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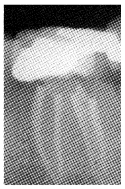

CASE REPORT

Root perforation associated with the use of a miniscrew implant used for orthodontic anchorage: a case report

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Abstract

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Aim To highlight one of the possible complications associated with the inter-radicular placement of orthodontic miniscrews.

Summary This case report describes the endodontic treatment and surgical repair of an iatrogenic root perforation involving a maxillary first molar tooth following the placement of an orthodontic miniscrew placed for anchorage purposes in the treatment of an adult patient. The orthodontic treatment plan was completed. The long-term follow-up shows a successful treatment outcome.

Key learning points

- Inter-radicular placement of orthodontic miniscrews is a valuable source of anchorage in the treatment of orthodontic patients.
- Root perforation is a possible complication from inter-radicular placement of orthodontic miniscrews.
- Root perforation can be successfully treated, but may involve apical surgery.

Keywords: iatrogenic root perforation, longterm follow-up, maxillary first molar, miniscrews, orthodontic anchorage, periapical surgery.

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Introduction

Anchorage planning is a prerequisite for good orthodontic treatment with fixed appliances. Implants offer an alternative to the traditional orthodontic anchorage methods and are advocated when the teeth and supporting structures lack quantity or quality, when extraoral devices are impractical or when noncompliance during treatment is likely (Favero *et al.* 2002). In recent years, the use of dental implants for orthodontic anchorage has increased in popularity (Kanomi 1997, Park *et al.* 2004, 2005). Conventional dental

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implants can only be placed in edentulous and retro-molar areas. Mid-palatal implants avoid the space limitation, but can only be used in the maxilla. However, conventional and mid-palatal implants have significant disadvantages such as two-stage surgery, high cost, limitations in the direction of forces, possible nerve damage during placement and hygiene issues (Costa *et al.* 1998, Freudenthaler *et al.* 2001). In the last few years, implants of smaller sizes have been developed to overcome some of these difficulties. These so-called 'miniscrew implants' are small enough for placement in any surface of the alveolar process even in the interdental/inter-radicular spaces. They are relatively inexpensive, and the techniques for placement and removal are simple (Kanomi 1997, Park *et al.* 2004, 2005).

Most reports on the use of miniscrew implants are in the form of case reports or preliminary studies on sharing experiences on limited numbers of patients or on the incidence of implant failure (Kanomi 1997, Costa *et al.* 1998, Freudenthaler *et al.* 2001, Park *et al.* 2004, 2005). There is limited information available on the risks to teeth with miniscrew implant placement. While it is acknowledged that there are risks to the periodontal ligament and root during insertion, these risks have not been quantified (Kravitz & Kusnoto 2007). Placement protocols vary hugely (Crismani *et al.* 2010). It is generally accepted that superficial injuries to the root without pulpal involvement will heal without complication following damage from a microscrew drill or implant after discontinuing contact (Maino *et al.* 2007). Kadioglu *et al.* (2008) examined damage to the root surface in 10 patients after intentional contact with miniscrews. They reported swift repair and almost complete healing within a few weeks after removing the screws. However, these injuries involved the outer root surface and were largely superficial. There are few case reports in the literature that report root perforation following miniscrew placement.

The use of transalveolar screws for intermaxillary fixation (IMF) following maxillofacial trauma is not too dissimilar from the mini implants used for orthodontic anchorage in so far as they are placed into the alveolar bone (Jones 1999). Self-tapping threaded titanium screws 2 mm in diameter are inserted into pre-drilled holes at the junction of the attached and free mucosa. One or more screws can be inserted into each quadrant. Temporary IMF is achieved using either elastics or wires. In a study by Fabbroni *et al.* (2004), 27.1% of the screws placed had tooth contact as assessed radiographically. Of these, 11.2% were deemed to be major contact (screw hole impinged more than 50% of the screw diameter into the root), with the loss of pulp vitality in six of the affected teeth. There are several other reports (Holmes & Hutchinson 2000, Majumdar & Brook 2002) advising caution in the use of these intermaxillary fixation screws. In an audit carried out by Farr & Whear (2002) on nine patients, the use of intermaxillary fixations screws was restricted to consultants only owing to the unacceptably high rate of apparent radiographic damage to tooth roots. Of the 36 screws used, the adjacent tooth roots could be adequately visualized in 31 cases. In 13 of these cases, there appeared to be radiographic evidence of root damage, with four screws appearing to have entered the pulp cavity.

No such data exist on the impact of orthodontic miniscrew implants used for orthodontic anchorage to the adjacent teeth. Given that there are relatively high rates of pulpal complications associated with intermaxillary fixation screws, it seems reasonable to expect similar complications with the placement of orthodontic miniscrews.

To date, there are limited reports of pulpal complications following orthodontic miniscrew placement (Hwang & Hwang 2011). This article highlights a case where miniscrew implant sheared during placement after inadvertently engaging the mesial root dentine of a maxillary first molar. This resulted in pulpal necrosis and the creation of a root perforation, which required conventional root canal treatment followed by an apicectomy on the mesial root to repair the root perforation.

Case report

A 25-year-old female caucasian attended for orthodontic treatment, unhappy with the crowded and rotated appearance of her maxillary anterior teeth (Fig. 1.).

She had a class 1 type malocclusion with a 6-mm overjet (on a rotated maxillary central incisor) and normal overbite on a mild skeletal 11 base with rotations of all her maxillary and mandibular incisors. She was to be treated on a nonextraction basis with interdental stripping (IDS)/enamel reduction to create space anteriorly and posteriorly.

Orthodontic treatment was commenced using anchorage reinforcement (a transpalatal arch). Maxillary ceramic and mandibular stainless steel brackets were placed. Treatment commenced in January 2004.

Mid-treatment, the patient commented that her maxillary teeth seemed more prominent as they became less rotated. Anchorage reinforcement was needed to retract the now proclined maxillary incisors. The plan was to use orthodontic miniscrews to achieve the necessary anchorage to allow retraction of the proclined incisors.

The pre-treatment OPG radiograph was used to assess possible sites for miniscrew placement (Fig. 2). A site between the maxillary second pre-molar and first molar tooth was identified as being the most suitable. Local anaesthetic (Lignospan Special; Septodont, Paris, France) was given, and a round bur was used to mark the attached buccal mucosa and cortical bone. Two self-screwing 8-mm long 1.3–1.2 mm tapered miniscrews were used. On placement of the miniscrew in the maxillary right buccal quadrant, it was noted that the miniscrew 'kept turning' but was not engaging the buccal bone. On further examination, the miniscrew tip was missing. A periapical radiograph revealed the retained miniscrew tip was in close proximity/overlying to the mesio buccal root of the maxillary first molar (Fig. 3). The patient was advised about this complication and an agreement reached to monitor the situation.

Further interdental stripping was carried out to allow the retraction of the proclined maxillary incisors using intra-elastics.

Ten days later, a buccal sinus tract appeared from the root region associated with tooth 16 (Fig. 4). Sensibility tests elicited a positive response from the tooth.

A decision was made to remove the fractured miniscrew tip. Local anaesthetic (Lignospan Special, Septodont) was administered, and a mucoperiosteal flap was raised. The tip of the miniscrew was recovered with a periosteal elevator, and the flap repositioned with sutures (Fig. 5). Chlorhexidine mouth rinse was advised, and amoxicillin 250 mg four times a day was prescribed for 1 week.

Figure 1 Pre-treatment orthodontic records.

Figure 2 Cropped OPT showing right side.

Figure 3 Periapical radiograph showing retained miniscrew tip in the mesial root of 16.

Healing was uneventful at 2 weeks. Tooth 16 elicited a positive sensibility test. At a further appointment, further IDS was carried out anteriorly, and the fixed appliances were removed following a treatment time of 9 months. The patient was happy with the overall orthodontic outcome. The sinus reappeared near the mesio buccal root of 16, and the patient was referred to a specialist endodontist for an opinion.

At that time, there was a history of discomfort from tooth 16, which was aggravated by cold. The tooth was slightly tender to percussion. Tooth mobility was within normal limits. Periodontal probings ranged from 3 mm interproximally to 1 mm buccally and lingually. There was a sinus tract present on the buccal gingivae overlying the tooth. A previous radiograph with a gutta-percha point in the sinus GP tracing was included with the referral letter. Radiographic examination revealed a periapical radiolucency over the mesio buccal and possibly the palatal roots (Fig. 6). Sensibility testing elicited positive responses. A diagnosis of pulpal necrosis following root perforation was made. The agreed treatment plan was to carry out conventional root canal treatment and to attempt an internal perforation repair if possible.

Local anaesthetic infiltration was given (Lignospan Special, Septodont) over tooth 16. Under rubber dam isolation (Hygenic; Coltene/Whaledent AG, Alstatten, Switzerland), the pulp chamber was accessed using a diamond fissure bur in an air turbine handpiece. The canal orifices were identified using a dental microscope (Global Surgical Corp., St Louis,

Figure 4 Sinus tract over 16 following miniscrew fracture.

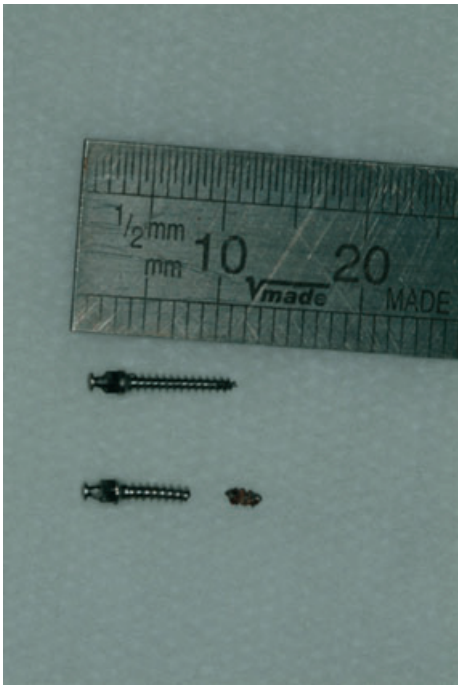

Figure 5 Intact miniscrew and fractured miniscrew with retrieved miniscrew tip.

MO, USA). The canals were explored with hand K-files. The disto-buccal and palatal canals were patent. Both the MB and MB2 canals were obstructed. It was not possible to bypass the obstruction. Root canal treatment was completed using a 5% solution of sodium hypochlorite as the primary irrigant and 17% EDTA used to remove the smear layer. The canals were shaped using a combination ProTaper and .06 Profiles (Densply Maillefer, Ballaigues, Switzerland). The canals were filled with gutta-percha (Autofit; Sybron Endo, Orange, CA, USA) and root canal sealer (Roth Root Canal Cement; Roth International Ltd., Chicago, IL, USA) using a vertical compaction technique. Treatment of both the distobuccal and palatal roots was uncomplicated. However, treatment of the mesial root was challenging. There were three factors that prevented the placement of a technically satisfactory root filling in this root: the perforation was large and located on the buccal aspect of the root (Fig. 7), debris had been intruded into the perforation site creating an

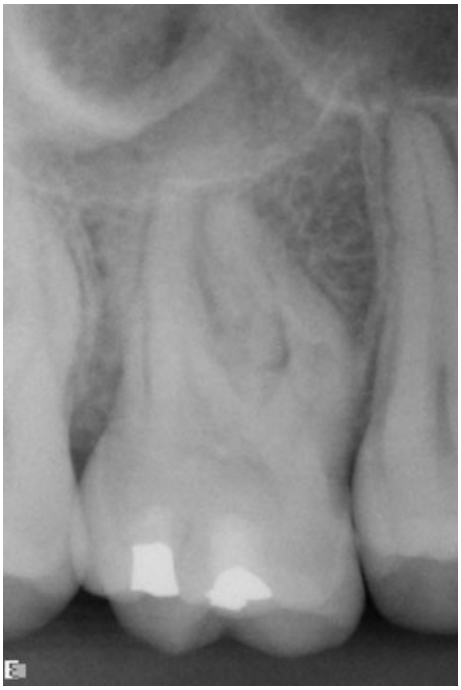

Figure 6 Periapical view of tooth 16 following miniscrew removal.

obstruction (Fig. 7), and the perforation had occurred in an area where there was abrupt curvature (Figs 3 and 6). It was therefore decided to complete the root filling to the level of the perforation with a view to carrying out apical surgery to remove the root apex below the perforation. Treatment was completed over two visits. An interim dressing of calcium hydroxide (Ultracal XS; Ultradent Products Inc., South Jordan, UT, USA) was placed. A post-treatment radiograph was taken (Fig. 8) to assess the quality of the root filling in the DB and P canals.

Under local anaesthetic, a full periosteal flap with two vertical releasing incisions was raised. There was an obvious bony fenestration at the site of the perforation. On curetting the granulation tissue in this fenestration, the perforated root was uncovered (Fig. 7).

The bone apical to the perforation was removed, and the MB root was resected to include the perforation. The resected root-end was prepared using an ultrasonic tip (KiS Microsurgical Ultrasonic Instruments, Obtura Spartan, CA, USA) (Fig. 9) and the root-end cavity dried using a Stropko irrigator (Sybron Endo, CA, USA) and filled with MTA (MTA-Angelus, Londrina, PR, Brasil). The flap was sutured using 06 monofilament sutures (Prolene; Ethicon Inc, Sommerville, NJ, USA). A post-treatment radiograph was taken (Fig. 10) to assess the quality of the filling.

Continued follow-up over 5 years has shown a successful outcome from both an orthodontic and an endodontic perspective (Figs 11 and 12). Clinically the tooth has remained symptom-free. At the last recall visit, there was no tenderness to buccal palpation and no tenderness to percussion. There has been no periodontal attachment loss and no pocketing. Radiographically, there are no signs of periapical disease.

Discussion

The use of orthodontic miniscrew implants has become an accepted and reliable method of aiding orthodontic anchorage (Chaimanee *et al.* 2011). The placement of orthodontic

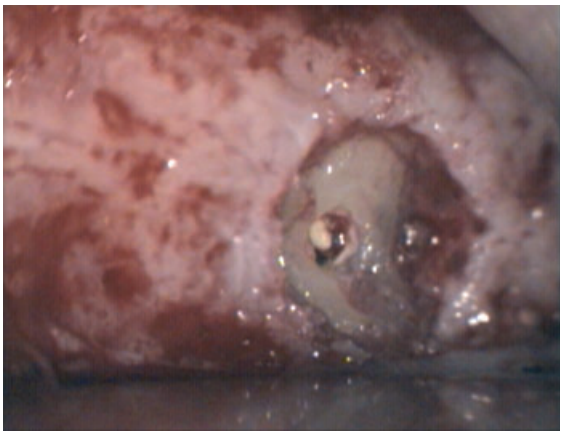

Figure 7 View of surgical field following flap reflection and granulation tissue removal.

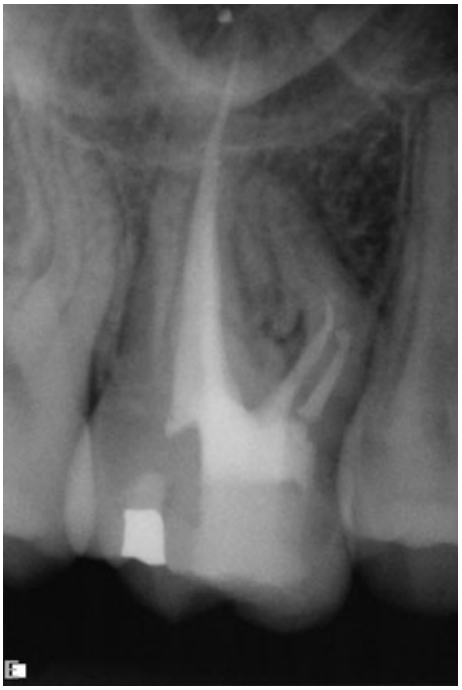

Figure 8 Periapical view of tooth 16 following root canal treatment, October 2005.

miniscrew implants in the inter-radicular alveolar bone has been recommended as a simple placement and removal location (Lee *et al.* 2009). Several studies have been carried out to assess safe locations in the inter-radicular bone for miniscrew placement (Schnelle *et al.* 2004, Poggio *et al.* 2006, Chaimanee *et al.* 2011). A minimum of 1-mm clearance around the miniscrew has been recommended to preserve periodontal health and avoid complications (Poggio *et al.* 2006). Therefore, when the diameter of the miniscrew and the minimum clearance of alveolar bone are considered, an inter-radicular space of 3 mm is needed for safe miniscrew placement (Schnelle *et al.* 2004, Poggio *et al.* 2006). 'Safe zones' have been identified for miniscrew placement (Poggio *et al.*

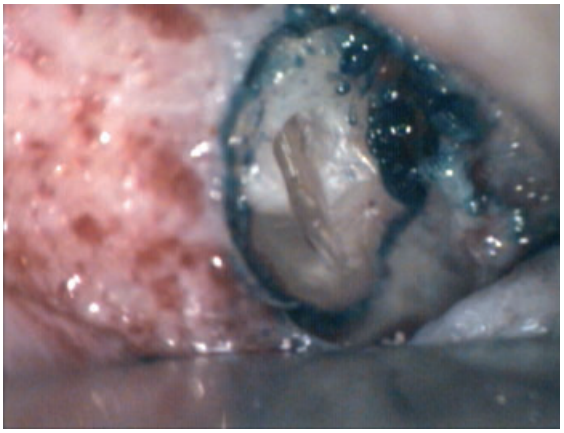

Figure 9 Resected root face showing root preparation stained with methylene blue.

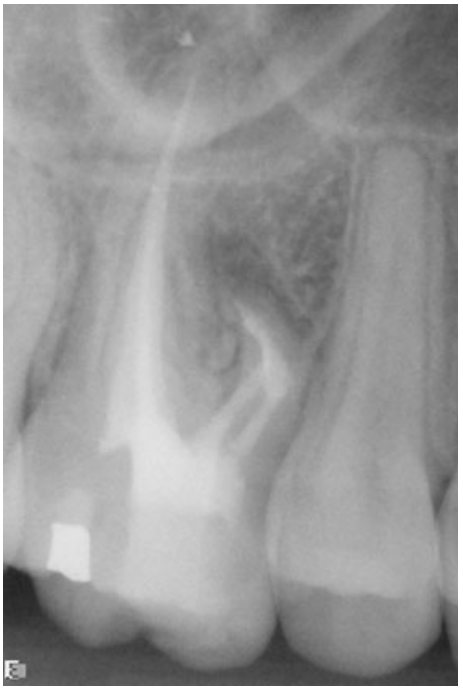

Figure 10 Periapical view of tooth 16 following completion of surgical treatment, November 2005.

2006, Lee *et al.* 2009, Chaimanee *et al.* 2011). There has been a move away from placing them in unattached mucosa, where there is often sufficient space to place them, as these miniscrews often 'loosen and fall out' before clinicians have completed treatment. In the attached mucosa, there is little space interproximally to place miniscrews (Ludwig *et al.* 2011), and without careful pre-placement assessment, root damage could ensue. It is essential to take periapical radiographs of the proposed implant site. Most orthodontists do not routinely take periapical radiographs as part of their practice. While it appears miniscrews that come into contact with roots loosen early, and any deleterious side affects to the teeth appear to be subclinical.

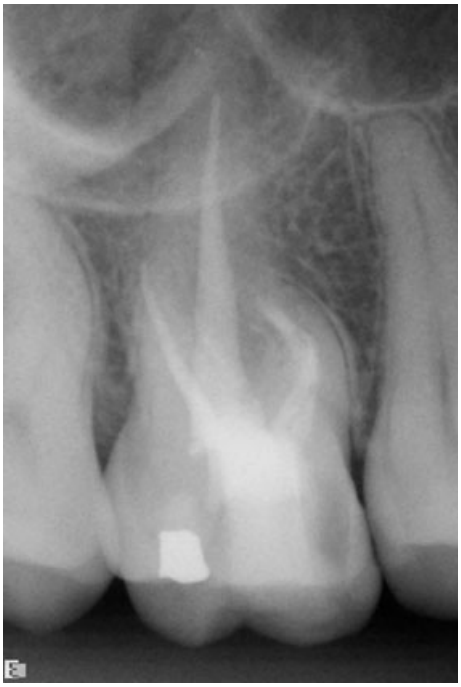

Figure 11 Periapical view of 16 at 5-year recall, April 2011.

Figure 12 Post-treatment orthodontic records.

In the posterior maxilla, the safest inter-radicular space is the space between the second pre-molar and first molar (Poggio *et al.* 2006, Lee *et al.* 2009, Chaimanee *et al.* 2011, Ludwig *et al.* 2011). In the posterior mandible, the safest zones are between the first and second pre-molars and between the first and second molars (Poggio *et al.* 2006, Lee *et al.* 2009, Chaimanee *et al.* 2011, Ludwig *et al.* 2011). However, there is some uncertainty as to where the miniscrews should be placed relative to the alveolar crest in the safe zone in the posterior maxilla. Chaimanee *et al.* (2011) found that available inter-radicular bone, greater than 3 mm, was available at a distance of 9 mm and 11 mm from the alveolar crest, which would position the screw in the free mucosa. This is in contrast to the recommendations of Poggio *et al.* (2006) who report that the insertion of miniscrews in the maxillary molar region more than 8 mm above the alveolar crest must be avoided because of the presence of the maxillary sinus. Poggio *et al.* (2006) further recommended miniscrew placement in an oblique direction at an angle of 30–40 ° to the tooth axis so that the miniscrew could be sited in attached gingival. Ludwig *et al.* (2011) were the first to investigate interdental bone width in relation to the mucogingival border and the proximal contact point, and thus produce reliable data for identifying suitable miniscrew insertion sites in the maxilla and mandible.

In this case, a miniscrew site assessment was made on an OPG (Fig. 2). The so-called 'safe zone' in the maxilla was the preferred site. The only issue to consider was the distance above the alveolar crest to place the miniscrew. It was decided to place it as high up as possible but to keep the miniscrew in the attached gingiva, to increase its potential for survival (Viwattanatipa *et al.* 2009). Figure 4 shows the ensuing fistula from the actual position of the miniscrew after the tip had separated. It is apically positioned almost at the junction of the free and attached gingival. However, when this is compared to the periapical radiograph taken immediately after the tip fractured (Fig. 3), the radiographic image suggests that the site chosen was much closer to the alveolar crest. This is the difficulty associated with miniscrew placement. It is impossible to predict accurately using a two-dimensional image where the roots are located. This is further compounded by the fact that these miniscrews perform better when they are placed in the attached gingiva.

Summary

The use of mini implant systems to achieve anchorage in orthodontic treatment offers considerable advantages in certain cases (Kanomi 1997, Park *et al.* 2004, 2005). There is limited information available on the potential complications associated with their use (Kravitz & Kusnoto 2007). This case highlights one of the potential difficulties associated with the placement of an orthodontic miniscrew implant even though it was placed in a so-called 'safe zone'. The use of periapical radiographs in the assessment of tooth and root position is essential. Reliance on the OPG for tooth and root assessment is not predictable even in the so-called 'safe zones'. Further clinical randomized studies are needed to minimize the risks associated with miniscrews. This reports shows the long-term outcome of a maxillary molar tooth following an iatrogenic perforation with the use of an orthodontic miniscrew.

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