Apical Surgery on Fractured Roots: Case Reports

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Introduction

There are various factors that could influence long-term prognosis in endodontics. It is our duty to provide appropriate postoperative care for patients. A recent study[1] shows that success rates of modern endodontic treatments are as high as those of implant surgery in the long run, thanks to advanced technology and materials used in endodontics. The significant finding reported from comparing implant and endodontic cases was that implants required more postoperative treatments to maintain them.

In spite of the high success rates in endodontics, some of the cases will fail over time, even if the root canal therapy is performed perfectly. Common causes of postoperative failures are coronal leakage, root fracture, root resorption, and endo-perio complications. There is one thing in common among those causes: abnormal occlusal forces on a tooth can be a cause of failure in endodontic treatment. Wilcox, et al[2] showed that canal enlargement of 40% to 50% of the root width increased susceptibility to vertical fracture. It has also been shown that attempts at removal of separated files usually result in the removal of a large amount of root dentin, which ends up reducing the root strength by 30% to 40%, leading to possible fracture later on.[3] Root fracture occurs, depending on the crown-root ratio and anatomical features of the tooth, and the amount of remaining root dentin. Patients habits of mastication such as clenching and grinding are also considered to relate to root fracture by abnormal occlusal forces. The more favorable the crown-root ratio, the better the tooth can withstand masticatory forces, and the better the prognosis. Teeth with short, slender, and/or tapering roots have a poorer prognosis than those with long and broad roots. Multirooted teeth usually resist traumatic forces better than singlerooted teeth. Flared molar roots give better support than fused, conical roots. Broad occlusal tables and large crowns can contribute to increased mobility. The support of the tooth is determined by the height of the alveolar crest and the length and shape of the root. Canines can withstand loss of support better than lateral incisors by virtue of their longer roots and root concavities. Maxillary first premolars show early mobility because of the tapered roots. Some patients have teeth with short roots and others have root resorption, both of which have often been seen as a result of orthodontic therapy. Such teeth are less resistant to excessive occlusal forces which play key roles in root resorption and root fracture. Accordingly, orthodontic therapy and bruxism contribute to those phenomena.[4]

Two surgical cases involving root fracture of molars are presented in this article. Both of these cases had been successful for the first year after the endodontic treatments were completed, but they failed later on due to root fracture possibly due to excessive occlusal forces. These case reports described below showed successful outcomes achieved by surgical removal of the fractured portion of the roots from the teeth, and removal of abnormal occlusal force from the teeth. What should have been done will be discussed for long-term success in endodontically treated teeth.

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Case Report 1

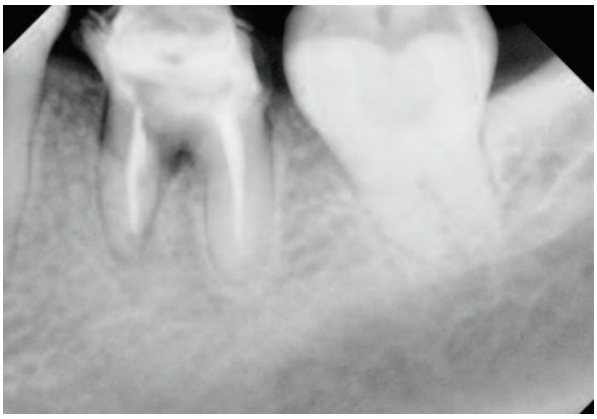

Figure 1: Preoperative radiograph showing the widened periodontal ligament.

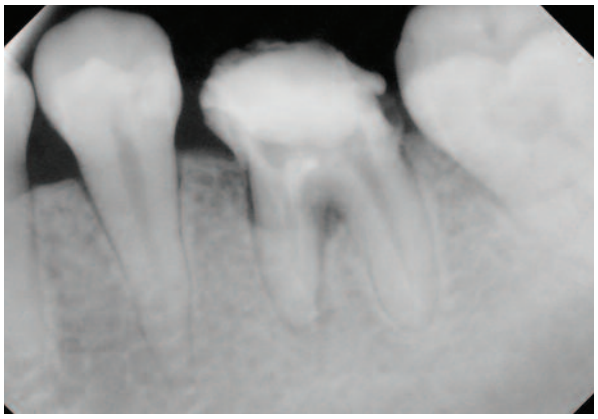

Figure 2: Radiograph taken after root fillings were removed from the canals.

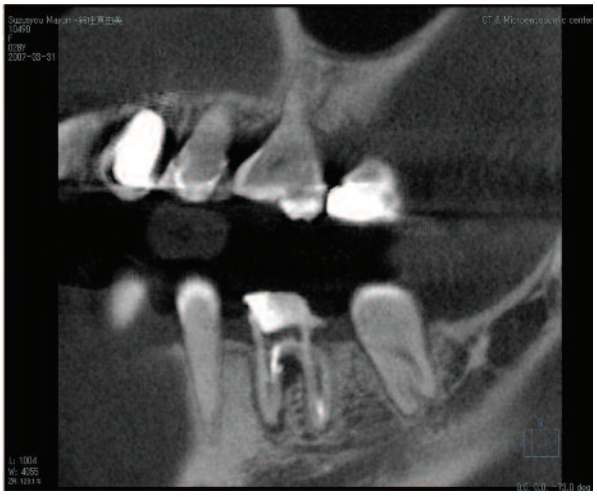

Figure 3: Computed tomography (CT) image showing periapical and furcational lesions.

Figure 4: CT image showing a 2-rooted molar with 4 canals.

A 32-year-old woman was referred for treatment of her lower left first molar, which was painful on biting with recurrent swelling. The tooth had been restored with a PFM crown. She had endodontic treatment about 3 years prior. It was noted that all the teeth in mandibular left molar region had pain upon biting and percussion. She confessed that she d had a habit of grinding and clenching her teeth since she had orthodontic treatment at the age of 22 years, mostly during sleep. The tooth was tender to percussion, and the buccal furcation area was inflamed. Periodontal probings were 4 mm or less with no mobility and Class I furcation involvement. The sinus tract opening was seen on the buccal mucosa area.

Radiographs were taken for preoperative examinations. However, the tooth was computed tomography (CT)-scanned after the majority of root filling materials was removed from the root canals to obtain better images. The radiographs and CT images revealed that the periodontal ligament widened apically about 3 mm from the top of the crestal bone surrounding the tooth, which indicated that the tooth had problems relating to either excessive force from abnormal occlusion or periodontal disease (Figures 1 to 4). There was a pair of canals both in the mesial root and in the distal root. The root fillings in all 3 canals seemed to occupy the canal space up to the termini. There were periapical lesions associated with the mesial root and the furcation area. The provisional diagnosis was a failed endodontic treatment complicated by periodontal disease. According to her dental record provided by the referring

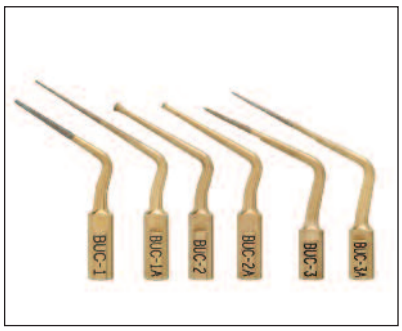

Figure 5: BUC ultrasonic tips (Obtura Spartan).

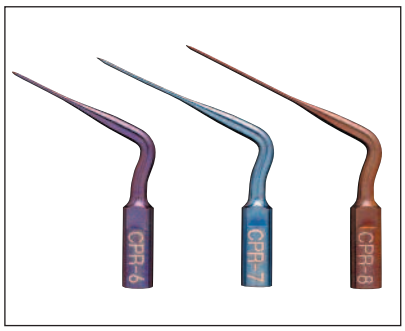

Figure 6: CPR titanium tips 6 to 8 (Obtura Spartan).

Figure 7: Root ZX (J. Morita USA).

Figure 8: System B heat source (SybronEndo).

Figure 9: Obtura gun unit (Obtura Spartan).

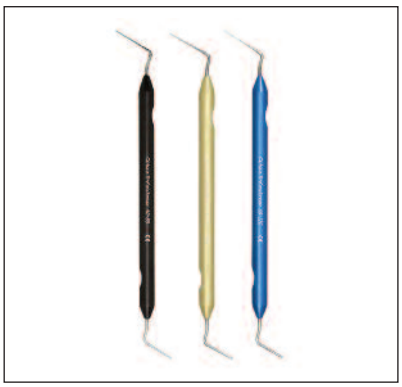

Figure 10: S-Kondensers (Obtura Spartan).

dentist, the composite resin filling on this tooth was chipped off 3 years ago, and she received endodontic treatment at the same time. Analysis of the occlusal relationship was normal, but occlusal wear was found on adjacent teeth that had composite resin fillings on the occlusal plane.

Retreatment

The tooth was retreated by sectioning the crown into 2 pieces. Gutta-percha filling material was removed with a BUC-1A ultrasonic tip (Obtura Spartan) (Figure 5) and the prototype instrument for gutta-percha removal (TGR). Then the tooth was sealed with temporary cement for a moment to be CT-scanned, and the retreatment was resumed with more details from CT images. There was an isthmus in the mesial root connecting the mesiobuccal canal and the mesiolingual canal. The isthmus seemed to be responsible for the periapical lesion around the mesial root and was chemomechanically cleaned with a CPR-8 ultrasonic tip (Obtura Spartan) (Figure 6) and 17% EDTA solution. All the canals were negotiated with a No. 10 K file to working length, which was verified by an apex locator (Root ZX [J. Morita USA]) (Figure 7) and then prepared with GT rotary files (DENTSPLY Tulsa Dental Specialties). The canals were temporarily dressed with calcium hydroxide mixed with 2% CHX to disinfect the canal system between the appointments.

At her second visit, root canal preparation for mesiolingual and -distal canals was completed with a No. 30/.10 GT file. A No. 70 K file was easily dropped through the canal terminus of the mesiobuccal canal. Irrigation was carried out by using 5.25% sodium hypochlorite solution refreshed every 5 minutes, and this process was repeated for 30 minutes. MTAD (DENTSPLY Tulsa Dental Specialties) was used for final rinse of all the canals. The mesiolingual and distal canals were then obturated with gutta-percha and pulp canal sealer (SybronEndo) using a System B heat source (SybronEndo) (Figure 8) and an Obtura gun (Obtura Spartan) (Figure 9) for backfilling. The mesiobuccal canal was subsequently obturated with gray ProRoot MTA (DENTSPLY Tulsa Dental Specialties) and an S-Kondenser as a carrier (Obtura Spartan) (Figure 10) because the apical terminus measured more than 0.7 mm in diameter, and gutta-percha filling was not the best choice for complete seal. A radiograph was taken to confirm that all the canals were properly filled (Figure 11).

At her third visit, fiber posts were placed with composite

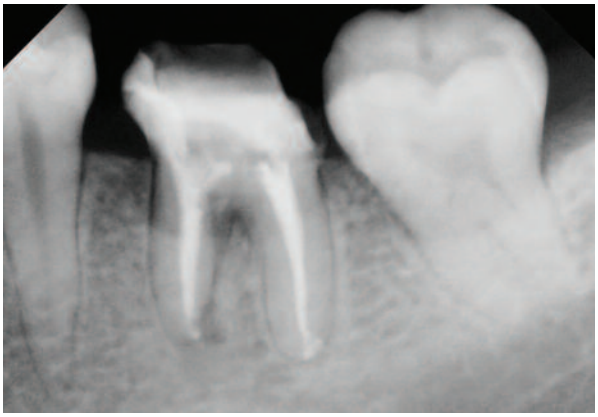

Figure 11: Postoperative radiograph showing all the canals obturated.

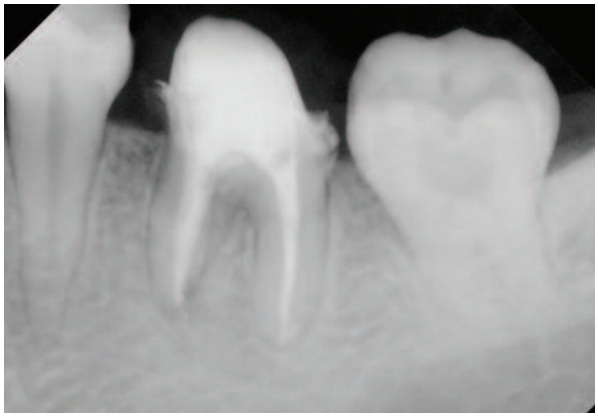

Figure 12: Radiograph on 3-month recall showing the complete healing of lesions.

resin so that the tooth could be more resistant to fracture. The patient reported that the tooth had been asymptomatic since the previous visit. The patient was recalled 3 months later. The 3-month review showed that the periapical lesions associated with the mesial and distal roots and the furcation area had resolved and there was no evidence of the periodontium breaking down. It was confirmed that the tooth had completely healed of lesions associated with the roots and the furcation area (Figure 12). The patient was then sent back to the referring dentist for the final restoration with a crown.

Three-Month Recall Visit

The patient returned for a 3-month recall after the placement of a crown by the referring dentist, and the radiograph showed enlarged periodontal ligaments around the root (Figure 13), but the tooth had remained asymptomatic ever since it was obturated. She was advised that she should consult the referring dentist on her bruxism. However, the patient showed up 13 months later with a chief complaint of the recurrent percussion pain on biting. Radiographs were taken for examination, and it was revealed that the tooth was back to what it used to be with a circumscribed radiolucency of the mesial root (Figure 14). The tooth had been restored by the referring dentist with a PFM crown. The patient reported that the chewing sensitivity of the mandibular left first molar had gradually increased soon after the 3-month recall. Periodontal probings were 4 mm or less with no mobility. The tooth was diagnosed with a symptomatic radicular periodontitis caused presumably by vertical root fracture associated with her bruxism. The patient was informed that surgical intervention was needed to determine whether the mesial root had fractured or not. Treatment options including the possibility of extraction of the tooth were discussed and the patient agreed to surgical treatment.

Surgical Intervention

The surgical intervention under a dental operating microscope (Opmi 111 [Carl Zeiss]) revealed that the tooth had a vertical fracture line on the mesiobuccal root coronally extending approximately 5 mm from the apex (Figure 15). The patient was informed of the partially fractured root during the surgical procedure, but insisted on retaining the tooth.

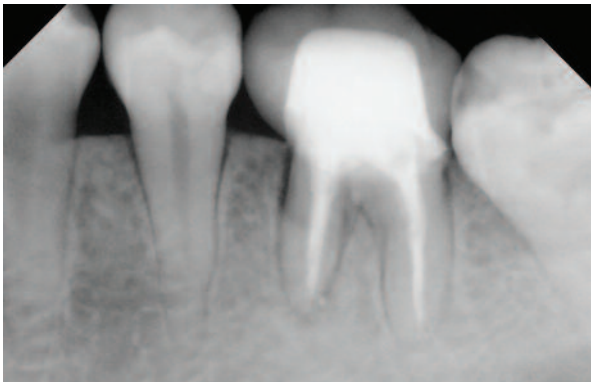

Figure 13: Radiograph taken 3 months after the crown placement showing enlarged periodontal ligaments.

Figure 14: A 13-month postoperative radiograph showing a periapical lesion around the mesial root and enlarged periodontal ligaments.

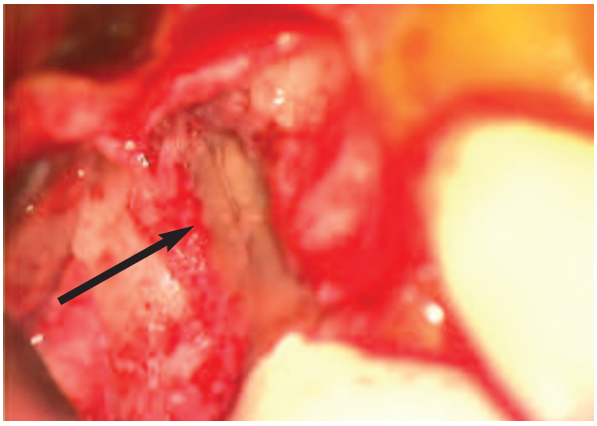

Figure 15: Arrow indicates fracture on mesial root.

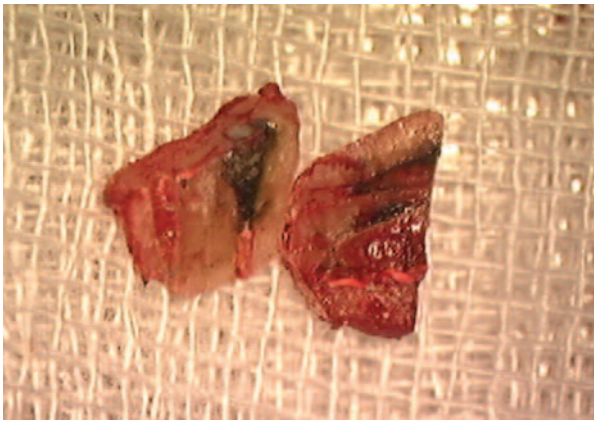

Figure 16: Retrieved fragments of the fractured root showing infection.

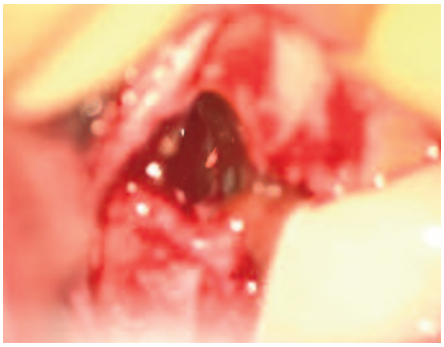

Figure 17: Resected root surface revealing mesiobuccal canal with MTA filling and mesiolingual canal with gutta-percha filling.

Figure 18: KiS D1 ultrasonic tips (Obtura Spartan).

Figure 19: Radiograph showing the mesial root end was resected, and calcium sulfate was placed in the osteotomy.

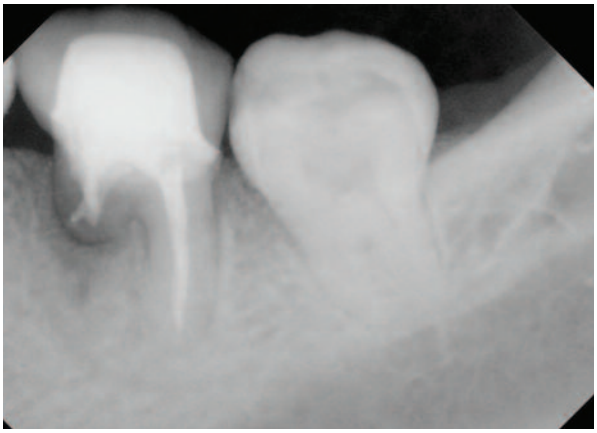

Figure 20: Radiograph taken 6 months after surgical intervention, showing complete healings of periapical lesion and widened periodontal ligaments.

Thereafter, the mesial root end was entirely resected with a Lindemann bur (Hu-Friedy) up to the end of the fracture line (Figure 16). The resected root surface was then stained with methylene blue to identify more anatomical details. Both mesiobuccal and -lingual canals were identified and there was no sign of further fracture line or an isthmus left on the resected root surface (Figure 17). Gutta-percha filling material was removed from the mesiolingual canal, and the root end was prepared with the KiS D1 ultrasonic tip (Obtura Spartan) (Figure 18) on a piezoelectronics (Obtura Spartan). The root end cavity was carefully inspected at high magnification under the microscope to confirm the integrity. A 17% EDTA solution

Figure 21: Preoperative radiograph showing periapical lesions.

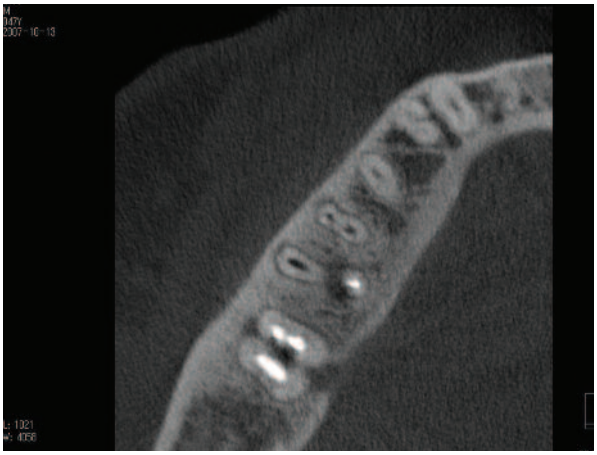

Figure 22: CT image showing an isthmus in mesial root.

was used to remove the smear layer from the root end. ProRoot MTA was then mixed with water. The mesiolingual canal was retrofilled with it and the osteotomy was filled with calcium sulfate to induce bone growth (Figure 19). The patient was placed on 3-month recall. The 3-month postoperative radiograph showed that the periapical lesions associated with the mesial root had largely disappeared, but the widening of the periodontal ligament still remained the same as before, which indicated the presence of abnormal forces from occlusion. Adjustment of occlusion on the tooth as well as treatment for her bruxism was suggested to the referring dentist, and the patient was again placed on another 3-month recall. She returned 3 months later, and the 6-month postoperative radiograph after the apical surgery finally showed the periodontal ligament was back to normal and periapical lesions was completely healed (Figure 20)

Case Report 2

A 47-year-old man was referred for treatment of his right mandibular first molar. His referring dentist had once performed endodontic treatment on the tooth but didn t achieve complete healing. The previous endodontic treatment had been accomplished a month before, and the access cavity had been sealed with Cavit G temporary cement (3M ESPE).

The patient had reported to have one episode of moderate pain and swelling associated with the tooth. The tooth was symptomatic and tender to percussion or biting with a sinus tract opening on the buccal mucosa area. He admitted that he had been under a lot of stress and had a clenching habit while working on the computer in his office, or even while lost in thought, daydreaming. Periodontal probings were 3 mm or less, with no mobility. Radiographs were taken for preoperative examinations (Figure 21), and the tooth was CT-scanned after the majority of root filling materials were removed from the root canals to obtain clear images. The CT images revealed that there were mesiobuccal and -lingual canals in the mesial root with an isthmus connecting them and each canal in the distobuccal and -lingual roots (Figure 22). There were periapical lesions associated with the mesial- and the distolingual roots. The distobuccal canal appeared to have been overprepared by approximately 40% to 50% on the serial cross-sectional CT images. The root fillings in all 4 canals seemed to occupy the canal space up to the termini. The periodontal ligament was within normal limits. The provisional diagnosis was radicular periodontitis developing with infection from the isthmus area and the distolingual canal. The referring dentist reported that the distolingual canal was severely infected, particularly around the orifices of those canals. Analysis of the occlusal relationship indicated normal occlusion, but occlusal wear was obvious on most of the posterior teeth that had dozens of shiny spots on the metal crowns and abrasion on occlusal cusps..

Retreatment

Retreatment started by isolating the tooth with a rubber dam. Gutta-percha filling material was removed with a BUC 1A ultrasonic tip and the TGR, and then the tooth was CT-scanned for more details. There was an isthmus found connecting the mesiobuccal and mesiolingual canals. The isthmus seemed to be responsible for the periapical lesion around the mesial root and was chemomechanically cleaned using a CPR-8 ultrasonic tip with 17% EDTA solution. The distolingual canal was relatively clean, but had some debris left over in the orifice area. All the canals were negotiated with a No. 10 K file to working length which was verified by a Root ZX apex locator and then prepared

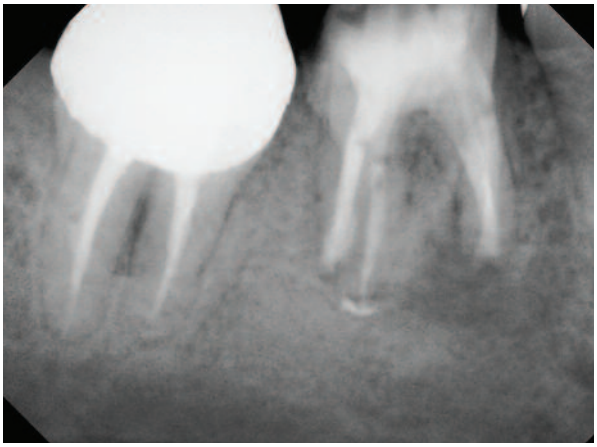

Figure 23: Postoperative radiograph showing all the canals were properly obturated.

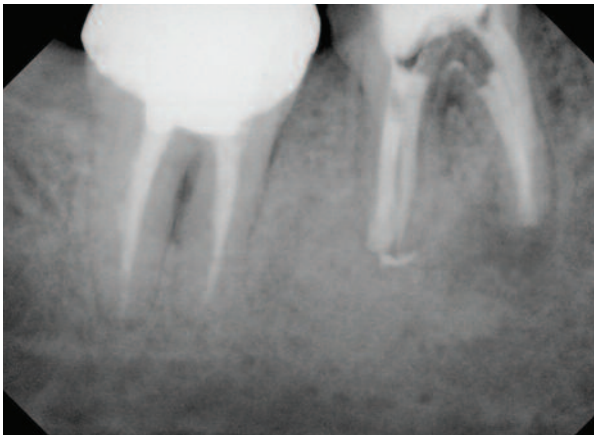

Figure 24: Postoperative radiograph after 3 months.

Figure 25: Postoperative radiograph after 6 months.

Figure 26: Postoperative radiograph after 18 months with widened periodontal ligaments.

with GT rotary files. The canals were temporarily dressed with calcium hydroxide mixed with 2% chlorhexidine (CHX) to disinfect the canal system between the patient's visits.

At his second visit, the distolingual canal was prepared with a No. 30/.10 GT file. However, a No. 70 K file dropped through the mesiobuccal, the mesiolingual, and the distobuccal canal termini, all of which were considered too large to obturate with gutta-percha fillings for complete sealing. All the canals were irrigated with 5.25% sodium hypochlorite solution refreshed every 5 minutes, and this process was repeated for 30 minutes. MTAD was used for final rinse of all the canals. The distolingual canal was then obturated with gutta-percha and pulp canal sealer using the System B heat source and was backfilled with the Obtura gun. The rest of the canals were subsequently obturated with gray ProRoot MTA, because warm vertical condensation with gutta-percha filling material was not good enough to seal the canals with large canal termini, especially in retreatment cases. A radiograph was taken to confirm the appropriate obturation into every canal (Figure 23). The tooth had been asymptomatic ever since the endodontic treatment was initiated. The patient was then placed on 3-month recall.

The 3-month review showed that almost half of the periapical lesion associated with the mesial root had been disappearing, and the majority of periapical lesions associated with the distal roots had resolved (Figure 24). There was no evidence of the periodontium breaking down. At his third visit, fiber posts were placed with dual-cured composite resin so that the tooth could be more resistant to fracture. The patient was then sent back to the referring dentist for restoration. The patient was advised to return 3 months after the restoration with a crown.

The 3-month post-restorative recall showed shrinkage of apical radiolucency of the mesial root (Figure 25), but the periodontal ligament seemed to be widened. He was advised that he should consult the referring dentist on his clenching habit. After all, the patient had returned 12 months after the previous visit with a chief complaint of the swelling on the buccal mucosa. Intraoral examination

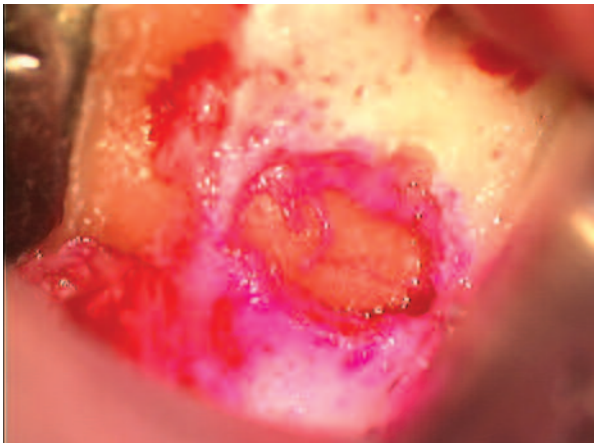

Figure 27: Distobuccal root with a vertical fracture line.

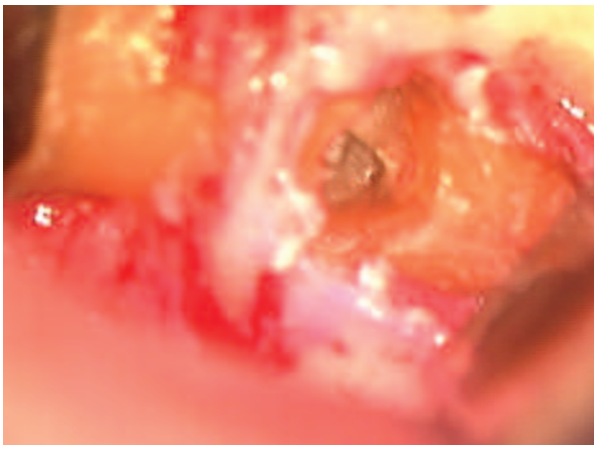

Figure 28: Distobuccal root end was separated from the coronal portion of the root.

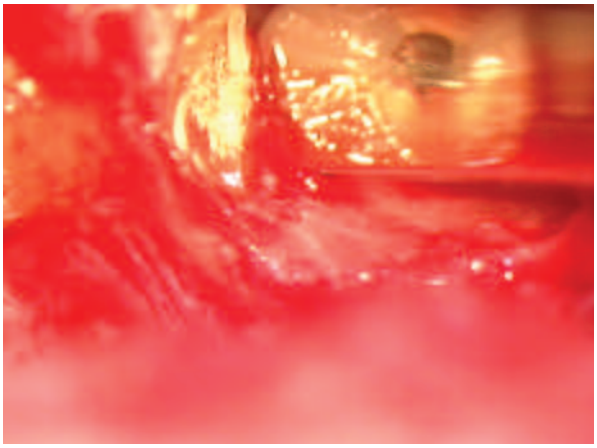

Figure 29: Resected root surface on the micromirror showing MTA filling.

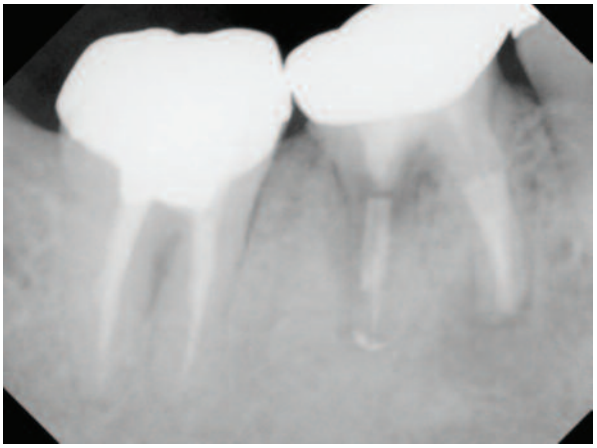

Figure 30: Postoperative radiograph after the apicosurgery.

revealed a sinus tract opening on the inflamed mucosa. A radiograph was taken for examination and it showed that there were no obvious developing lesions associated with either the mesial root or distal ones except that the periodontal ligament around the apical half of the distobuccal root was widened (Figure 26). The patient reported the chewing sensitivity of the mandibular right first molar had gradually increased 7 months after the crown was placed on the tooth. Periodontal probings remained 3 mm or less with no mobility. The tooth was diagnosed with a symptomatic radicular periodontitis caused by potential vertical root fracture associated with his clenching habit. The patient was informed that surgical intervention was needed to determine whether the distal root had fractured or not. Treatment options including the possibility of extraction of the tooth were discussed, and the patient agreed to surgical endodontics.

Surgical Intervention

The surgical intervention under the microscope revealed that the tooth had a vertical fracture line on the distobuccal root coronally extending approximately 5 mm from the apex, and the fracture line ended about 5 mm below the level of crest bone (Figure 27). The patient was informed of the vertical root fracture during the surgical procedure, but he insisted on retaining the tooth because the root fracture was confined to the apical portion. Thereafter, the distobuccal root end was resected with a Lindemann bur where the fracture line terminated (Figure 28). The resected root surface was then stained with methylene blue to identify more anatomical details. There was no sign of further fracture line found on the resected root surface. The root end cavity was carefully inspected at high magnification under the microscope, and it was confirmed that the MTA filling was intact in the center of root end surface (Figure 29). A 17% EDTA solution was used to remove smear layer from the root end and rinsed with 2% CHX solution and a postoperative radiograph was taken (Figure 30). Abnormal cusps on the occlusal table that could interfere with smooth lateral and anterior movements were eliminated after the surgery. The patient returned 3 months later and the 3-month postoperative

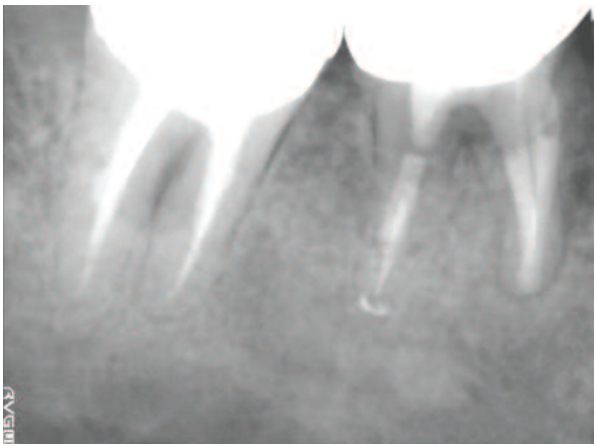

Figure 31: Postoperative radiograph 3 months after the apicosurgery.

Figure 32: Postoperative radiograph 6 months after the apicosurgery showing complete healings of apical lesions.

radiograph showed that the majority of the radiolucency associated with the distobuccal root had disappeared, but it was still visible on the radiograph (Figure 31). The patient was again placed on another 3-month recall. He returned 3 months later, and the 6-month postoperative radiograph finally showed the periodontal ligament was back to normal and the periapical lesions appeared to be healed (Figure 32).

Discussion

Both of the teeth, described in these 2 case reports, had the roots fractured once. However, it was surgical intervention and removal of occlusal trauma that brought both cases to a successful resolution in the end. What was learned from these cases was the importance of postoperative care, even though the causes of root fractures were hypothetical. The root canals were definitely enlarged by 40% to 50% of the root width, and thus were accordingly susceptible to vertical fracture. Periodontal studies suggest that the lesion of occlusal trauma is an injury to the periodontal ligament structure (the cementum, the periodontal ligament, and the associated alveolar bone). Excessive force can lead to pathologic changes in the periodontal ligament. Reported findings include vasculitis, disorganization of cells and fibers, bone and cementum resorption, necrosis of collagen fibers, and hyalinization of the periodontal ligament.[5,6] The type of damage depends upon the direction, duration, and magnitude of the force and is limited to the ligament region. The first case presented above revealed that the tooth had once been healed by the nonsurgical endodontic treatment, which was confirmed on the 3-month postoperative radiograph. It then later fractured, possibly after it was restored with a crown. Initially, the tooth had been free from excessive occlusal forces during the endodontic treatment at least until the crown was placed on it. In other words, there had been no excessive forces from occlusion loaded on the tooth during that period, which was confirmed by the reduction of periodontal ligament width on the radiographs. The preoperative radiograph showed the enlarged periodontal ligament around the root, and the 3-month recall radiograph showed the healing of the p-eriodontium; then another 3 months later it was back to what it was on the first visit. Taking all that happened into consideration, there should have been occlusal trauma existing for a certain period of time resulting in the widening of the periodontal ligament, which eventually triggered off the development of root fracture on the tooth. It was also noticed that the widening of the periodontal ligament remained the same even 3 months after the apical surgery, but it was back to normal soon after occlusal trauma was removed from the tooth by the referring dentist. Hence it was obvious that abnormally excessive occlusal force was responsible for the root fracture. The second case here illustrated that the root that lost 40% to 50% of dentin in diameter was susceptible to root fracture, which did occur in the end, possibly when force loaded on the tooth exceeded its limit.

Conclusion

These 2 cases suggest that an endodontically treated tooth needs immediate attention to abnormally excessive force from occlusion after the placement of the crown; so that the tooth, especially the one with canal enlargement of more than 40% of the root width, will remain healthy in the long-term period. However, endodontic success will not always contribute directly to

long-term survival of the tooth. There are several factors of endodontic failure. They are residual bacteria colonizing inside or outside the canal system (in the form of biofilms), foreign body reactions to obturation materials, the occurrence of true cysts, and cholesterol crystals.[7-9] The review of these 2 case reports revealed that the endodontic treatments failed because of the infection that occurred subsequently after root fractures.

Therefore, it was concluded that occlusal trauma was identified as a cause of infection, and postoperative care of occlusion after endodontic treatment played an essential role in the prevention of root fracture for long-term endodontic success.

Disclosure: Dr. Terauchi reports no conflicts of interest.

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Apical Surgery on Fractured Roots: Case Reports, by Yoshitsugu Terauchi, DDS, PhD: *Dentistry Today,* Vol. 29, No. 8, pp 86-91.

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