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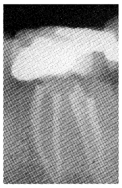

CASE REPORT

Playing wind instruments as a potential aetiologic cofactor in external cervical resorption: two case reports

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Abstract

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Aim To present two cases of external cervical resorption (ECR) on maxillary incisors, in which the primary aetiologic factor is suggested to be pressure trauma by frequently playing wind instruments.

Summary The exact aetiological spectrum of ECR is still poorly understood. For resorption to occur, a defect in the cementum layer (trigger) is a likely prerequisite. Whilst the mechanism for continuation (stimulus) is still unclear, knowledge of potential predisposing factors is important in assessing patients at risk. Pressure generated by playing wind instruments could present an aetiological factor in ECR because it affects the cervical region of the root surface. The cases that are presented may confirm this hypothesis and the extent of resorption defects is shown by cone-beam computer tomography (CT) and micro-focus CT imaging techniques.

Key learning points

- The repetitive forces generated by playing wind instruments could be compared to excessive, longstanding, orthodontic forces and therefore may initiate and stimulate ECR.
- Music teachers as well as general dental practitioners should be aware of the potential impact of playing wind instruments on the orofacial structures.
- If possible, a protective mouth guard should be fabricated and used whilst practicing.
- Cone-beam CT analysis is useful for the clinical diagnosis and treatment planning of ECR.
- Micro-focus CT analysis does reveal the extent and complexity of an ECR defect *ex vivo*.

Keywords: computed tomography, cone-beam, external cervical resorption, micro-focus, wind instruments.

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Introduction

Invasive external cervical resorption (ECR) is a relatively uncommon, insidious and often aggressive form of tooth resorption. Characterized by its cervical location and invasive nature, this type of resorptive process leads to a progressive and usually destructive loss of tooth structure (Heithersay 2004). The exact cause of ECR, however, is still poorly understood. Root cementum is considered to protect the underlying dentine from being resorbed (Schroeder & Scherle 1988, Neuvald *et al.* 2000). Damage to or a deficiency of this cementum layer below the epithelial attachment level may allow direct contact between the dentine and the potentially resorptive cells of the periodontium and therefore trigger clastic activity (Lindskog & Hammerström 1980). The mechanism for activation of ECR with the invasion of a fibro-vascular/osseous tissue is still debated. Some have regarded it as a purely inflammatory reaction, where the resorptive process is initiated and stimulated by sulcular microorganisms (Trondstad 1988, Gold & Hasselgren 1992, Trope 1998). Others have considered it as an aseptic process, namely a type of benign proliferative fibro-vascular/osseous disorder, in which microorganisms have no pathogenic role but are secondary invaders (Fish 1941, Southan 1967, Heithersay 1999a,). The pulp tissue on the other hand plays no role in the aetiology of ECR (Frank & Torabinejad 1998).

Several aetiologic factors have been suggested that may damage the cervical region of the root surface. Heithersay (1999b) investigated potential predisposing factors in 257 ECR lesions in 222 patients. He concluded that a history of orthodontic treatment, dental trauma and bleaching were commonly associated with ECR, whilst orthodontic treatment was a potential predisposing factor for 24.1% of the teeth with ECR. In the present paper, the authors suggest that the repetitive forces generated by playing wind instruments may cause ECR in the same way as excessive longstanding orthodontic forces can do. Following tissue necrosis adjacent to exposed cervical root dentine, mononuclear precursor cells are stimulated to differentiate into odontoclasts, which are attracted to and gradually attack root dentine (Andreasen 1985, Patel & Kanagasingam 2009).

Case reports

Case 1

A 38-year-old African male in normal health was referred to the University Hospital (Leuven, Belgium) by his general practitioner and presented himself with a periapical radiographic image suspicious for ECR on three maxillary incisors. In addition, he mentioned suffering from pain after playing the trumpet and reported playing the trumpet for a few hours each day since his youth. The related pain began some years ago. Concerning his dental history, the patient had not undergone any orthodontic treatment or periodontal surgery. There was no history of dental trauma nor could he demonstrate any parafunctional habits. No restorations were present on the involved teeth. Clinical examination did not reveal any irregularities except for some plaque and calculus (Fig. 1a,b). On the periapical film, an image suspicious for ECR could be observed (Fig. 2). Three anterior teeth 12, 11, 21 had resorptive defects in an advanced stage. Bony-like tissue appeared to have completely replaced the normal dentinal structure. In order to have a three-dimensional view on the lesion a cone-beam computer tomography (CT) scan was made using a small volume scanner (3D Accuitomo 80; J Morita, Kyoto, Japan) with exposure parameters set at 80 kV, 3.0 mA and 17.5 s, and resolution parameters of 40 mm × 30 mm for size (diameter × height) of the imaging volume, 0.125 mm × 0.125 mm × 0.125 mm for voxel size and 0.500 mm slice width (Patel & Dawood 2007). The sagittal images showed oval shaped lesions, filled by replacement bony-like

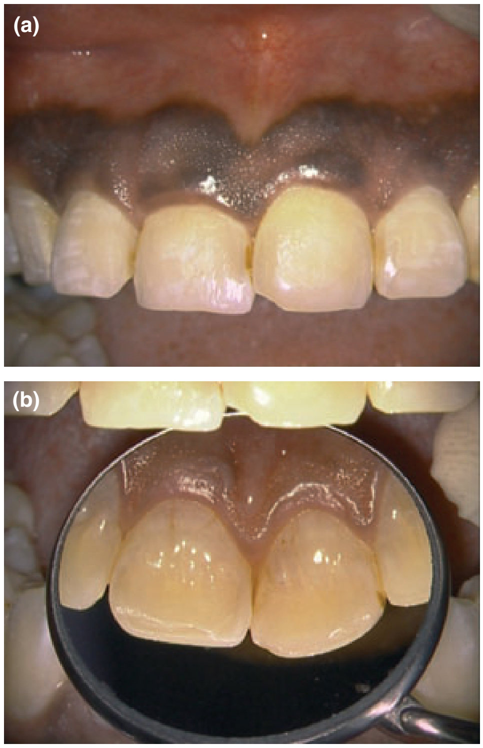


Figure 1 Clinical examination (a) buccal view, (b) palatal view.

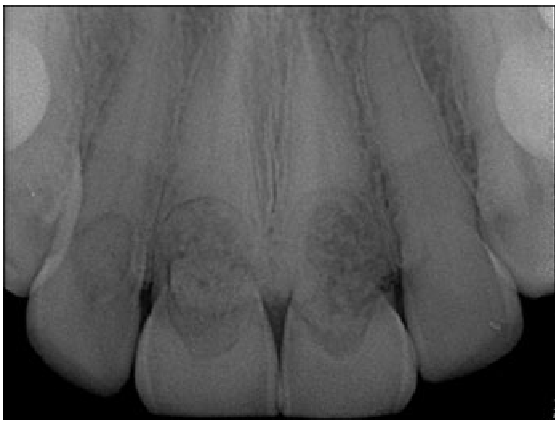


Figure 2 Periapical radiograph showing external cervical resorption (ECR) in three maxillary incisors.

tissue in the cervical area (Fig. 3a). The root canal appeared obliterated up to the middle part of the root. There was no apical pathosis detectable. On the cross-sectional images replacement of the dentine by ossoid-like tissue was clearly visible. The adjacent bone seemed to have the same altered composition as the osseodentine (Fig. 3b).

Concerning the aetiology of these extensive ECR defects, the most suggestive factor was the excessive force generated by playing the trumpet. When lips are pursed against the metal cup-shaped mouthpiece the incisors align vertically and the pressure in a palatal direction induces a tilting moment at the cervical level. In addition, when playing brass

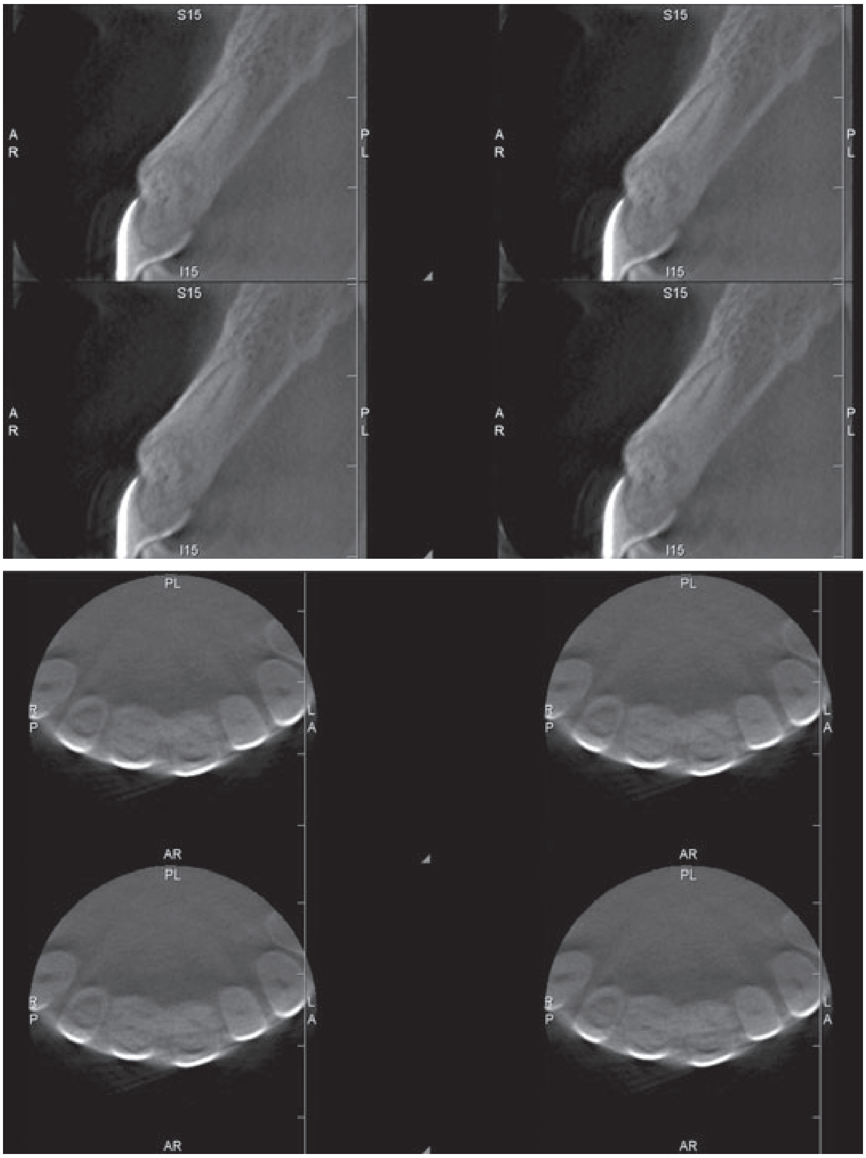
(a)
(b)


Figure 3 Cone-beam computer tomography (CT) images: (a) sagittal images, (b) cross-sectional images.

instruments, the lips are vibrated (Fig. 4a). Considering the frequency of playing, the cementum could become damaged, which is a prerequisite for resorption to occur. The osteoclast/blast cycle is then activated throughout the periodontal ligament to resorb tissue and to deposit new tissue.

Because of financial restraints, the patient decided to adopt a 'watchful waiting' approach. Extraction would have been challenging because of the presence of the fibro-osseous tissue, where there is no difference visible between the fibro-osseous tissue in the teeth and the affected adjacent bone. To reduce the inflammatory component of the resorption, a subgingival ultrasonic scaling followed by prophylactic polishing with Zircate paste (Caulk Dentsply) was performed. The chronic periodontal inflammation, which was probably contributing to the resorption, is being kept under control by periodic repetitions

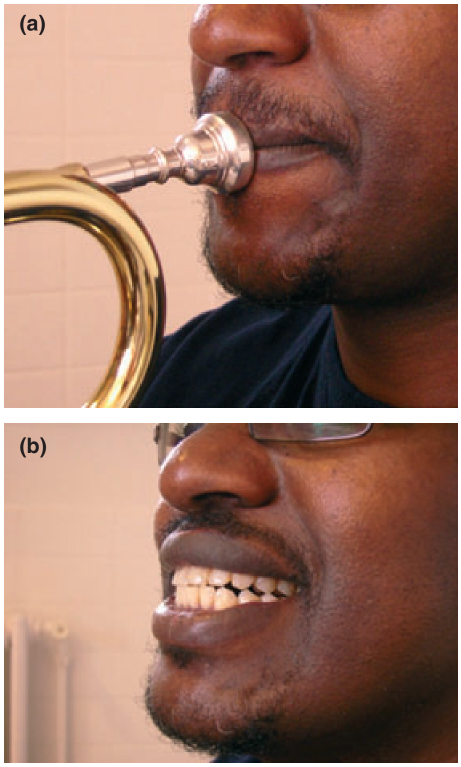


Figure 4 (a) the embouchure of the trumpet is generating pressure on the frontal teeth on the buccal side, (b) the mandibular incisors are generating pressure on the maxillary incisors on the palatal side by edge-to-edge occlusion.

of this treatment and as long as the tooth can function and the patient continues to attend, the condition is likely to be prevented from rapid progression.

Case 2

A 41-year-old Caucasian female was referred by her general practitioner for treatment of tooth 11, with a darkening pink spot in the cervical area. The patient was free of pain and had no significant problems on her maxillary incisors. No parafunctional habits were identified and the patient's medical history was non-contributory. There was no history of orthodontic treatment or periodontal surgery nor trauma. She did not grind, clash or clench her teeth, and the tooth had not been restored or received endodontic treatment. A pink spot on the cervical area was visualized as highly vascular resorptive tissue through the thin enamel. After probing, the portal of entry of the resorption could be located on the palatal side. Bleeding in such cases can be the result of probing into the fibro-vascular mass, or it could be the result of gingivitis, caused by plaque and calculus (Fig. 5a–c) (Hammarström & Lindskog 1985).

The periapical radiograph presented a much more extended resorption lesion than clinically expected (Fig. 6). A radiolucent lesion projecting over the root canal was noted that started from the cervical area until the apical third of the root. In order to have a three-dimensional image of the tooth and to make subsequently an accurate diagnoses and treatment plan, a cone beam CT was made (3D Accuitomo 80), with exposure parameters 80 kV, 3.0 mA and 17.5 s, and resolution parameters of 40 mm × 30 mm for size

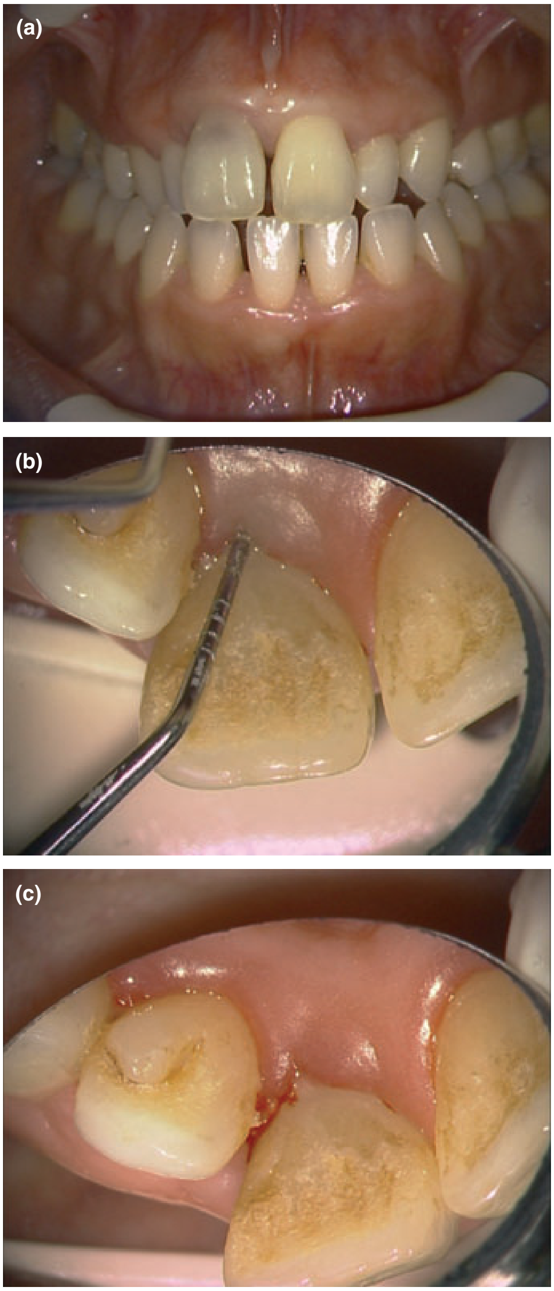


Figure 5 (a) detailed view of the pink spot on tooth 11, (b) probing palatally, (c) bleeding after probing. The presence of plaque and calculus is remarkable on the palatal side.

(diameter and heath) of the imaging volume, 0.125 mm × 0.125 mm × 0.125 mm for the voxel size and0.500 mm slice width). The resorption extension in the three planes could be visualized, mainly in the sagittal and cross-sectional slices (Fig. 7a,b). In the sagittal slices, the root canal walled by resorption along almost its complete length is pictured. The cross-sectional images clearly reveal the circumferential resorption, the portal of entry palatally and a thin radiopaque line which is bordering the pulp space. This protective resorption resistant (retarding) sheet (PRRS) is remarkable and a diagnostic factor for ECR.

Figure 6 Periapical radiograph of tooth 11 showing an extensive radiolucent lesion, projecting over the root canal.

It is this protection of the pulp which explains the absence of symptoms till late in the process. There is no apical pathosis detectable. In this case there was no fibro-osseous tissue in the resorptive cavity, meaning there was no evidence of repair.

Based on the findings of the cone-beam CT, the diagnosis of ECR was confirmed. It transpired the patient admitted to playing the saxophone frequently since her youth. The saxophone is played intra-orally with a wedge-shaped mouthpiece that has a single bamboo reed attached to its underside. The maxillary incisors rest on the sloping upper surface of the mouthpiece, whilst the lower lip is placed between the lower surface of the mouthpiece and the mandibular incisal edges. There is also a lingual pressure on the maxillary anterior teeth. This pressure induces a tilting moment cervically, which could consequently condense the cementum. This cementum deficiency allows direct contact between dentine and the potentially resorptive cells of the periodontium. The immune system recognizes this as a foreign body and an inflammatory process occurs (Chambers 1981). Cementoclasts and hard tissue resorbing cells throughout the periodontal ligament are activated and the resorption is initiated. The sulcular microorganisms are subsequently a possible maintaining factor for the inflammation, which maintains the resorption. In the meantime, fibro-vascular ingrowth into the resorption cavity occurs and proceeds the resorptive cells with nutrition through blood supply (Fig. 8).

Since the dimensions of the resorption were extensive and there was at this stage no inflammation or degradation in the adjacent bone, the circumstances for implant planning were ideal. The best option of treatment was extraction. A preliminary single anterior denture was fabricated for immediate replacement of the tooth. After a healing period of 3 months, the gingival condition was optimal and an implant was placed (Fig. 9a–c). The denture was adjusted in order not to hinder osseointegration.

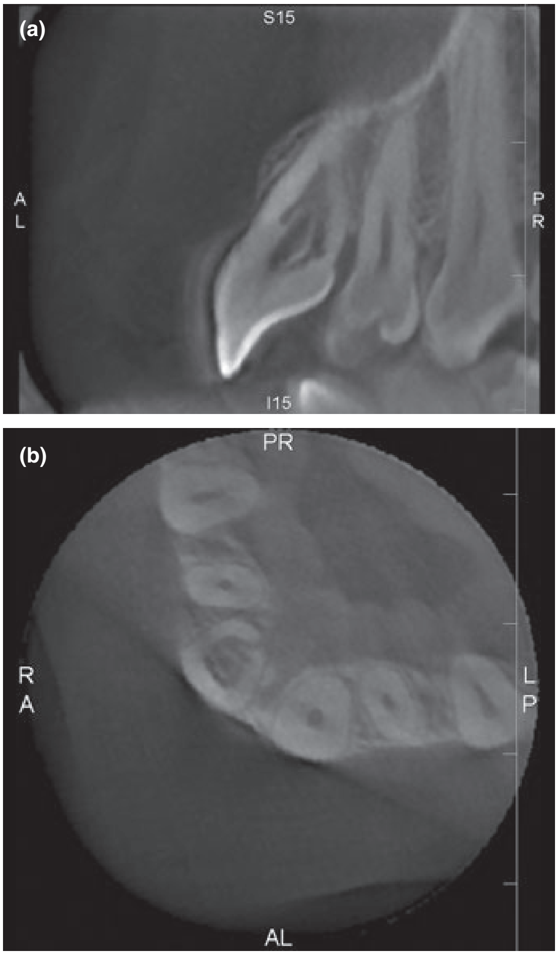


Figure 7 Cone-beam computer tomography (CT) images: (a) sagittal slices, (b) cross-sectional images.

Figure 8 Playing the saxophone; the embouchure is giving a pressure especially on tooth 11, which has a tilted orientation.

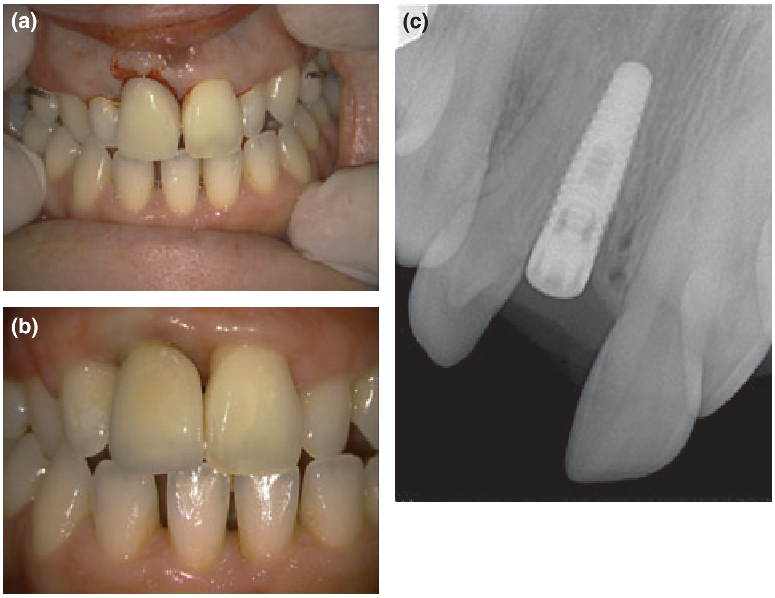


Figure 9 Clinical view: (a) after placing the immediate replacement prosthesis, (b) after placing the implant and crown, (c) radiographic view of the osseointegrated implant.

After extraction, the tooth was used as a study object for further understanding of the insidious process of external cervical root resorption. An examination with the surgical microscope revealed a resorptive cavity located on the cemento-enamel junction palatally. It represented a small portal of entry to an unexpected extensive resorptive process inside the tooth. Another small opening could be detected, located in the middle of the root that might have been an accessory canal involved in the process (Fig. 10a–d).

Radiographic examination of the extracted tooth was accomplished using a CCD sensor (VistaRay, Dürr Dental, Bietingheim-Bissingen, Germany). The canal was protected by a layer of predentine and tubular dentine of approximately 200 μm in width. The reason of the existence of this protective layer is not clearly described in dental literature, but is probably responsible for the late onset of symptoms in this condition. The resorption was largely on the palatal side of the root and it left an irregular and mottled pattern in the dentine. The irregular pattern is likely a result of the pattern of attack by the odontoclasts attached to the dentine (Fig. 11a,b).

Finally, the tooth was also studied using a micro-focus CT scan. All images were acquired on a high-resolution micro CT (Skyscan 1172, Kontich, Belgium) reconstructed to video with VGStudio Max 2.0 (Volume Graphics, Heidelberg, Germany). The micro CT images show the relatively intact outer structure of the tooth that did not reflect the extension of the resorption. Some cementum defects were detected on the outer root surface, which were not as visible on the freshly extracted tooth in Fig. 10 (Fig. 12). A transparent view on the resorptive process inside the tooth reveals the complex resorption network in three dimensions (Fig. 13).

The cross-sectional virtual micro CT slices display (available as Supporting information online which enables the reader to scroll through all the slices and have a real-life view on the resorptive process) the three-dimensional extension of the resorption and the various portals of entry. An intact PRRS is clearly visible on several sections, as is the irregular pattern of the resorption surrounding the root canal. A few side channels are visible (Fig. 14). On the buccolingual images, the mottled aspect of the dentine, which represent the niches of the clastic cells, are obvious. Pulp stones were present and are likely to be a

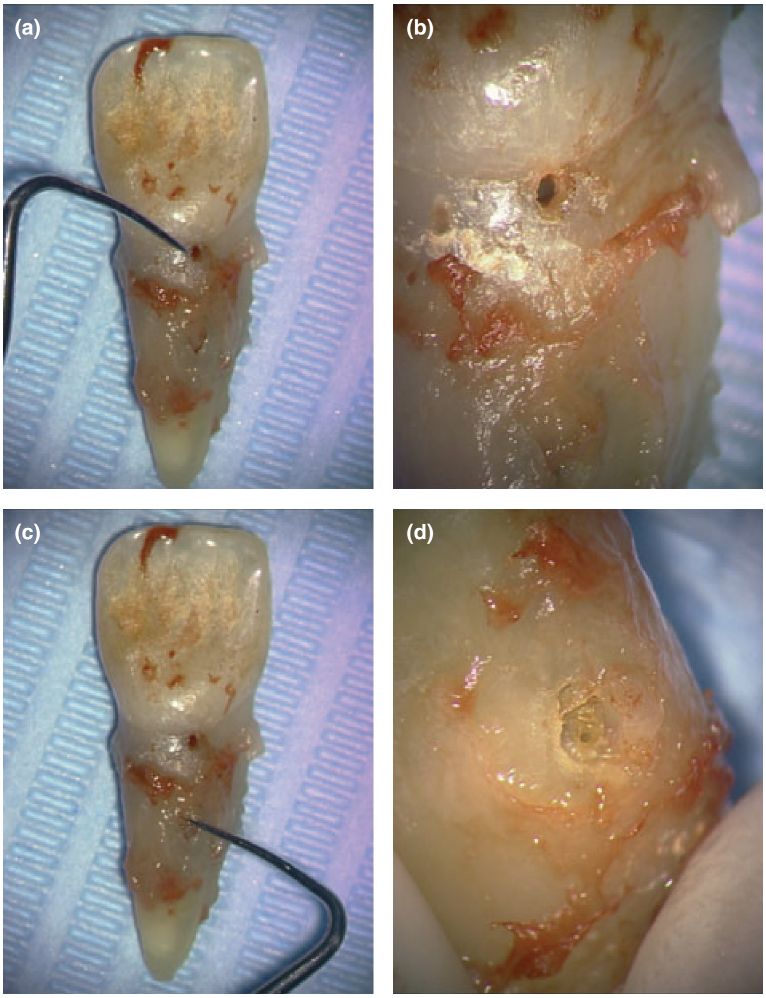


Figure 10 Microscopic examination of the extracted tooth: (a) portal of entry at the cemento enamel junction, (b) detailed view of (a), (c) accessory canal, (d) detailed view of (c).

potential reaction within the irritated pulp. A side channel connected with the resorption lesion is also visible (Fig. 15). On the mesiodistal images the protective resistant (retarding) sheet is visible. As the resorption process progresses circumferentially around the PRRS the root canal is surrounded symmetrically by the clastic action (Fig. 16).

Discussion

Playing a wind instrument is a complex neuromuscular task that requires increased breathing and orofacial muscle activity (Howard & Lovrovich 1989). To play a wind instrument, an embouchure must be formed whereby the lips, tongue and teeth are applied on the mouthpiece to act both as a seal and a funnel for the air. As a result, orofacial problems can occur. Orthodontic problems, soft tissue trauma, focal dystonia, denture retention, herpes labialis, parototitis dry mouth and temporomandibular joint (TMJ) disorders have been identified as common problems endured by career musicians (Yeo *et al.* 2002). Forces produced by the playing of wind instruments are larger than forces produced by average muscle contractions and approach the pressure levels of

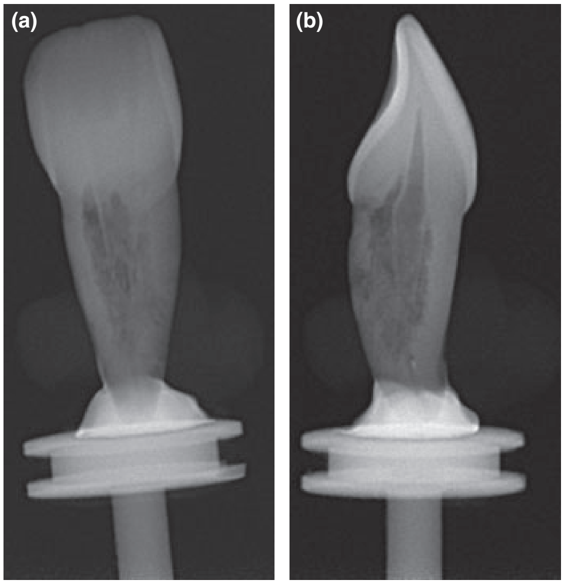


Figure 11 Radiographic examination of the extracted tooth: (a) buccal view, (b) sagittal view.

Figure 12 Micro computer tomography (CT) image showing the affected outer structure of the tooth.

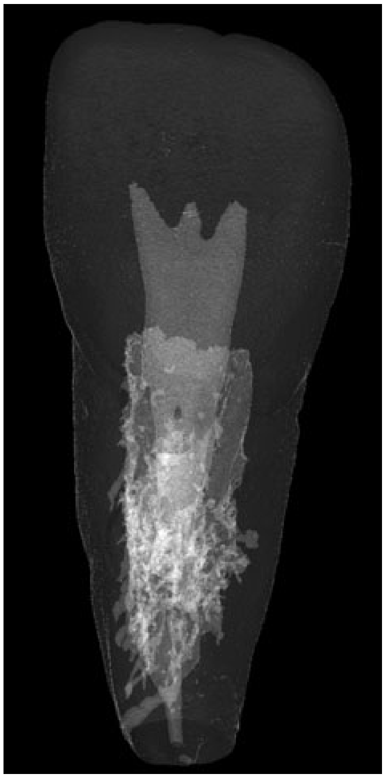


Figure 13 Transparent micro computer tomography (CT) image showing the affected inner structure of the tooth.

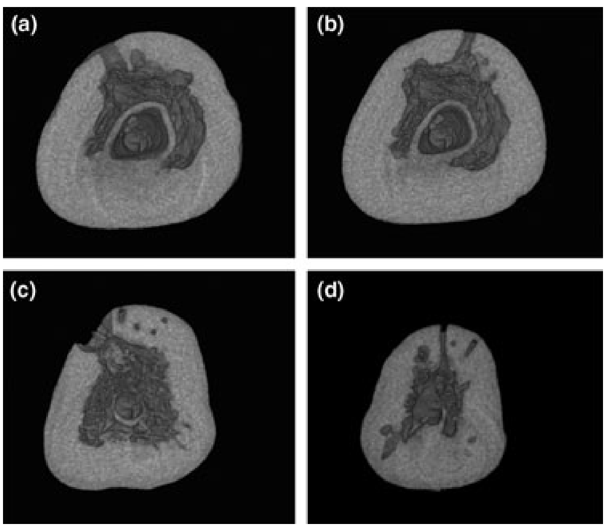


Figure 14 (a-d) Cross-sectional micro computer tomography (CT) images.

maximum lip effort, which may reach levels of sufficient magnitude, duration and direction to produce a malocclusion or help to correct one. The optimal force for orthodontic tooth movement (tipping, rotation, extrusion) is 35–60 g exerted usually over 6 h, whereas the

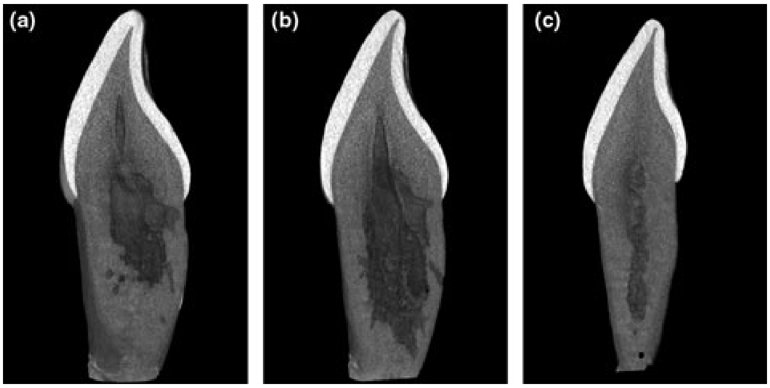


Figure 15 (a-c) Mesiodistal micro computer tomography (CT) slices.

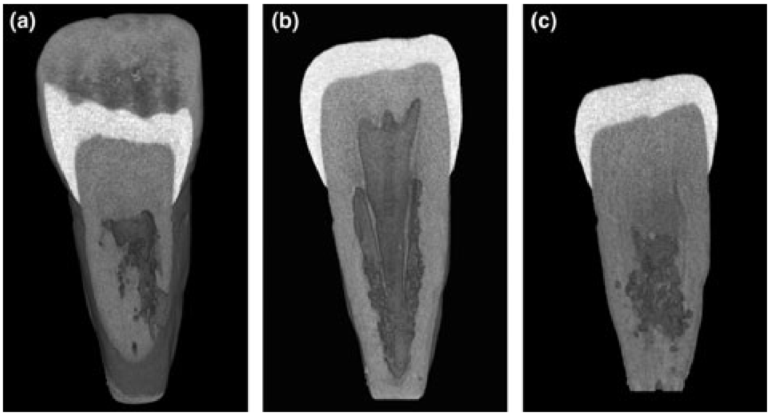


Figure 16 (a-c) Vestibulolingual micro computer tomography (CT) images.

mean force exerted by three different wind instrument groups is substantially greater (flute 211 g, reed 270 g, brass 500 g). These forces are potentially harmful to teeth and the occlusion if exerted for sufficient time (Borchers *et al.* 1995). As orthodontic forces can initiate ECR, and as wind instruments are comparable to orthodontics effects, one can make the interpolation that playing wind instruments might also trigger ECR. This aetiology is in both of the cases plausible, although other possible triggers may have been relevant. Brass instrument players, such as trumpeters, have a tendency to bruxism (Bejjani 1996), which is also a potential aetiologic factor of ECR. This might apply to case 1, the trumpet player. Whatever, the cause of the initial damage to the protective cementum, subtle vascular damage in the periodontal ligament caused by subclinical subluxation and contusion, can induce reparative processes as occurs following dental trauma (Andreasen 1985). Cell crushing and cell decomposition can trigger a cascade of cell responses causing repair and resorption. What causes the stimulation of the activated clastic cells is not fully understood. In both cases, it seems that the maintaining factor for resorption was microbiological. Single reed instrumentalists, such as saxophonists, salivate more than other musicians with an associated increase in calculus formation (Bergström & Eliasson 1988). The consequence of more periodontal problems is not supported by research as neither increased alveolar bone loss nor increased periodontal disease is evident in wind instrumentalists in the presence of good oral hygiene (Bergström & Eliasson 1988).

Heithersay (1999b) concluded that in 14.9% no potential predisposing factors could be identified and suggest that a good history was essential in identifying the aetiology of ECR. Any pressure on the teeth, if generated frequently, is a possible aetiologic factor. Excessive pressure on teeth can be exerted by nail biting, ectopic eruption, retained teeth (especially the maxillary canines and the third molars), bruxism, a restoration which is too high and in traumatic occlusion. All those factors should be taken into account in the etiologic checklist for ECR.

The occurrence of ECR is probably higher than generally acknowledged as detection is mainly based on conventional radiographs. With the advent of high resolution cone-beam CT, a more precise tool for three-dimensional imaging and analysis is available. Especially in the axial and sagittal views, the exact position and extent of ECR can be diagnosed.

Conclusion

Invasive external cervical resorption is a clinically challenging condition with a debatable pathogenesis. Current interpretations rely on an assessment of the clinical manifestations, behavioural characteristics and the micro CT visualization of the pathologic process, but a more accurate determination of the aetiology of this disorder is needed. Identification of potential predisposing factors may allow some preventive measures to be implemented. Investigation of those individuals who play wind instruments professionally could be an option for research in order to gather epidemiological data on occurrence and incidence.

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Supporting Information

Additional Supporting Information may be found in the online version of this article.

Video 1 Transparent view of the relation between inner and outer tooth structure, invaded by the resorption process.

Video 2 Cross-sectional view of the resorbed inner tooth structure and the preservation of the PCRRS.

Video 3 Mesio-distal sectional view and zoom of the resorbed inner tooth structure and preservation of the PRRS.

Video 4 Vestibulo-palatal sectional view of the resorbed inner tooth structure and the preservation of the PRRS.

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