Clinical
Case Report

Aaron Bottner
DDS

Aaron Fox
BSc DDS

Teodora Gheorghe
BSc (Hons) DDS

Orthodontic Treatment Planning Involving Teeth with Root Fractures and Previous Apical Surgery

Introduction

As growing numbers of adults are seeking orthodontic treatment, a greater proportion of orthodontic patients are presenting to clinicians with previously endodontically treated, heavily restored, and/or fractured teeth. Some suggest that there are potential risks associated with orthodontic movement of these teeth, including root resorption, ankylosis, or other detrimental effects, yet research in this area is limited and these risks have not been conclusively demonstrated (1,2).

Root fractures are thought to be more often associated with endodontically treated teeth (3), yet some studies have suggested that, in certain populations, root fractures involving non-endodontically treated teeth are not uncommon (4). Numerous theories have been put forth to explain this phenomenon, including patient dietary patterns involving the habitual and repetitive mastication of hard food, increased attrition, and trauma (4, 5). In radiographs, a radiolucent fracture line may be visible or other indirect evidence may be present (4).The clinical outcome of such teeth is dependent on the type of healing response between the segments, which is strongly influenced by the stage of root development and the extent of coronal segment mobility (6).

Apical surgery is a treatment option in cases that present with post-treatment periapical disease, in addition to orthograde retreatment. Persistent periapical disease may be associated with microbial and non-microbial etiologic factors (7). The advantage of apical surgery is that it imparts specific benefits that address causes where there may otherwise be limitations associated with a conventional orthograde retreatment approach.

This case report presents an example of orthodontic treatment planning involving teeth with root fractures and previous apical surgery.

Clinical Case

A 65-year-old female patient presented with the chief complaint of a desire for overjet reduction and pre-implant placement orthodontic treatment. The patient reported a history of several cosmetic surgeries in the past seven years. The orthodontic diagnosis was a Class II Division 1 malocclusion of skeletal and dento-alveolar etiology. This malocclusion was characterized by a retrognathic facial type and convex profile type, and was associated with minimal crowding, multiple missing teeth, and excess overbite and overjet. Three of the maxillary incisors had all-ceramic crowns (Figure 1). Extra-oral examination revealed tenderness to palpation of masseteric muscles bilaterally, suggesting a nocturnal bruxism habit. This coincided with generalized attrition visible on intra-oral examination.

Upon radiologic investigation, an oblique fracture plane extending through the palatal root of tooth #14 was visualized both on plain images and as an incidental finding in a set of cone beam computed tomography (CBCT) images acquired for nearby implant site measurements (Figures 2 and 3). The cause of this fracture could not be determined, however, it is relevant to note that as in other reported cases, the patient presented with generalized attrition and may have had a history of trauma related to intubation involved in recent surgeries. The radiologic appearance of the root of tooth #22 was also found to be consistent with rarefying and sclerosing osteitis (Figure 4).

Endodontic examination of tooth #14 was without significant findings: the soft tissue appeared within normal limits, as did probing depths and tooth mobility. Sensibility testing using Endo Ice® produced a pulpal response consistent with adjacent teeth (#13 and #12). The endodontic diagnosis of tooth #14 was a normal pulp and normal periapex. No endodontic treatment was advised for tooth #14.

Figure 1.
Intraoral orthodontic photograph series.

The patient did not report a history of symptoms associated with tooth #22. The tooth had an initial root canal treatment completed in 2010. Intra-oral examination revealed the presence of an apically positioned sinus tract, and the tooth was tender to percussion. Periodontal probing of tooth #22 was within normal limits. A sinogram was traced to the mid-root region with a gutta-percha point (Figure 4). The root canal filling appeared to be consistent with gutta-percha, and a metal post was present terminating at the mid-root region. The endodontic diagnosis of tooth #22 was previous root canal treatment, with chronic apical abscess. Treatment options were discussed and the patient elected for apical surgery.

Two carpules (3.6 ml, 0.036 mg epinephrine) of 2% lidocaine 1:100,000 epinephrine were administered as a buccal infiltration involving teeth #11, #21, #22 and #23. One-half carpule (0.9 ml, 0.009 mg epinephrine) of 2% lidocaine 1:100,000 epinephrine was administered as an incisive canal block, and one additional carpule (1.8 ml, 0.036 mg epinephrine) of 2% lidocaine 1:50,000 epinephrine was delivered as a buccal infiltration of site #22. An intrasulcular incision extending from the mesial of #11 to the distal of #23 with a vertical release incision at the distal of #23 was delivered, and a full thickness mucoperiosteal flap was raised. A well-circumscribed osseous defect was found in the mid-root region along the buccal surface. High-powered microscopic examination revealed a portal of exit on the external root surface at the epicenter of the osseous defect. This portal of exit (either a lateral canal or dentinal tubule) was prepared using a microsurgical ultrasonic tip. A conservative osteotomy was prepared, coinciding with the apex of the root with a high-speed carbide bur to expose the apical 3 mm of external root surface for resection. Hemostasis of the crypt was achieved using ferric sulfate applied with a cotton pellet. The external root surface was stained with methylene blue at both the apical and mid-root regions prior to resection to rule out the presence of a root fracture. A conservative 3 mm apical resection was achieved using a high-speed carbide bur. The root end was retro-prepared using a 3 mm microsurgical ultrasonic tip. Mineral trioxide aggregate (MTA) was used as the retrofilling and lateral canal root filling material. The crypt was carefully debrided and flushed with saline prior to soft tissue closure. Suturing of the surgical site was carried out using 5.0 Tevdek® suture material, with single-interrupted sutures across the horizontal incision and along the vertical releasing incision. All special post-operative instructions were explained to the patient. The patient returned four days post-operatively for suture removal and follow-up assessment. The patient continues to be monitored, and follow-up images show post-operative periapical healing (Figure 4).

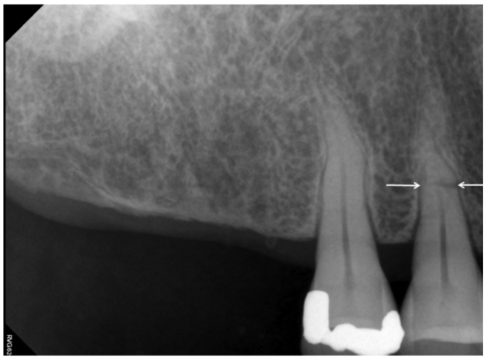


Figure 2.
Radiolucent fracture line extending through tooth #14 root.

Figure 3.
Oblique fracture plane extending through palatal root of tooth #14.

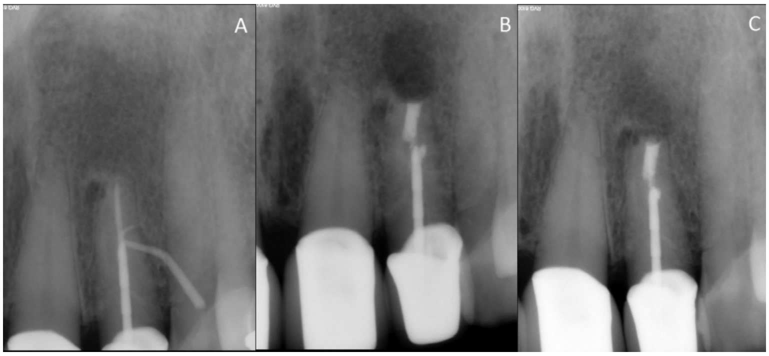


Figure 4.
Sinogram of tooth #22 (A), tooth #22 after apical surgery (B), healing in periapical region of tooth #22 (C).

Following completion of endodontic therapy, orthodontic treatment was initiated with full bonding and is currently in progress. The patient has elected to undergo a bilateral sagittal split osteotomy mandibular advancement in order to reduce her overjet.

Discussion

Though in this case report, visualization of the root fracture appeared clear both on plain film and on CBCT, this is not usually the case. For example, in order to visualize vertical root fractures in plain film, the angulation of the primary beam needs to be within 4° of the fracture plane (8). The presence of artifact and the incomplete nature or size of a fracture may still not allow clear visualization on CBCT. In fact, it was found that when it came to the detection of vertical root fractures in teeth with endodontic treatment, there was insufficient evidence to suggest that it is a reliable imaging modality for this purpose (9).

Unfortunately, the literature concerning the orthodontic movement of endodontically treated and fractured teeth is currently limited to case reports/series and expert opinion. While it is generally considered safe to orthodontically move these teeth, clinicians should

Table 1. Recommendations related to the orthodontic movement of endodontically treated teeth.

<table>
<tr><th colspan="2">Scenario</th><th>Recommendation</th></tr>
<tr><td colspan="2">Endodontically treated tooth without periapical lesion</td><td>Orthodontic forces may be applied a few days following completion of endodontic treatment. Wait longer if patient is still in pain.</td></tr>
<tr><td colspan="2">Endodontically treated tooth with inflammatory periapical lesion</td><td>Orthodontic force may be applied a few days following completion of endodontic treatment, but might wait 15-30 days to be careful. Wait longer if patient is still in pain. Healing may be delayed with tooth movement but not hindered.[19]</td></tr>
<tr><td rowspan="3">Endodontically treated tooth with pulp necrosis by dental trauma</td><td>Mild trauma (concussion/mild subluxation)</td><td>Wait three to four months and re-assess for vitality, root resorption, ankylosis, mobility, etc.</td></tr>
<tr><td>Moderate trauma (severe subluxation/ luxation/ displacement/ extrusion)</td><td>Wait one year and re-assess for vitality, root resorption, ankylosis, mobility, etc.</td></tr>
<tr><td>Avulsion</td><td>Wait one to two years and re-assess for vitality, root resorption, ankylosis, mobility, etc.</td></tr>
</table>

proceed with caution (10). As many endodontically treated teeth are heavily restored, orthodontic bands, rather than bonded brackets could be considered (11).

Consolaro and Consolaro (1) provided three subcategories to consider with regard to the orthodontic movement of endodontically treated teeth: 1) endodontically treated teeth without periapical lesion; 2) endodontically treated teeth with inflammatory periapical lesion; and 3) endodontically treated teeth with pulp necrosis by dental trauma. A possible consequence to consider in all cases is pseudo-overfilling. This occurs when apical external root resorption, due to applied orthodontic forces, blunts and shortens the root, leaving a non-phagocytable gutta percha cone(s) and sealer surpassing the new apical limit of the tooth. Another potential consequence is persistence or re-activation of a previous periapical lesion, as a result of apical resorption and bone remodelling opening canaliculi, tubules and accessory canals of apical deltas that still harbour bacterial components.

With regards to teeth with a history of trauma, the sequelae are more of a consequence of the trauma, rather than the orthodontic movement, but may include root resorption and ankylosis. Teeth treated by apicoectomy should be managed similarly to those treated by orthograde root canal treatment, and this procedure has been shown to be effective in assisting in the eruption of impacted teeth with root dilacerations (12). One should keep in mind that the root will be shorter following the apicoectomy, so the centre of resistance will be located more coronally. Some recommendations are provided in Table 1 (1,13-15).

Orthodontic movement of fractured teeth can also be accomplished. However, depending on the extent of healing, the fracture site may consolidate and move as one unit or separate into fragments (16). Different management strategies have been advocated depending on the precise clinical conditions, including: root canal treatment of the coronal section and extraction of the apical segment (6), continuous root canal treatment of both segments and reinforcement with a fiber post-splint (17), and no treatment of the segments (18).

Conclusion

Though little published literature exists on the topic, this case demonstrates comprehensive orthodontic treatment planning inclusive of teeth with an oblique root fracture and a previous endodontic apicoectomy.

Acknowledgement

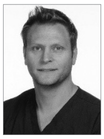
This report was prepared and presented as part of the requirements for the University of Toronto Faculty of Dentistry Clinical Conference Seminar Series PDE9094Y directed by Dr. Siew-Ging Gong and Dr. Iacopo Cioffi. OD

REFERENCES

1. Consolaro A, Consolaro RB. Orthodontic movement of endodontically treated teeth. *Dental Press Journal of Orthodontics*. 2013 Jul-Aug;18(4):2-7.
2. Ioannidou-Marathiotou I, Zafeiriadis AA, Papadopoulos MA. Root resorption of endodontically treated teeth following orthodontic treatment: a meta-analysis. *Clin Oral Investig*. 2013 Sep;17(7):1733-44.

3. Tamse A. Vertical root fractures in endodontically treated teeth: diagnostic signs and clinical management. *Endodontic Topics*. 2006Mar; 13(1):84-94.
4. Chan CP, Lin CP, Tseng SC, Jeng JH. Vertical root fracture in endodontically versus nonendodontically treated teeth: a survey of 315 cases in Chinese patients. *OOOOE*. 1999 Apr30;87(4):504-7.
5. Newland MC, Ellis SJ, Peters KR, Simonson JA, Durham TM, Ullrich FA, Tinker JH. Dental injury associated with anesthesia: a report of 161,687 anesthetics given over 14 years. *J Clin Anesthesia*. 2007 Aug 31;19(5):339-345.
6. Andreasen JO, Bakland LK, Flores MT, Andreasen FM, Andersson L. Traumatic dental injuries: a manual. John Wiley & Sons; 2011 Oct 7.
7. Nair PN, Sjogren U, Krey G, Kahnberg KE, Sundqvist G. Intraradicular bacteria and fungi in root-filled, asymptomatic human teeth with therapy-resistant periapical lesions: a long-term light and electron microscopic follow-up study. *Journal of Endodontics*. 1990 Dec;16(12): 580-8.
8. Kositbowornchai S, Nuansakul R, Sikram S, Sinahawattana S, Saengmontri S. Root fracture detection: a comparison of direct digital radiography with conventional radiography. *DMFR*. 2001 Apr;30(2): 106-9.
9. Chang E, Lam E, Shah P, Azarpazhooh A. Cone-beam computed tomography for detecting vertical root fractures in endodontically treated teeth: a systematic review. *Journal of Endodontics*. 2006 Feb;42(2): 177-185.
10. Spurrier SW, Hall SH, Joondeph DR, Shapiro PA, Riedel RA. A comparison of apical root resorption during orthodontic treatment in endodontically treated and vital teeth. *Am J Orthod and Dentofacial Orthopedics*. 1990 Feb;97(2):130-4.
11. Murray PG, Millett DT, Cronin M. Bonded molar tubes: a survey of their use by specialist orthodontists. *J Orthod*. 2012 Jun;39(2):129-35.
12. Neto JV, de Pinho Costa S, Estrela C. Orthodontic-surgical-endodontic management of unerupted maxillary central incisor with distoangular root dilaceration. *Journal of Endodontics*. 2010 Apr; 36(4):755-9.
13. Beck VJ, Stacknik S, Chandler NP, Farella M. Orthodontic tooth movement of traumatised or root-canal-treated teeth: a clinical review. *N Z Dent J*. 2013 Mar;109(1):6-11.
14. Hamilton RS, Gutmann JL. Endodontic-orthodontic relationships: a review of integrated treatment planning challenges. *International Endodontic Journal*. 1999 Sep;32(5):343-60.
15. Drysdale C, Gibbs SL, Ford TR. Orthodontic management of root-filled teeth. *Br J Orthod*. 1996 Aug;23(3):255-60.
16. Flores MT, Andersson L, Andreasen JO, Bakland LK, Malmgren B, Barnett F, et al. Guidelines for the management of traumatic dental injuries. I. Fractures and luxations of permanent teeth. *Dent Traumatology*. 2007 Apr;23(2):66-71.
17. Kapur A, Utreja A, Goyal A, Pankaj P. Orthodontic movement of a maxillary central incisor with a horizontal root fracture treated using an intraradicular fibre splint. *Contemp Clin Dent*. 2013 Apr-Jun;4(2): 271-3.
18. Duggan D, Quinn F, O'Sullivan MO. A long-term follow up of spontaneously healed root fractures later subjected to orthodontic forces-two case reports. *Dent Traumatology*. 2008 Apr;24(2):231–4.
19. de Souza RS, Gandini LG, de Souza V, Holland R, Dezan E. Influence of orthodontic dental movement on the healing process of teeth with periapical lesions. *Journal of Endodontics*. 2006 Feb;32(2):115-9.

Dr. Aaron Bottner graduated from the Western University's Faculty of Dentistry in 2011. He is currently a third-year resident in the graduate orthodontics program at the University of Toronto.



Dr. Aaron Fox graduated from the University of Toronto's Faculty of Dentistry in 2006 and is currently a third-year resident in the endodontic graduate program at the University of Toronto.

Dr. Teodora Gheorghe graduated from the University of Toronto's Faculty of Dentistry in 2014, where she is also currently a third-year resident in the oral and maxillofacial radiology graduate program. She has presented various research findings at conferences in Canada and the United States.