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Multidisciplinary approach to the treatment of an oblique crown–root fracture

CASE REPORT

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Abstract – This case report describes the management of an oblique crown–root fracture of the buccal cusp of the upper right first premolar. After removal of the fractured cusp, a provisional restorative build-up in this area was carried out, in order to carry out an endodontic treatment in a sterile environment. A glass fibre post and core were then constructed and over a 90-day period the tooth was extruded orthodontically by 4 mm. The periodontal fibres associated with this tooth were cut with a tiny surgical blade to help to prevent reintrusion of the tooth and achieve fine contouring of the gingival margins. The new tooth position was maintained with a retainer for a further 60 days and after a period with a provisional acrylic crown, a porcelain bonded crown was fitted. This case report demonstrates that such a multidisciplinary treatment approach to an oblique subgingival fracture is a reliable and predictable manner in which to save a tooth that would have otherwise been difficult, if not impossible, to restore with a resultant good long-term prognosis.

Orthodontic root extrusion, or forced eruption, was first described by Heithersay in 1973 (1) and various cases have been published subsequently (2–8). The aim of this movement was to raise the defect of a fractured root surface from within the alveolar bone to a supragingival position. This is accomplished by providing a horizontal component, usually a wire attached to the adjacent teeth, from which a vertical force is then exerted on the root. A straight root will be moved above the level of the bone in a matter of only a few weeks, whereas in movement of multi-rooted or curved roots, more time is needed as the tooth must also move through bone (9). The tooth must then be held in position until the periodontal tissues heal and stabilize.

Simon (9) presented the indications for root extrusion, namely any cervical third root problem that involves or extends 0–4 mm below the crest of the alveolar bone, including horizontal fractures, caries, repair of resorption defects and iatrogenic perforations of the coronal third of the root, and where it is necessary to slowly extract a tooth when radiation therapy presents a risk of postextraction osteoradionecrosis. It has also been advocated in the treatment of infrabony pockets (10). In any case, it is important that the patient has good oral hygiene, or is at least keen to improve. Furthermore, a final crown-to-root ratio of at least 1:1 should be maintained, to ensure adequate periodontal support (9).

When there is a subgingival fracture of a tooth, various problems are encountered. The position of the tooth substance remaining at the level of the fracture line does not allow a perfect seal to be achieved during the restoration of the tooth. Subsequent good oral hygiene is difficult to maintain and this, together with a deficient seal, renders the tooth susceptible to coronal leakage, jeopardizing the outcome of the treatment. Coronal leakage is an important cause of failure in root canal treatment (11). This is the justification for carrying out an orthodontic extrusion in cases of subgingival fracture, to bring subgingival margins supragingivally, whilst preserving the physiological periodontal attachment.

The different treatment options available should be considered and explained to the patient, and informed consent obtained for the treatment chosen:

1. Orthodontic extrusion of the remaining portion of tooth and eventual restoration.
2. Crown lengthening by surgical means and eventual restoration.
3. Extraction of the residual tooth and immediate or delayed implant surgery or construction of a bridge.

This clinical report describes the multidisciplinary management of an oblique crown–root fracture of the buccal cusp of an upper first premolar.

Case report

A 19-year-old Caucasian girl presented at the clinic with a traumatic injury to the mandible, in an upwards direction. The patient complained of acute shooting pain from the tooth 14, the pain being notably worse on touching the tooth. There was a superficial graze on the chin. Intraorally, the soft tissues were intact, but the buccal cusp of tooth 14 had fractured 4 mm subgingivally, there was an enamel–dentine fracture of the palatal cusps of teeth 24 and 25 and there was a fracture confined to the enamel of tooth 45.

The orthodontic diagnosis was class I occlusion with an open anterior bite, and there was a hypertrophic frenulum with a midline diastema. Photographs were

taken of the facial profile from anterior and lateral aspects and of the teeth from anterior, lateral and occlusal aspects. A radiograph was exposed of the tooth 14 (Fig. 1). Emergency treatment consisted of extraction of the extremely mobile fractured buccal fragment (Figs 2–5) followed by a pulpectomy and placement of a temporary restoration. The patient was referred to the endodontic clinic for a root canal treatment of this tooth.

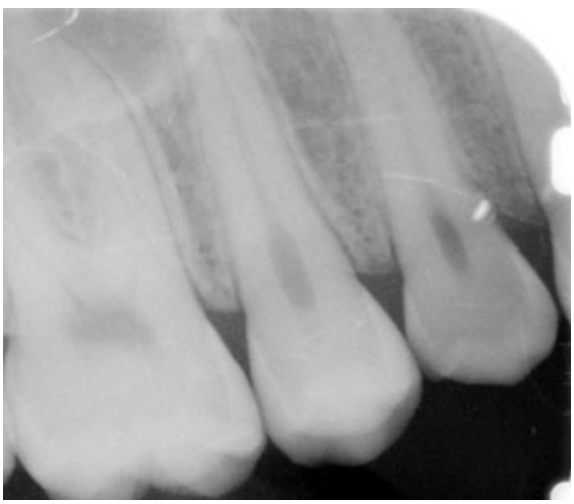
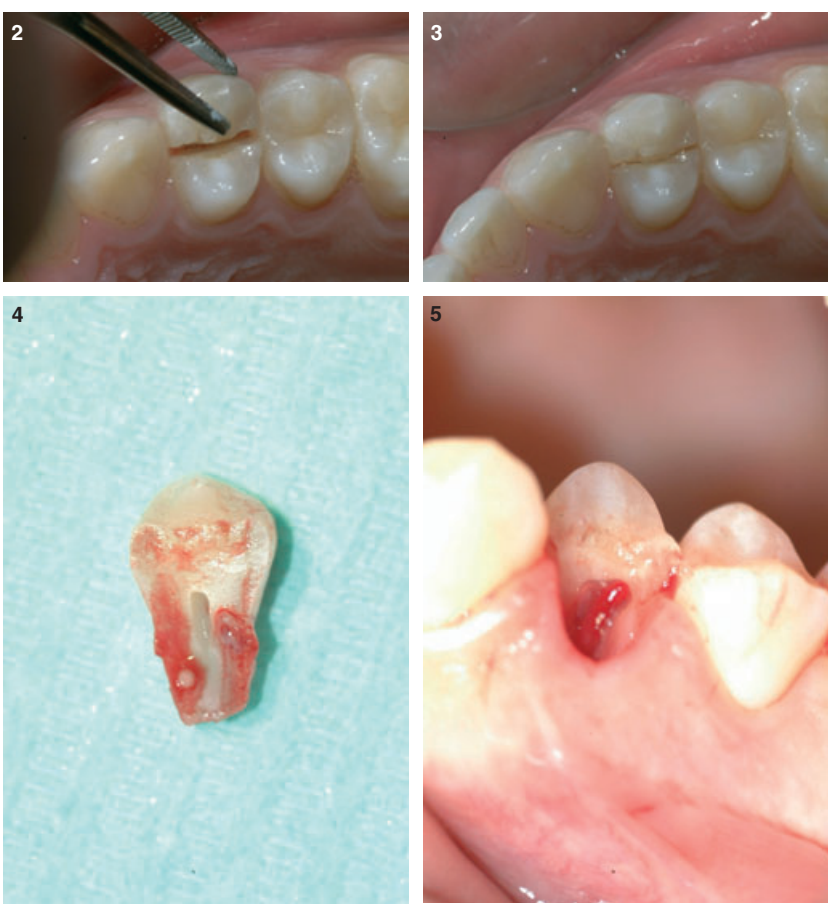


Fig. 1. Preoperative bitewing radiograph taken by general practitioner.

The patient presented on the same day at the endodontic clinic, with the only symptom now being tenderness of the buccal gingival margin. A periapical radiograph was taken using a film holder (Dentsply, Rinn Corporation, Elgin, IL, USA) (Fig. 6). Treatment was carried out under an operating microscope (Opmi PRO Magis; Carl Zeiss SpA, Milan, Italy). A provisional restorative build-up of the buccal wall was carried out using glass–ionomer cement (Ketac Molar; ESPE, Seefeld, Germany) in order to execute an endodontic treatment and consecutive post and core construction in a sterile and dry environment using a rubber dam. The canals were opened coronally with a Gates Glidden bur No. 4 and prepared using a crown-down technique, initially with hand files (K-Flexofiles; Dentsply-Maillefer, Ballaigues, Switzerland), employing a balanced force technique, then with Protaper Rotary Files (Dentsply-Maillefer). Copious irrigation with warmed 5% sodium hypochlorite solution (Niclor; OGNA, Muggiò (Mi), Italy) was carried out throughout the procedure. Obturation of the canals was effected by vertical condensation of tapered gutta-percha points (Analytic Technology, Kerr, Scafati, Italy) using the System B Heat Source 1005 (Analytic Technology, Redmond, WA, USA) and backfilling using the Obtura II gun (Obtura Spartan, Fenton, MO, USA), leaving space for a post in each canal (Fig. 7).



Figs. 2–5. Photographs showing extent of fracture of buccal cusp.

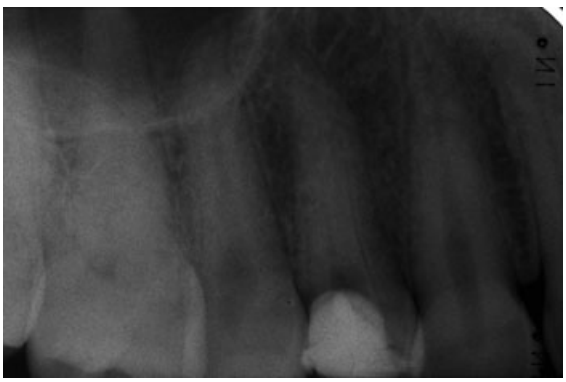


Fig. 6. Radiograph taken prior to endodontic treatment, where cusp has been removed.

Fig. 8. Final radiograph showing posts and core.

Fig. 7. Postendodontic radiograph, posts cemented.

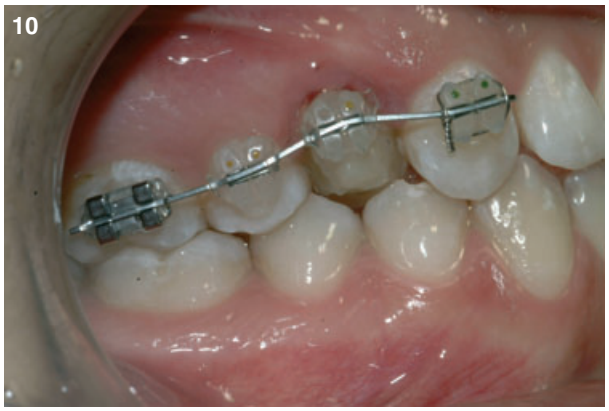
Fig. 9. Clinical view of posts and core.

Any traces of obturation material in the canal were removed with pure alcohol followed by sterile water and the canal dried using a Stropko irrigator under the microscope, ensuring perfect moisture removal. The dentine was etched using 15% phosphoric acid gel (Coltène Etchant 15, Altstätten, Switzerland) for 10 s, rinsed thoroughly with sterile water and dried as before, before applying a light-cured adhesive agent (Coltène One Coat Bond, Altstätten, Switzerland). A glass fibre post (Dentatus, Hägersten, Sweden) was cemented into each canal with ASBA luting cement (La maison dentaire SA, Balzers-FL, Switzerland) and a core was constructed in composite (Synergy; Coltène Whaledent, AG Altstätten, Switzerland) (Figs 8 and 9). Fabrication of the posts and core was carried out during the same appointment as the root canal treatment, in order to ensure a good seal against coronal leakage. The patient was referred to the orthodontist for the subsequent phase of treatment.

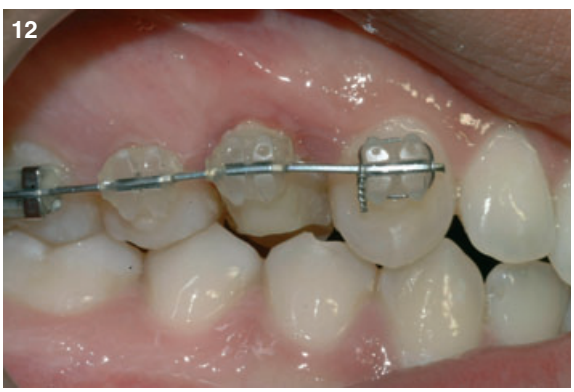
The tooth was extruded orthodontically over a 90-day period by 4 mm. The appliance consisted of an archwire of diameter 0.016×0.022 in (Nitinol; 3M Unitek, Monrovia, CA, USA) fixed by Edgewise brackets with slot 0.022 in (Clarity; 3M Unitek) to the teeth 16, 15, 14 and 13, using light-cured composite cement (Transbond; 3M Unitek) (Figs 10 and 11). Every 30 days the appliance was reactivated and the occlusion reduced to make space for further vertical movement (Figs 12–15). After the fractured tooth margin had been exposed sufficiently above the gingival level, the periodontal fibres associated with the tooth 14 were cut with a tiny surgical blade to help to prevent reintrusion of the tooth. The final tooth position was maintained with a retainer, consisting of a stainless steel archwire 0.019×0.025 in, for a further 60 days (Fig. 16) and a provisional acrylic crown was then cemented with Zinc Phosphate cement (Dentsply DeTrey GmbH, Konstannnnz, Germany) (Fig. 17). Composite resin fillings were carried out on the teeth 24, 25 and 44, and oral hygiene instruction was given. A review appointment of the tooth 14 at 6 months demonstrated that the periapical condition was stable (Fig. 18), as was the bone level and gingival contour. The construction of a porcelain-bonded crown by the patient's dentist was recommended. The patient, who was now studying away from home, returned for the permanent crown 1 year after the extrusion had been completed (Figs 19–21). A further radiographic and clinical review was carried out at 21 months (Fig. 22); the tooth and periodontal condition were stable.

Discussion

Orthodontic forced eruption can be effected in different ways (9, 12, 13). A hook attached to a post can be used



Figs. 10 and 11. Orthodontic extrusion of the tooth 14.



Figs. 12 and 13. Every 30 days occlusion adjusted/reduced.

Fig. 14. After 60 days.

Fig. 15. After 90 days: extrusion of 4 mm.

to pull the root vertically towards a horizontal bar attached to the adjacent teeth, by means of an active elastic (1). Alternatively, brackets can be bonded to the cusp or restoration, more gingivally on the tooth to be extruded, and more incisally on the adjacent teeth, and the extrusive force is provided by an orthodontic wire. In the case described in this article, the latter method was chosen and resulted in good controlled movement of the tooth. The tooth was extruded along its axis, without moving from its natural position in the dental arch and without exerting tilting forces on the anchor teeth.

According to Simon (9), occlusal movement of the gingival housing with the root seems to be a function of how rapidly the root is extruded and how much force is used. If the gingival tissue does move with the tooth, then surgical contouring of the gingivae may be required before the preparation of the tooth for a crown. In the case of rapid extrusion of the tooth, the periodontal fibres stretch and readjust, yet the bone does not have time to remodel because of the fast movement. Thus, there is no coronal shift of the marginal bone, facilitating prosthetic restoration as there is no need to reshape bone

Fig. 16. Retention for 60 days.

Fig. 17. Provisional acrylic crown.

(14). Some claim that a sulcular incision, either at each appointment during the extrusion process, or just before the stabilization period, is necessary to prevent bone and soft tissue movement (15, 16).

An alternative course of action is to lengthen the clinical crown by removing supporting alveolar bone, hence exposing further sound tooth structure. The disadvantage with this technique is that reshaping the bony architecture of the involved tooth also requires the removal of supporting bone from adjacent teeth in order to achieve a smooth flow from tooth to tooth (9). Not only will there be an aesthetic problem which may be difficult to correct, but some additional bone resorption should also be expected after any surgical procedure. Furthermore, the resultant crown-to-root ratio can be unfavourable when such a crown lengthening procedure is carried out.

An extrusion of 4 mm was achieved in this case. One of the main dictating factors in the amount of extrusion

Fig. 18. Review at 6 months.

necessary is the requirement for sufficient tooth structure to provide a ferrule effect over sound dentine for the crown. The purpose of the ferrule is to counteract functional forces on the post–core–root complex. It is essential when placing a ferrule that due consideration is taken of the periodontal attachment apparatus to avoid subsequent periodontal disease (17).

A period of retention is necessary to prevent reintrusion of the tooth, although tendency towards relapse is not as great as with other types of orthodontic movement. Various stabilization periods have been recommended; 1 month per mm of extrusion was suggested by Lemon (18), 7 weeks by Simon et al. (19). One week has been observed by Andreasen to be sufficient time to create adequate support for an avulsed tooth that has been splinted (20). The case described in this article was stabilized for 60 days and no reintrusion was seen subsequently.

Before commencing orthodontic extrusion of a traumatized tooth with pulp involvement and where apexification is not necessary, a good root canal treatment should be carried out. This should be under aseptic conditions (21), hence with rubber dam isolation. The construction of a missing wall using either glass–ionomer or composite cement is advocated where there is extensive tooth loss to prevent microbial contamination by the seeping in of saliva or crevicular fluid; the benefits of a glass–ionomer build-up, where the margins are subgingival, are that the material is relatively moisture tolerant, bonds to dentine, and releases fluoride. This provisional wall can also be taken advantage of, if constructed thinly enough, as it can be used as a matrix for the construction of the composite core at the end of the endodontic treatment; the difference in colour from that of the composite makes it easy to see that it has all been removed at a later date, during crown preparation. Without such a matrix it is difficult, if not impossible, to construct a

Figs. 19 and 20. Crown preparation, prior to fit of permanent crown.

Fig. 21. Permanent crown.

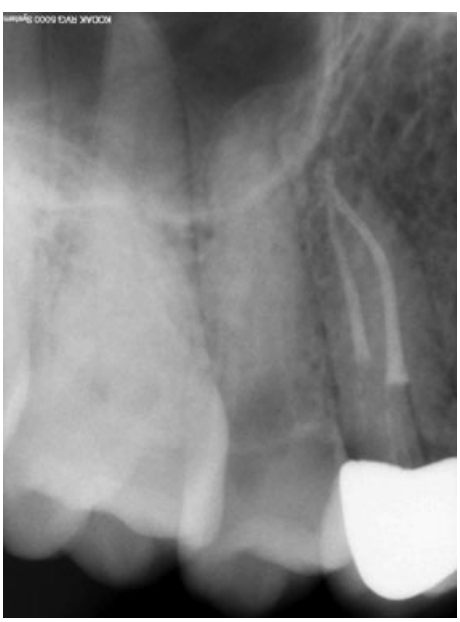


Fig. 22. Review periapical radiograph at 21 months.

well-adhered composite with a perfect seal, and thus with a good prognosis. Composite is the material of choice for the actual core, as it is much stronger than glass–ionomer cement (22).

Root treatment carried out in a single visit is preferable in trauma cases such as this, the prognosis being extremely good for a vital pulp extirpation (23). In a case with a necrotic pulp or where the tooth has already been root-treated, an evaluation of the individual tooth should be made as to whether one or more appointments are appropriate. In this case the postendodontic restoration was also placed during the same appointment, thus eliminating any risk of inter-appointment infection of the root canal system.

The goals of treatment were achieved in this case, namely, preserving biological width, sterility of the root canal system, the ferrule effect and aesthetics.

Conclusion

The technique described is not common practice, probably due to apprehension of the first-time approach, the worry that the procedure is complex, and a lack of familiarity of this field of dentistry. This case report demonstrates that such a multidisciplinary treatment approach to an oblique subgingival fracture is a reliable and predictable manner in which to save a tooth that would have otherwise been difficult, if not impossible, to restore with a resultant good long-term prognosis. Such teeth would once have been extracted, but can now be saved and restored with a functional and aesthetically pleasing result.

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