develop under certain circumstances. The pathophysiology is based on a complicated relationship between resorbing cells, inflammatory cells and the hard-tissue-generating structures. Clastic cells play an important role. An imbalance between osteoclasts and osteoblasts in favour of osteoclastic activity results from the injury and inflammatory stimulus. Many resorptive lesions develop very slowly, virtually chronically. This is known as transient resorption and does not need further therapy. If, in addition to a damaged desmodontium, continuous irritation of the osteoclasts acts on the outer root surface, a transient external resorption is likely to develop into a progressive inflammatory external resorption[2-4,6,7]. According to Harris et al[5], external resorption is divided into three groups:

- progressive inflammatory resorption
- replacement resorption
- invasive cervical resorption.

Progressive inflammatory resorption may cause short-term massive destruction of hard tissue leading to the loss of the tooth. The prognosis depends on early diagnosis and appropriate therapy. Identification and elimination of the triggering stimulus is of paramount importance.

Subcutaneous emphysema

Subcutaneous emphysema is abnormal air-inclusion in the tissue. It occurs during endodontic treatment primarily because of increased airflow through the root canal into or along the tissue fascia, and also to other dental procedures using compressed air. The increasing number of incidents seems to be related to the shift from hand-operated air-blowers used early last century to mechanical compressed air systems[11], as well as to the more recent contra-angle handpieces operated by compressed air and turbines. In most cases, the subcutaneous emphysema is not problematic and does not need further invasive therapy.

Pain relief with analgesics, treatment of the swelling by cooling, and reassurance of the patient are uppermost in treatment. Emphysema can also develop as a result of iatrogenic extrusion or injection of NaOCl or H_2O_2 into the periradicular tissue[12,13], or from over-instrumentation or an irrigation needle wedged in the root canal. In contrast to air emphysema, the consequences of extrusion or injection of NaOCl can be dramatic and may cause in many cases long-term complications, including extensive painful swellings that can be connected with ecchymoses as well as tissue and bone necrosis. In conjunction with secondary infection, these may lead to hospitalisation of the patient. Some rare cases of long-term paraesthesia and irreversible nerve damage have also been reported[14-21].

Case report

Medical/case history and clinical examination

Referred by his general dental practitioner, a 49-year-old male patient presented with the presumptive diagnosis 'resorption at the mandibular left first molar' for clarification of whether the tooth could be maintained. He had no medical history of relevance. Approximately 8 weeks before, diffuse pain was felt at the tooth with strong and continuous sensitivity to cold and discomfort when palpating the cheek in the root area. As the patient intended to travel abroad, the general dental practitioner placed a subgingival cervical filling with IRM® (Intermediate Restorative Material; Dentsply Maillefer, Konstanz, Germany). A small area of the pulp tissue was exposed and direct pulp capping was performed. The cold sensitivity improved, but the unpleasant sensation when palpating the cheek remained. The patient had taken acetaminophen for a few days.

The tooth was restored with a mesio-occlusodistal (MOD) ceramic inlay. On the buccal surface, a fine longitudinal crack was noticed. There were also mesiobuccal erosive alterations on the root surface, with a partly subgingival temporary filling. The tooth showed a buccal recession, and the mesiobuccal attached gingiva was slightly swollen (Fig 1), with probing depths of 5 mm. Discreet bleeding occurred during probing, but all other probing locations around

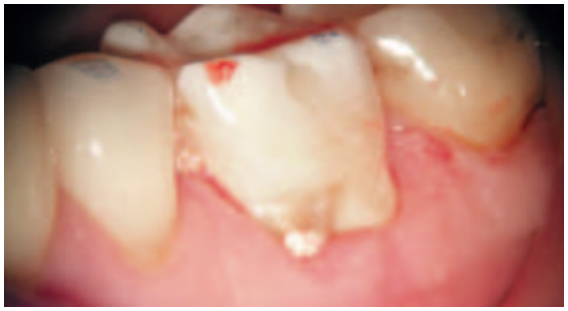

Fig 1 Initial clinical situation with temporary filling in the eroded mesiobuccal root. The gingiva is slightly inflamed; at the buccal aspect a fine longitudinal crack is visible.

Fig 2 Initial radiograph from the referring general dental practitioner, showing an oval radiolucency in the coronal third of the mesial root.

the tooth were unremarkable. In the middle of the mesiobuccal root, the mucosa was slightly tender. General oral hygiene was evaluated as good. The tooth reacted slightly positively to the sensitivity test with CO_2 snow, in particular when compared with the adjacent teeth and the contra-lateral tooth 46. Mobility and percussion reactions were normal. The original radiograph brought by the patient showed a vertical oval radiolucency in the coronal third of the mesial root (Fig 2). Further preoperative radiographs (Figs 3 to 5) showed mesiobuccally the radiopaque IRM filling and a small radiolucency resembling a resorption lacuna. In the eccentric projection, the corresponding structures were projected separately, with the course of the beam showing a buccal location. The location of the radiolucent area in relation to the pulp chamber could not be determined because of the superimposed filling.

The following diagnoses were established: (i) invasive cervical resorption appearing as external resorption; (ii) irreversible pulpitis.

Treatment planning

After diagnosis, the patient was presented with the following options: without treatment, the prognosis

Fig 3 Preoperative radiograph in ortho-radial projection; apical of the radiopaque temporary filling another radiolucency can be seen.

Fig 4 Radiograph in distal-eccentric projection; filling and radiolucency are projected mesially.

Fig 5 Radiograph in mesial-eccentric projection; filling and radiolucency are projected distally.

would surely worsen and the tooth would be lost; after extraction, the tooth would have to be replaced by a conventional fixed dental prosthesis or implant; another possibility was to try to retain the tooth. After discussing these treatment options with the patient and after being advised in detail about the risks, costs and benefits, he decided to retain the tooth.

The treatment plan was to begin with root canal treatment. This included the exploration of the resorption, its location (subcrestal, subgingival, or a combination of both), its dimensions, and accessibility with high magnification from the inside of the tooth. The treatment concerning the resorption of the buccal surface was to be decided in later sessions. Depending on the clinical situation, this could be either a conventional subgingival restoration, or a surgical intervention inspecting the defect, with an intra-operative filling.

Treatment

In the first treatment appointment, an access cavity was prepared through the ceramic restoration under local anaesthesia (Ubistesin forte®, 3M Espe, Seefeld, Germany) and rubber dam isolation. Working under a dental microscope (Pro Ergo®, Zeiss, Oberkochem, Germany) the altered and haemorrhaging inflammatory pulp tissue was extirpated and four root canal orifices were located (Figs 6 and 7). The root canals were instrumented after working length determination (Root ZX®, Morita, Dietzenbach, Germany) and radiographic verification of the apex locator readings (Fig 8). Both the distal and the mesiolingual root canals presented were instrumented up to size 40, taper 0.4, using rotary nickel titanium (NiTi) files (Mtwo®, VDW, Munich, Germany) and a torque-control motor (Endo IT®, VDW) without any problems, followed by a manual step-back sequence in 0.5 mm steps using NiTi Nitiflex instruments (Dentsply Maillefer) to obtain a 10% taper. In the mesiobuccal root canal there was a large resorption defect with softened dentine, heavy bleeding and inflamed pulp tissue. Within the scope of the coronal pre-enlargement with Gates-Glidden burs (VDW), a large amount of softened dentine was removed. Dentine hardness was examined using a Micro-Opener (Dentsply Maillefer), revealing several point-shaped, bleeding resorption lacunae apical and buccal of the IRM filling. The apex locator suspended in the Micro-Opener showed five small resorptive perforations of the dentine, connecting with the bone. The gingiva was not involved. In the area of the extensive resorption, no reproducable glide path could be established owing to the strongly lingual deviation of the canal, so the root canal was instrumented to size 35 with pre-bent stainless-steel hand instruments (Senseus Flexofile®, Dentsply Maillefer). The subse-

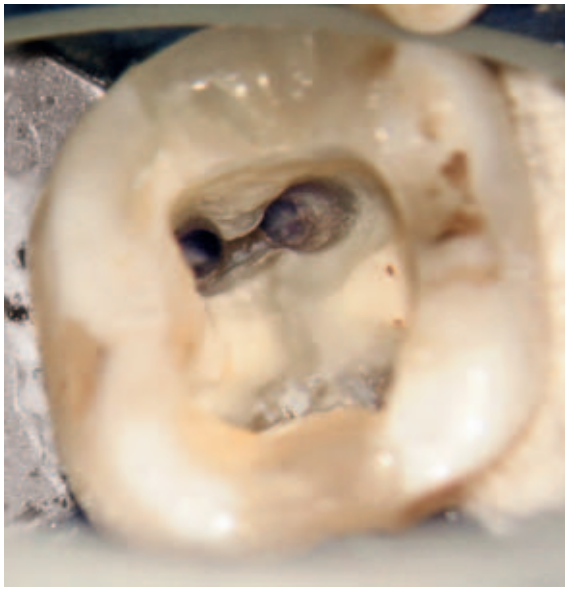

Fig 6 Clinical view inside the distal root canal revealing two separate canal orifices in the shape of an hourglass, with a deep isthmus connection confluent in the middle third of the root.

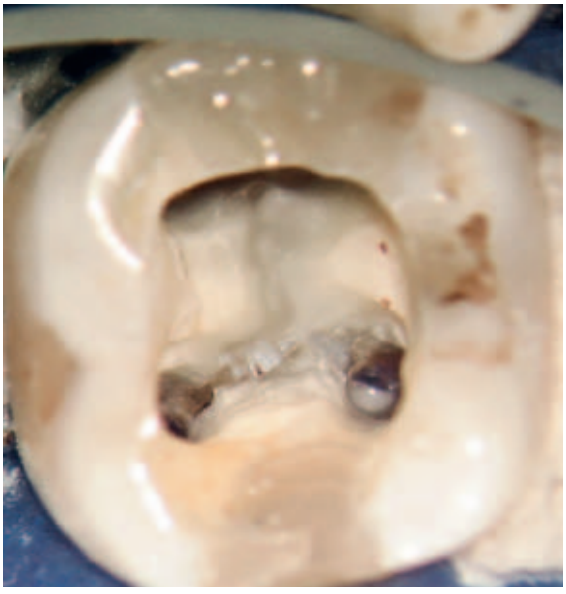

Fig 7 Another perspective shows the two mesial canal orifices. After isthmus preparation, the suspicion of a third mesiocentral root canal was not confirmed.

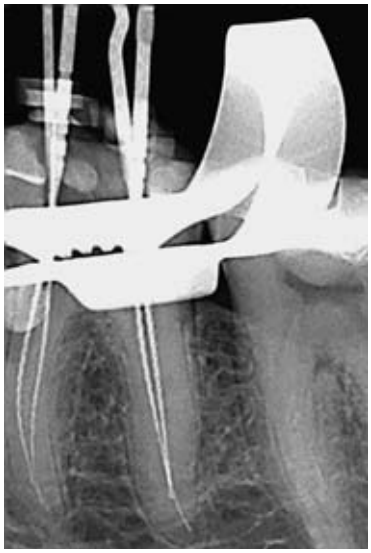

Fig 8 Working length determination radiograph.

Fig 9 Control radiograph showing homogenous obturation of the distal root canals confluent in the middle third of the root canals.

quent step-back preparation, as described above, was completed with size 35 and a 10% taper. After the use of each instrument, the root canals were copiously irrigated with 5% NaOCl solution. The final irrigation sequence in the distal canals, prior to the obturation, consisted of 17% ethylenediaminetetraacetic acid (EDTA), 5% NaOCl and 96% ethanol.

In the same appointment, both confluent distal root canals were obturated after being dried with paper points. Obturation was performed according to the warm vertical condensation technique with System B (Sybron Endo, Orange, USA) and BeeFill (VDW), and Kerr Pulp Canal Sealer EWT (Sybron Endo) was used as sealer (Fig 9). Both mesial root canals were dressed with $Ca(OH)_2$ (UltraCal®, Ultradent, South Jordan, UT, USA) and the access cavity was sealed with Cavit (3M Espe) and Tetric® Flow Chroma (Ivoclar Vivadent, Schaan, Liechtenstein) without conditioning.

Two weeks later the patient presented again. The tenderness in the mesial root area had diminished. The tooth was isolated under rubber dam, the temporary seal was removed and copious irrigation with 5% NaOCl solution was carried out. Both mesial root canals were then dried. Slight bleeding in the area of the fine resorption lacunae was controlled using paper points (VDW).

Owing to their confluency in the apical third of the root, both canals were obturated simultaneously up to the level below the resorption defect, in the same manner as the distal canals (Fig 10). At the same appointment, the defect in the mesiobuccal canal was filled with mineral trioxide aggregate (MTA; MTA Angelus®, Ermerling Consulting, Groitsch, Germany) from inside the canal with the MTA Gun (Dentsply Maillefer) (Fig 11). The remaining cavity was adhesively sealed with a dual hardening adhesive composite (A.R.T. Bond, Coltene®-Whaledent, Langenau, Germany, and LuxaCore®, DMG, Hamburg, Germany).

Four weeks later the first follow-up examination was performed. The initial tenderness to pressure in the cheek was minimal and the periodontal situation

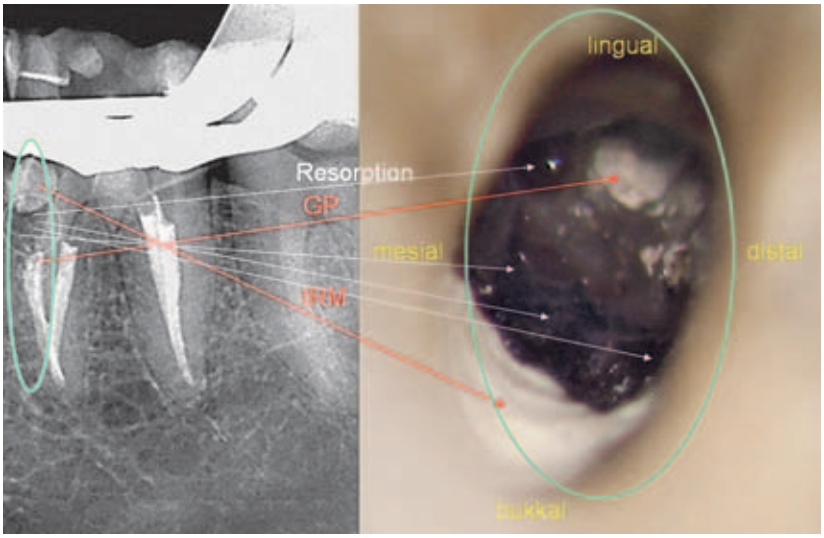

Fig 10 Three-dimensional relationship of the radiographic and clinical situation in the mesiobuccal canal at the second appointment. Homogenous obturation of both mesial canals below the resorption, confluent in the apical third of the root canals. Bucco-coronally, the old IRM® filling from the referring clinician is present; apico-lingually, the original mesiobuccal root canal is filled with gutta-percha (GP); between, corono-apically, the buccal resorptions with connection to the bone are shown.

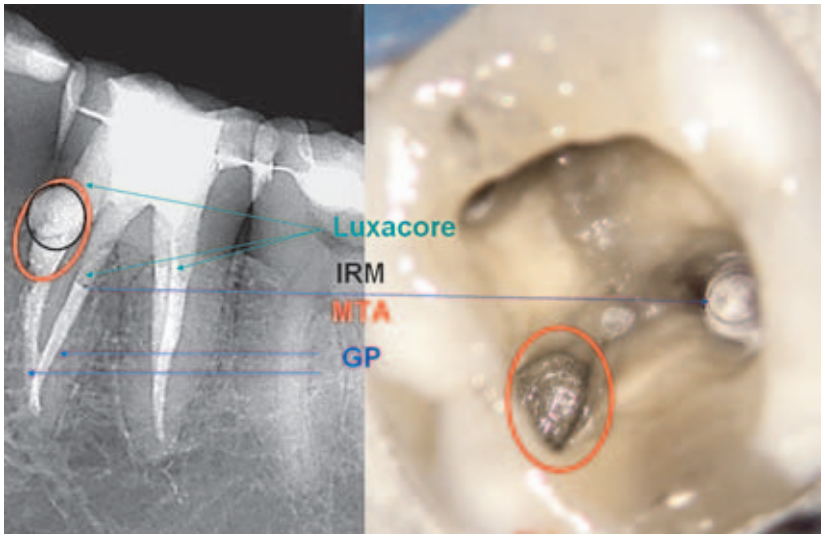

Fig 11 Final radiograph in distal-eccentric projection and clinical view after application of MTA at the second appointment. In the mesiobuccal root canal the various materials are shown: gutta-percha (GP), MTA, IRM®, and Luxacore®.

Fig 12 Anterior view showing the almost completely closed eye. Swelling in the region of the cheek is also obvious.

was unchanged. The deep subgingival cervical IRM filling was completely removed under local anaesthesia. To improve visual control, the sulcus was carefully enlarged with high-frequency surgery (KaVo, Biberach, Germany). Haemostasis was obtained using 15.5% ferric sulphate solution (Astringedent, Ultradent). A composite filling (Tetric Evo Ceram, Ivoclar Vivadent) was placed using Adhese (Ivoclar Vivadent) as a dentine adhesive.

For better control of the margins of the restoration, liquid and blood were blown out of the sulcus with a short blow using a multi-function syringe (KaVo). In a few seconds, an emphysema appeared, spreading caudally to the cheek, mandible and throat as well cranially to the lower and upper eyelids and the temple (Fig 12).

The patient was immediately instructed to cool the swollen areas with a cooling pad, and 800 mg ibuprofen was administered. Approximately 1 hour later, the patient was able to open his eye slightly. As he was feeling mentally and physically well, he returned home.

Owing to distance from the dental office, the patient was not asked to return. Instead, he was contacted by telephone every day and asked about his condition. He took ibuprofen for four more days after the incident. After 8 days the swelling was gone. The patient was symptom-free, with no paraesthesia or anaesthesia.

Six months after the root canal obturation and 5 months after the emphysema occurred, the patient presented again. The tooth was symptom-free and the emphysema had not left any damage. The radiographs showed a normal situation around the resorption, and a normal periodontal ligament was re-established (Figs 13 and 14). Clinically, the tooth showed a marked gingival recession. The attached gingiva was very narrow but not inflamed (Fig 15). The probing depths at six different measuring points were in the range of 2 mm. There was no bleeding on probing.

Discussion

Resorption

The differential diagnosis of an internal resorption was made from the radiographic findings, i.e. the shift of the resorption in angled projections[22]. Furthermore, the resorption lacunae of internal resorption are evenly rounded, while they may be irregular in external resorption (Figs 2, 3 and 5)[23]. In the present case, the clinical appearance of the resorption (Fig 1) was of an inflammatory nature.

Owing to the seriousness of the clinical situation, the resorption can be classified as an inflammatory

Figs 13 and 14 Radiographic follow-up 6 months after root canal filling. In the ortho-radial as well as in the distal-eccentric projection a normal periodontal space is visible. The area of the former resorption is tightly filled.

progressive form of external resorption. The injured periodontal tissue beneath the epithelial attachments indicated an invasive cervical resorption. In this particular form of progressive inflammatory resorption with a continuous stimulus, dentine suffers from an undermining damage.

Later, the pulp tissue and the neighbouring alveolar bone became involved. As the tooth had already been pre-treated by the general dental practitioner and no photographic documentation of the initial clinical situation was available, the often-typical condition of the cervical soft tissue of the invasive cervical resorption could not be used for diagnosis retrospectively[24-26].

External progressive inflammatory resorption is often reported as being caused by forced orthodontic therapy[27], the presence of apical periodontitis, or injury from traumatic luxation damaging the desmodontium[2,6]. Other aetiological factors such as enamel cracks, exposed dentine or exposed pulp tissue have been discussed[23]. Internal bleaching has also been suggested as an aetiological factor[8-10].

As the patient had undergone no orthodontic or bleaching treatment and there was no history of trauma, other factors must be responsible for the resorption, and this was probably a multifactorial process.

One possible pathway for bacteria was the exposed mesiobuccal root dentine, which was distinctly altered by erosion. According to Neuvald and Consolaro[28], healthy teeth have different morphologies at the cementoenamel junction, with areas of exposed dentine considered to be the cause of external resorption. Additional trauma of the root cementum could result from a forced cleaning technique or subgingival scaling during periodontal treatment.

Fig 15 Clinical situation 5 months after placing the buccal composite filling and the event of the emphysema. Mesiobuccally, the attached gingiva is not irritated, but is very narrow. The recession has increased by approximately 3 mm compared with the initial finding. The composite filling appears greyish owing to the underlying MTA.

The enamel crack on the buccal surface of the tooth could also be a further pathway for bacteria (Fig 1). Moreover, the repair and regeneration potential of the pulp tissue might have been diminished by previous coronal restorations, such as the MOD ceramic inlay.

The principal treatment goal was to obtain a durable predictable disinfection of the affected tissues and the subsequent restoration of the defect with adequate filling materials. In similar cases, the exposure of the defect by surgical intervention[4] or orthodontic extrusion[29] of the tooth are considered the therapies of choice.

To dissolve the granulation tissue, using trichloroacetic acid has been recommended[26]. If it is likely or cer-

tain that the pulp tissue is involved, then it is possible to obturate the resorption internally in combination with endodontic procedures[30]. Owing to the clinical and radiographic findings, it was impossible in the present case to correctly assess the three-dimensional location of the resorption.

The defect extended vertically over the entire coronal third of the root. Owing to the exposed pulp tissue caused by the pain treatment by the previous clinician, root canal treatment was indicated. Root canal treatment and orthograde intracanal inspection of the resorption were carried out using an operating microscope. As the resorption lacuna was limited by bone apical to the IRM filling, it was sealed internally with MTA in the second appointment.

Once the root canal treatment was completed, the buccal defect was treated in the third appointment. A primary surgical therapy was considered, but orthodontic extrusion was not indicated in this case. The primary surgical approach would have led to a technically more difficult and potentially problematic cover and blockage of the exposed mesiobuccal root canal. Therefore, the described procedure was preferred in the present case.

In the presence of external resorption of endodontic or traumatic origin, it is recommended to proceed in several appointments. After preparation and disinfection of the mesial root canals, they were medicated with $Ca(OH)_2$. Owing to the high pH-value, $Ca(OH)_2$ is able to eliminate bacteria, necrotise the vital cells in the resorption lacuna, neutralise the lactic acid produced by macrophages and osteoclasts, and thus stop the demineralisation of the hard tissue[31]. Ledermix (Riemser, Greifswald, Germany) has also been recommended as a root canal dressing in such cases, as it contains tetracycline, which is claimed to have anti-resorption properties[29].

Owing to its excellent tissue tolerance and sealing effectiveness, MTA is the first choice for restoring subcrestal defects[32-36]. Defects communicating with the oral cavity via the sulcus should be treated with conventional filling materials according to the clinical situation. In the second appointment, and under the microscope, a gingival participation in the defect was excluded, and the resorption lacuna was sealed with MTA after obturation of the root canals.

To prevent contamination of the resorption by the sealer, the root canal was filled as far as the defect. Conversely, primary treatment of the defect with MTA with subsequent filling of the root canal would also have been possible. In the present case, securing the root canal was the principal technical problem. It is recommended to block the root canal with paper points, gutta-percha cones or finger spreaders[37].

The procedure in the third appointment, i.e. the conventional subgingival filling, should be questioned. Even if the clinical situation could be controlled with a direct composite restoration, contamination of the conditioned dentine by sulcus fluid and/or blood as well as a negative effect on the tightness of the filling cannot be excluded. Also, adhesive dispersal into the sulcus cannot be controlled.

Regarding the surgical approach as an alternative treatment option, visual control and intraoperative correction would have been possible. Whether the MTA was completely covered by bone or if there was a fenestration connecting the oral cavity and the sulcus, and whether the IRM and MTA abutted one another would have to be clarified. It should be possible to control haemorrhages intrasurgically, and a glass-ionomer cement filling would be preferable. Thus, the emphysema would certainly have been avoided.

Subcutaneous emphysema

Although the subcutaneous emphysema could be considered accidental, this event could have been avoided by not using air pressure. During dental procedures, emphysema usually occurs with tooth extraction[38-41], with the greatest incidence in mandibular molars. Further risk factors are the duration of surgery, the use of high-speed contra-angles, compressed air, large quantities of irrigation solution, and the frequent use of retractors[38,42]. Also, root canal treatments that apply air to the root canal[43-46], as well as restorative treatments[47,48], are reported to be a source of emphysema. To avoid emphysema during root canal treatment it is recommended to use low-pressure devices instead of the conventional triple-function syringes. In particular, air-drying of widely enlarged or short root canals should be avoided[49].

A rapidly arising painful swelling with tissue cracking, extending to the throat, neck, orbit and temporal region is typical for emphysema. Although Rickles and Joshi[50] in their case report could not exclude the cor-

relation between emphysema that occurred during root canal treatment, and a pulmonary embolism resulting in death, in general emphysema is not considered life threatening.

In most cases, permanent damage was not observed. Whether induced by way of the root canal or directly in the tissue, as described in the present case, emphysema always represents considerable mental stress for the patient and the clinician. Despite the dramatic appearance of the swelling, the most important measure is to calm the patient and to tell them that the event has no long-term consequences. The swelling can be reduced using cooling pads. Subcutaneous emphysema produces pressure in the tissue, possibly resulting in severe pain and functional constraint, as in the present case where eye and mouth opening was almost impossible. For this reason, 800 mg ibuprofen was administered initially, with the advice to the patient to continue as needed. As well as the analgesic properties, the anti-inflammatory effect of ibuprofen is notable.

In the case of irrigation accidents, antihistamines to reduce the swelling, antibiotics when there is a risk of secondary infection, and corticosteroids to inhibit inflammation are recommended in addition to analgesics[14]. In the present case, there was no indication for further medication. The emphysema was completely healed after approximately 8 days and there was no need for further treatment procedures.

The resorption, nevertheless, requires regular observation. At the 6-month follow-up the radiographic and clinical findings were normal, but close monitoring of the area of the buccal filling is mandatory, as the situation is not conclusively clarified. With the occurrence of clinical or radiological irregularities, immediate explorative surgical intervention would be necessary.

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