Case report

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Doctoral School of Clinical Medicine, Albert Szent-Györgyi Medical School, University of Szeged

Endodontic Treatment of Compromised Teeth

A Case Series

DR. KENNETH SEROTA

The percentage of positive endodontic treatment outcomes has increased significantly over the past couple of decades with the advent of new diagnostic technologies, materials, instrumentation, and microsurgical protocols. The use of cone beam computed tomography (CBCT) in the diagnosis and/or management of endodontic problems is increasing. Its value in identification of untreated canals, chronic root fractures, perforating internal root resorption, the diagnosis, prognosis, and treatment planning of primary endodontic lesions with secondary periodontal involvement is unimpeachable. This article is a case series of the treatment of compromised teeth with long term positive results done prior to or on the cusp these innovations. Its purpose is to demonstrate that when elimination of bio-load and biomimetic closure of the root canal system is achieved irrespective of technology, periapical and periradicular pathosis will heal in the most complex of cases.

Keywords: cone beam tomography, internal resorption, fractured teeth, endo/perio lesions, missed canals

Introduction

The past couple of decades have been witness to the most rapid and extensive technological evolutions in dentistry. Legacy concepts have been completely changed so that endodontics can be performed with an unprecedented strategic preservation of dentin. Teeth considered to have a guarded prognosis can now be treated with predictable success [Dadresanfar & Rotstein, 2021].

Radiography is an integral component of Endodontics; however, it is well established that conventional radiographic techniques have limitations. These include anatomical noise [Bender & Seltzer, 1961], the two-dimensional nature of the images produced, and various degrees of geometric distortion [Forsberg & Halse, 1994] which may impede the accurate detection of periapical lesions confined to cancellous bone [Patel S, et al., 2019; Kanagasingam S, et al., 2017]. The advent of cone beam computed tomography (CBCT) has resulted in widespread adoption of this technology for three-dimensional image capture/processing as the sensitivity is higher than periapical radiographs [Wang P, et al., 2011]. Reconstruction of CBCT volumes is performed natively using a personal computer, as such, data can be reoriented in a true spatial relationship [Scarfe WC, et al., 2009].

CBCT images include curved planar, cross-sectional, axial, and 3D reconstruction. Therefore, missed canals/untreated canals [Fernández R, et al., 2013], vertical root fractures [Tsesis I, et al., 2008], and the intra-radicular and extra-radicular extent of resorptive lesions which are frequently confused and misdiagnosed in 2D images can be accurately assessed [Patel S, et al., 2009].

Root resection is the process by which one or more of the roots of teeth are removed at the level of furcation while leaving the crown. Consequently, the objective of periodontal furcation treatment is to eliminate the plaque-retentive areas in the exposed furcation and make the area more accessible for maintenance. Success depends on the magnitude to which the periodontal infection has invaded the furcation area. Early furcation involvement (just into the fluting of the furcation-typically, Degree I) may be treated by therapeutically debriding the area, addressing the etiologic factors (e.g., overhanging restorations, enamel projections) and improving hygiene access to the furcation entrance through odontoplasty. However, moderate to advanced furcation involvement, which includes destruction of the bone and connective tissue distinctively into or through the furcation (typically, Degrees II or III) may present more of a therapeutic challenge necessitating root resection, hemisection or regenerative procedures. We present a case report of a patient with severe bone loss on the distal root of mandibular molar for which root resection was performed.

Root resection is defined as the removal of a root in mandibular molars without reference to how the crown is treated [Anitha & Rao, 2015]. Root resection is indicated [O'Mara & Mounce, 1995] in cases with severe vertical bone loss involving only a single root of a multirooted tooth, furcation invasion due to any cause, iat-

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rogenic mishaps such as perforation through the floor of pulp chamber, or a vertical root fracture of one root.

The rationale for this therapeutic approach is to make the furcation area accessible and cleansable. Any roughness on the unaffected root surface would also be eliminated during this procedure to prevent further plaque accumulation [Carnevale G, et al., 2000]. Occlusal stress subjected to a permanent mandibular molar is very high and the resected tooth loses its ability to bear such intense loads [Babaji P, et al., 2015]. Hence, it is obligatory to adequately restore such a tooth with an extra coronal restoration or any prosthesis with adjacent support.

Internal root resorption (IRR) is a particular category of pulp disease characterized by the loss of dentine as a result of the action of clastic cells stimulated by pulpal inflammation. [Nilsson et al, 2013].

Awareness regarding the incidence of IRR after injuries is useful for clinicians to minimize the risk and severity of its occurrence because a late diagnosis of IRR may limit treatment alternatives and result in tooth loss [de Souza BDM, et al., 2020].

Hyperplastic invasive tooth resorption poses considerable challenges in management due to the complexity and aggressive nature of the resorptive process. Infection induced tooth resorptions require the removal of the invading micro-organisms by endodontic therapy with the possible inclusion of intra-canal medication which can also facilitate repair of the resorbed tooth structure. With careful case selection and complete inactivation of resorptive tissue, successful management can be achieved [Heithersay GS, 2008].

The decision to retain a tooth or extract it for implant placement is a function of predictable long-term success of the final restoration. This case series shows that the predictive prognosis for compromised endodontically treated teeth is a function of a fundamental principle; the elimination of bio-load and and the biomimetic closure of the root canal system form the equation for success.

Materials and Methods

Case Report One

In October of 2015, a 55-year-old male patient was referred to the practice with a swelling in the the maxillary right quadrant. The medical history was non-contributory. Clinical examination revealed a fluctuant swelling between teeth #s 1.5 and 1.4. On intra-oral examination, the probing depth along the mesial-buccal line angle of tooth #1.5 was determined to be 12 mm. The periapical radiograph (PAR) taken of the area revealed a mesial-proximal periradicular radiolucency [PRRL] extending to the apex of tooth #1.5. Tooth #1.5 had been previously endodontically treated and restored with a pin-retained fibre post and composite core supporting a zirconia crown *(Fig 1A)*.

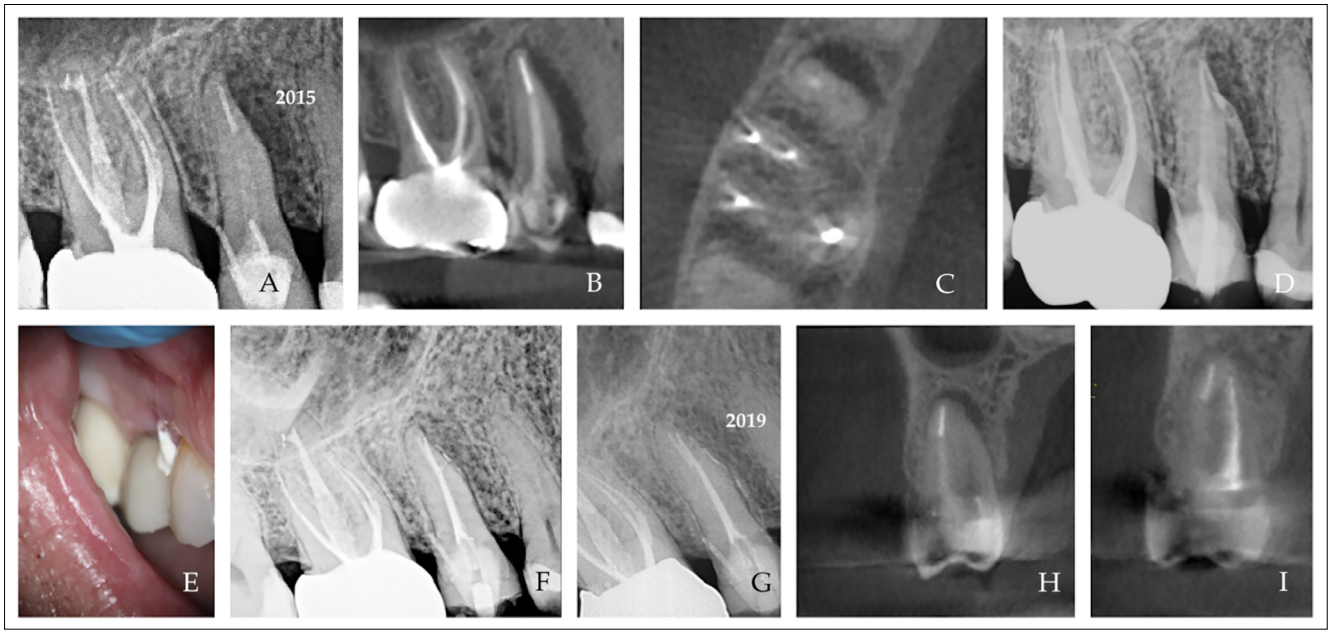

Fig 1A: PAR suggests a PARL along the mesial proximal aspect of tooth #1.5.
Fig 1B: Sagittal slice (CBCT) reveals the extent of the periradicular pathology.
Fig 1C: Axial slice (CBCT) reveals an untreated palatal canal in tooth #1.5 with a PRRL extending buccal to palatal on the mesial proximal aspect.
Fig 1D: Ca(OH)2 inserted in palatal canal is shown extruding into the lesion.
Fig 1E: Clinical photograph reveals the extrusion of the Ca(OH)2 between teeth #1.4 and 1.5.
Fig 1F: The obturation of the palatal root reveals a lateral lesion extending into the mesial-proximal infra-bony defect.
Fig 1G: A four-year follow-up PAR shows resolution of the infrabony defect.
Fig 1H: A coronal slice (CBCT) taken at the time of treatment in 2015 shows the lesion present about the root end.
Fig 1I: A coronal slice (CBCT) taken at the four-year follow-up shows resolution of the periradicular pathology.

The sagittal slice of the CBCT volume [Carestream CS 9000, Carestream Dental, GA] shows the PRRL lesion extending to the alveolar crest *(Fig 1B)*. The axial slice of the CBCT volume shows the extent of the rarefaction adjacent to the mesial aspect of the root and the presence of an untreated palatal canal *(Fig 1C)*. With the patient's consent, it was decided to selectively retreat the palatal canal.

Treatment was undertaken with administration of local anesthesia. A rubber dam was placed, and the palatal root canal instrumented with Protaper nickel-titanium rotary instruments (Tulsa Dental, Tucson AZ) to a working length of 20 mm and filled with a non-setting calcium hydroxide paste (Ca(OH)2) (UltraCal™ XS, UPI, S. Jordan UT] *(Figs 1D, 1E)*. The access chamber was sealed with Teflon and glass ionomer cement (GIC) (GC Fuji Filling™ LC, GC America) for a period of six weeks.

The root canal space was then obturated using a warm vertical condensation technique (WVCT). The obturation media (gutta-percha) was expressed into a lateral branching portal of exit *(Fig 1F)*. A PAR taken at the four-year follow-up shows resolution of the lateral lesion *(Figs 1G, 1H, 1I)*.

Advanced imaging (CBCT) allows the clinician to make predictable treatment decisions with respect to the presence or absence of periapical pathosis of individual roots as opposed to making assumptions about the tooth. Selective root retreatment is limited to a single root or roots clearly showing periapical pathosis while leaving root(s) with no visible or perceived pathosis untouched thus ensuring minimal root dentin removal [Nudera W, 2015].

Case Report Two

In October of 1998, a 39-year-old-male patient was referred to the office with a complaint of gum tenderness in the mandibular right quadrant. On intra-oral examination, the probing depth along the distal aspect of tooth #4.6 was determined to be 12 mm. Tooth mobility was not significant. The PAR revealed extensive bone loss surrounding the distal root of tooth #4.6 extending into the furcal region. The bone support of the mesial root was intact. A diagnosis of a perio-endo lesion was made.

Pulp sensibility testing of the teeth in the mandibular right quadrant identified the pulp of tooth #4.6 as necrotic *(Fig 2A)*, It was explained to the patient that successful treatment of perio-endo lesions was in general questionable/unfavourable, dependent on the severity of bone loss, root trunk length, degree of root separation, the ability to eradicate the osseous defect, and the restorative and oral hygiene procedures required.

With the patient's consent, anesthesia was administered, rubber dam placed, tooth #4.6 accessed, the chamber debrided, and the mesial canals treated with non-surgical root canal therapy. The distal buccal and lingual canals were penetrated to approximately 4 mm

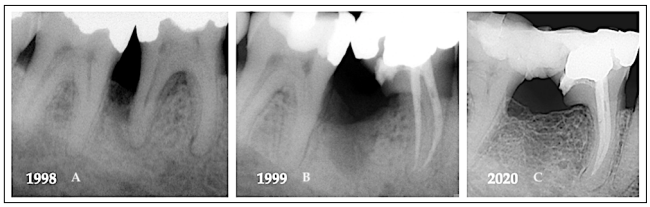

Fig 2A: PAR shows a PRRL about the mesial root of the #4.6 and loss of bone to the periapex of the distal root and into the furcation.

Fig 2B: The distal root was resected after root canal therapy and the surface of the resected coronal portion shaped convexly and polished with Shofu polishing burs (Shofu Dental Corp., San Marcos CA).

Fig 2C: PAR taken 22 years after treatment shows regeneration of the area of alveolar bone loss and re-establishment of the height of the osseous crest.

below the orifice and sealed with Mineral Trioxide Aggregate (MTA) (Tulsa Dental Products, Tuscon AZ). The MTA was allowed to set for two hours. A full thickness muco-periosteal flap was elevated and the distal root of #4.6 resected while retaining the overlying coronal portion of the coronal tooth structure *(Fig 2B)*. The occlusal table was reduced to redirect occlusal forces along the long axis of the mesial root. At some point after the hemisection, the referring dentist (RD) splinted teeth #'s 4.7 and 4.6 with a composite/Ribbond bridge.

A radiograph taken twenty-two years after the procedure shows osseous regeneration to the level of the furcation. corticalization was evident in the furcal region *(Fig 2C)*. The presence of furcation involvement in case of perio-endo lesion is a major challenge for treatment planning. The level of success of the hemisection procedure depends on the strength of the supporting bone of the remaining root of the tooth. In this case, the conversion of the furcation into a non-furcated single-root tooth was successful most likely due to the development of a favorable environment for oral hygiene maintenance.

Case Report Three

In March of 1999, a 47-year-old female patient was referred to the office with facial swelling in the maxillary anterior sextent; tooth #1.1 was tender to percussion and palpation. The medical history was non-contributory. Clinical examination showed large Class III and IV restorations in teeth #'s 1.1, 2.1 and 2.2 *(Fig 3A).*

Radiographic examination of tooth #1.1 showed periapical rarefaction. Tooth #2.1 showed a radiolucency in the middle third of the root and loss of bone beyond the PDL in contiguous relation to the mid-root pathosis. The patient reported that tooth #2.1 had been traumatized some 35 years prior. In the absence of CBCT imaging and based on palpation tenderness, it was assumed that the resorption perforated the facial aspect of the root and disrupted the overlying cortical bone.

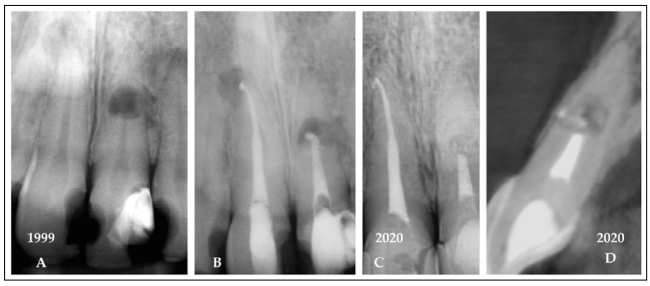

Fig 3A: Extensive restoration evident in teeth #'s 1.1, 2.1 and 2.2. PRRL evident on tooth #1.1 and internal resorption of the middle third of the root of tooth #2.1 noted.
Fig 3B: Obturation of tooth #1.1 and of tooth #2.1 to the inferior border of the resorbed area.
Fig 3C: Resolution of the apical lesion of tooth #1.1 is evident. Calcification of internal resorptive defect of tooth #2.1 is apparent.
Fig 3D: Sagittal slice (CBCT) of #2.1 showing calcified foci in the resorptive defect and closure of the facial root perforation and re-establishment of overlying cortical bone.

Pulpal sensibility testing of the teeth in the anterior determined that tooth #1.1 was non-vital. After obtaining informed consent for treatment of both teeth #'s 1.1 and 2.1, anesthesia was administered, rubber dam placed, and tooth #1.1 treated with conventional non-surgical root canal therapy using a WVCT technique. The access cavity was sealed with GIC and a surface nano-hybrid composite veneer (Herculite™ Ultra, Kerr Corp, Brea CA)

Tooth #2.1 was biomechanically instrumented to the incisal level of the resorptive defect taking care to avoid oversizing the canal diameter. A barrier of CollaCote® (Integra Lifesciences Corp) was placed at the terminus of the canal preparation and the canal sealed with an apical plug of white MTA. The coronal remainder of the canal obturated with WVCT. The access preparation was sealed with the technique previously referenced.

Figs 3A and 3B show the pre-operative and post-operative radiographs taken in 1999. There is a small amount of MTA extrusion, however, it has been shown not to have a detrimental effect in the periapical tissues (Nagmode PS, et al., 2016) A PAR taken twenty-one years after treatment shows a significant reduction in the size of the internal resorptive defect with small foci of calcification apparent. A sagittal slice (CBCT) shows the cortical bone overlying the defect to be intact. The resorptive defect while not eliminated in total, shows calculi of significant size.

The bioactive properties of MTA and others calcium silicate materials as root repair materials have a wide array of applications in endodontics. Their osteoinductive and osteoconductive properties recommend their use in multiple paradigms of endodontic therapy.

Case Report Four

In July of 2014, a 45-year-old female patient was referred to the office with a chief complaint of swelling in the distal papilla of tooth #1.4 for a period of 10 days. Clinical examination revealed an occlusal amalgam restoration. A probeable seam was detected in the distal marginal ridge (DMR). The probing depths along the distal-buccal and lingual line angles of the tooth revealed an infrabony pocket of 8 mm. The PAR taken showed bone loss between teeth #'s 1.4 and 1.5 and apical rarefaction *(Fig 4A)*. Pulp sensibility testing of tooth #1.4 elicited no response indicating a necrotic pulp. Removal of the amalgam and access preparation into the pulp chamber uncovered a mesial fracture line extending mesial proximally *(Fig 4B)*.

The treatment options were explained to the patient; 1) removal and replacement with a 3-unit fixed bridge, 2) removal, soft and hard tissue augmentation, and an implant retained restoration, 3) root canal therapy and a full coverage restoration. The patient was advised that option 3 has a questionable prognosis, however, for financial reasons, she chose the third option.

At the treatment appointment, anesthesia was administered, rubber dam placed and tooth #1.4 treated with conventional non-surgical root canal therapy using nickel-titanium instrumentation and obturated using a WVC technique *(Fig 4C)*. The vertical condensation of the gutta-percha extended into 2 visibly evident lateral canals which spatially approximated the infra-bony pocket along the distal proximal aspect of the root. While clinical importance of the presence of lateral canals in endodontics is questioned, their presence as a pathologic vector in this case cannot be discounted [Silveira CF, 2010].

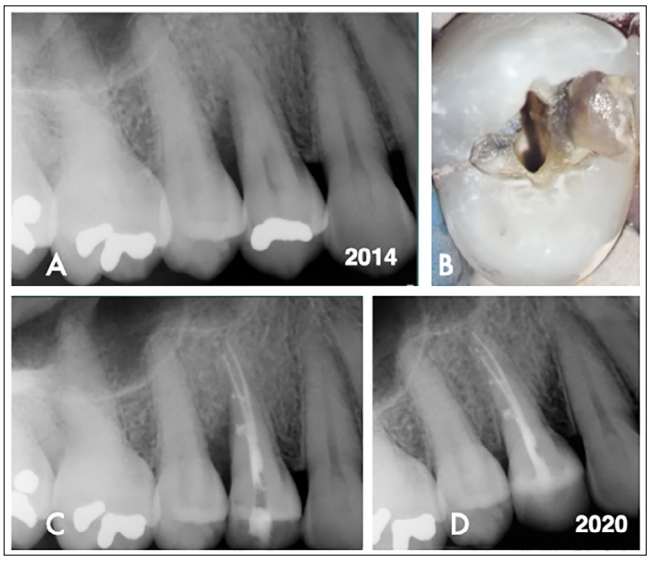

Fig 4A: PAR shows an angular bony defect along the distal proximal aspect of the root of tooth #1.4.
Fig 4B: A fracture line is apparent along the DMR. There is oxide in a fracture line at the base of the axial wall mesial to the buccal canal orifice.
Fig 4C: PAR shows gutta-percha in lateral canals exiting into the angular bony defect.
Fig 4D: PAR taken at six-year follow-up shows regeneration of the interproximal bone.

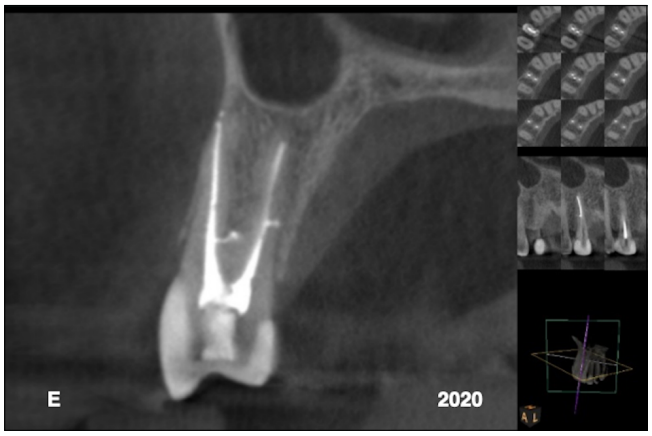

Fig 4E: Coronal slice (CBCT) shows obturation of lateral canals approximating the healed osseous defect.

The canal orifices were covered with Teflon and the access cavity sealed with flowable and nano hybrid resin. A PAR taken at a six-year follow-up shows resolution of the bony defect to the level of the cemento-enamel junction (CEJ).

There are many factors to be considered regarding saving teeth with apparent fractures; occlusion, location of the tooth in the mouth, presence of moderate-to-severe periodontal disease, age, gender, and the financial status of the patient [Liao WC, et al., 2021]. Radiographic images do not always reveal a clear vertical fracture line. In the early stages of a vertical root fracture, some cases did not show deep probing. The clinician must use best practices to facilitate recognition and diagnosis of the stage of the fracture and the potential for long term predicable success.

Conclusion

Treatment planning demands the analysis of all possible data accrual, the clinician's expertise, and experience. A more comprehensive understanding of the true effectiveness of current procedures will stimulate the development of new ideas and strategies, and thus improve the outcome and predictability of apical periodontitis treatment. Regardless of technologic changes, the primary positive prognostic fundamental are eradication of microflora, biofilm, and optimal sealing of the root canal system

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Esetismertetés

K Serota

Sérült fogak endodontiai kezelése

Esetsorozat

A pozitív endodontiai kezelési eredmények százalékos aránya jelentősen megnőtt az elmúlt néhány évtizedben az új diagnosztikai technológiák, anyagok, műszerek és mikrosebészeti protokollok megjelenésével. Egyre növekszik a kúpnyalábos komputertomográfia (CBCT) alkalmazása az endodonciai problémák diagnosztizálásában és/vagy kezelésében. Értéke a kezeletlen csatornák, krónikus gyökértörések, perforáló belső gyökérreszorpció azonosításában, a szekunder parodontális érintettséggel járó primer endodonciai elváltozások diagnosztizálásában, prognózisában és kezelésének tervezésében elvitathatatlan. Ez a cikk egy esetsorozat a sérült fogak kezeléséről hosszú távú pozitív eredménnyel, amelyet ezen innovációk előtt vagy a csúcsidején végeztek. Célja annak bemutatása, hogy a periapicalis és periradicularis patózis a bioterhelés megszüntetése és a gyökércsatorna-rendszer biomimetikus záródása technológiától függetlenül a legösszetettebb esetekben gyógyul.

Kulcsszavak: kúpos tomográfia, belső reszorpció, törött fogak, endo/perio elváltozások, kihagyott csatornák