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Clinical Technique/Case Report

Multidisciplinary Management and Pulp Vitality Preservation of a Tooth With Extensive Iatrogenic Furcal Root Perforation and Biologic Width Violation

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Clinical Relevance

Knowledge is lacking about the possibility of orthodontically moving a root-repaired tooth whose pulp has maintained vitality. The present case report provides an example of the successful management of a molar tooth with severe iatrogenic damage and multiple negative prognostic factors.

SUMMARY

This article describes the case of a vital molar tooth with a vast furcal iatrogenic root perforation and biologic width violation, which was successfully managed by a multidisciplinary approach aimed at preserving pulp vitality. The root perforation was cleaned and then sealed with mineral trioxide aggregate, which was positioned onto the pulp at the canal orifices. After one month, the patient was not reporting symptoms, and the tooth was positively responding to the thermal test. The tooth was orthodontically extruded, subjected to minimally invasive crown lengthening, and prepared to receive a full-crown restoration. Radiotransparent composite resin was chosen as a permanent restorative material to better monitor possible endodontic complications at the coronal level. The patient's tooth was followed up for eight years uneventfully. The present case is an example of the possibility to subject a root-repaired tooth with fully formed apices to conservative yet complex multidisciplinary treatment while maintaining pulp vitality.

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INTRODUCTION

Root perforations are unfortunate mechanical or pathologic complications that involve the direct communication between the endodontic space and the external root surface.[1] The prognosis of a tooth affected by a perforation is related to the size and location of the lesion, the elapsed time from the initial damage, and the possibility that the defect can be effectively cleaned and sealed.[2] The root perforation may cause complications that require extraction of the affected tooth; indeed, iatrogenic perforations and stripping are the reason for extraction in up to 4.2% of endodontically treated teeth.[3]

Though the prognosis for coronally positioned perforations was considered poor in the past,[4] especially in the case of furcal localization, the development of bioactive materials in the past three decades, such as mineral trioxide aggregate (MTA), has improved the management of root perforations.[5] MTA is generally accepted as the root repair material of choice for perforations within bone, thanks to its sealing ability,[6] marginal adaptation,[7] and capacity to promote bone and cementum formation.[8] A recent systematic review reported that the nonsurgical repair of root perforations with MTA cement can reach success rates up to 80.9%.[9]

In addition, the properties and versatility of MTA cement have aroused the interest of clinicians and researchers in the management of vital permanent teeth with cariously exposed pulp.[10] Nowadays, increasing attention is given to minimally invasive endodontic treatments, such as partial and total coronal pulpotomy associated with MTA positioning, as an alternative to conventional root canal treatment, even in teeth with mature apices.[11,12] A systematic review on the topic reported that the two-year success rate of full pulpotomy executed on cariously exposed permanent posterior teeth can exceed 90%.[12]

Extensive caries and other sources of damage that invade the biologic width may cause gingival inflammation, clinical attachment loss, and alveolar bone resorption.[13] Biologic width can be recovered by performing periodontal surgery, orthodontic extrusion, or a combination of both approaches.[14] The coexistence of severe damage and negative prognostic factors can diminish the probability of endodontic success. This case report presents the successful multidisciplinary management and eight-year follow-up of a mandibular molar with extensive iatrogenic perforation, treated with simultaneous perforation repair and full pulpotomy, and violation of the biologic width recovered by orthodontic extrusion and minimally invasive crown lengthening.

CLINICAL CASE REPORT

In May 2010, a 26-year-old white man in good general health was referred by a private practitioner to receive root perforation repair and root canal treatment of the lower right first molar (tooth 30), which was originally affected by asymptomatic disto-occlusal decay that apparently did not involve the pulp. During access cavity preparation, the pulp was exposed and vast perforation occurred on the pulp chamber floor while the practitioner attempted to locate the canal orifices. When asked about the preoperative endodontic diagnosis, the dentist declared that he did not detect any clinical evidence of pulpal pathology. Given the aforementioned, the pulp was assumed to be preoperatively healthy. The patient provided radiographic documentation consisting of a preoperative periapical radiograph and an intraoperative radiograph with the perforation already visible (Figure 1A, B).

The tooth was still responding normally to the pulp cold thermal test, which was carried out by applying a cotton pellet soaked with ethyl chloride on the buccal surface of the tooth. The temporary filling was removed, and a composite resin buildup restoration was performed before isolating the tooth with a rubber dam. Even under operating microscope magnification (M525, Leica Microsystems CMS GmbH, Mannheim, Germany), the canal orifices were barely detectable and poorly accessible. Since the pulp at the canal orifices and the periodontium were not bleeding, a second line of treatment was considered that consisted of direct pulp capping and concurrent perforation repair with MTA.

The accessible endodontic space was disinfected with gentle continuous rinses of 2.5% sodium hypochlorite solution for 10 minutes. A considerable amount of MTA cement (ProRoot MTA, Dentsply Tulsa, Tulsa, OK, USA) was placed into the defect with the aim of sealing the perforation and the canal orifices. To achieve immediate coronal seal, a hard-set calcium-hydroxide base (Life, Kerr, Bioggio, Switzerland) was applied to the MTA cement and the coronal access was filled with composite resin (Filtek Flow and Filtek Z250, 3M ESPE, St Paul, MN, USA). The adhesive procedures entailed enamel and dentin etching with 37% phosphoric acid (Total Etch, Ivoclar Vivadent, Schaan, Lichtenstein) for 15 seconds followed by application of the All-Bond 3

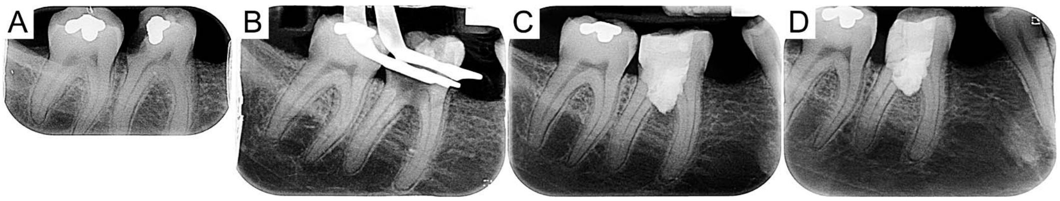


Figure 1. *Radiographic documentation provided by the patient at the first visit. (A): Preoperative radiograph and (B) intraoperative periapical radiograph where the iatrogenic furcal perforation of tooth 30 is clearly visible. (C): Immediate postoperative radiograph; after cleaning and disinfection, mineral trioxide aggregate was placed to seal the defect and cover the vital pulp at the canal orifices. (D): One-month control radiograph with no signs of complications.*

system (Bisco, Schaumburg, IL, USA) according to the manufacturer's instructions. Leaving the preparation visibly moist, All-Bond parts A and B were mixed in a 1:1 ratio, applied to the entire tooth preparation for 10 seconds, and gently air dried for 15 seconds. Then, All-Bond resin was applied to the preparation, air thinned, and light cured for 10 seconds with a light-emitting diode lamp at 1500 mW/cm^2 (Radii plus, SDI, Melbourne, Australia). The same lamp was used to light-cure the composite resins. A radiographic control revealed extrusion of the MTA cement in the furcation area (Figure 1C).

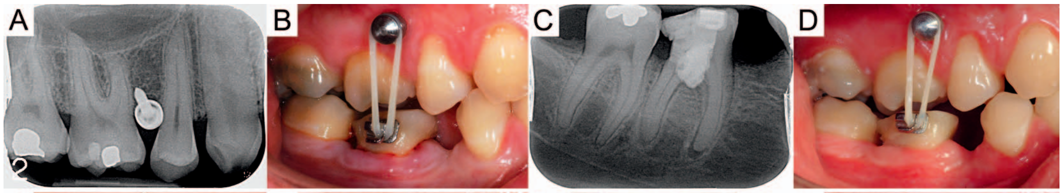
The tooth was checked weekly for one month and received an occlusodistal patchwork composite restoration to address a partial fracture of the pre-endodontic restoration (Figure 1D). As the patient reported no pain or dysfunction at the recall visits, he was offered the possibility to receive an orthodontic extrusion combined with a surgical biologic width realignment and an indirect restoration. After local anesthesia was administered, a mini-screw (Imtec ORTHO Implant, 3M Unitek, Monrovia, CA, USA) was placed between the first molar and the first premolar of the opposing jaw (Figure 2A), and fiberotomy was performed on tooth 30. Then, an orthodontic buccal tube with hook (Morelli Ortodontia, Sorocaba, Brazil) was bonded to tooth 30 with dual cure resin cement (Heliosit Orthodontic, Ivoclar Vivadent). The extrusion force was exerted by using a rubber band connecting the head of the screw and the buccal tube (Figure 2B). Two months later, the extrusion was deemed satisfactory (Figure 2C, D). A biologic width realignment was performed to reestablish harmonious contour of soft and hard tissue, remodeling only the distal bone while preserving the furcation area (Figure 3A). The initial keratinized gingiva was 2- to 3-mm thick. Under local anesthesia, the distal papilla was incised and displaced; then, a 3-mm-long releasing incision was made mesially (Figure 3A). The interproximal bone crest was remodeled with diamond burs with the aim of removing only what was strictly necessary to restore the 3-mm distance from the restorative margins and reestablish the biologic width. The bone of the furcation area was fully preserved.

In the same appointment, a bonded retainer was placed on tooth 30 and tooth 31 (Figure 3B, C). The retainer was kept in place for two weeks to stabilize the result obtained with the orthodontic extrusion. In the absence of symptoms and with positive response to the pulp cold thermal test, the retainer was removed. Alginate impressions were taken to obtain a provisional acrylic resin crown. Then, tooth 30 was prepared with a feather-edge margin circumferentially. The crown was relined and finished so as to not interfere with the gingival healing and was cemented with eugenol-free cement (Temp Bond NE, Kerr) (Figure 3D, E). The early placement of the provisional crown served for both soft-tissue conditioning and orthodontic stabilization thanks to the occlusal contacts. After six weeks, the crown was relined again for soft-tissue conditioning and kept in place for six months.

The permanent crown was manufactured with composite resins for indirect restorations (Signum, Heraeus Kulzer, Hanau, Germany) and luted with self-adhesive resin cement (RelyX Unicem, 3M ESPE) (Figure 3F, G, and H) approximately one year after the pulp capping and perforation repair. For eight years, the patient was recalled annually for a clinical and radiographic assessment, and no complications occurred (Figure 4A, B).

DISCUSSION

Repairing a root perforation can be a simple task with predictable outcome, as in the case of easily accessible small lesions. Conversely, the same procedure may require advanced instruments and skills when the perforation is vast or localized to the deep portions of the endodontic space. Other patient-related factors may contribute to treatment success, primarily compliance and the capability of being subjected to long operative sessions, especially under the operating microscope. When several operative



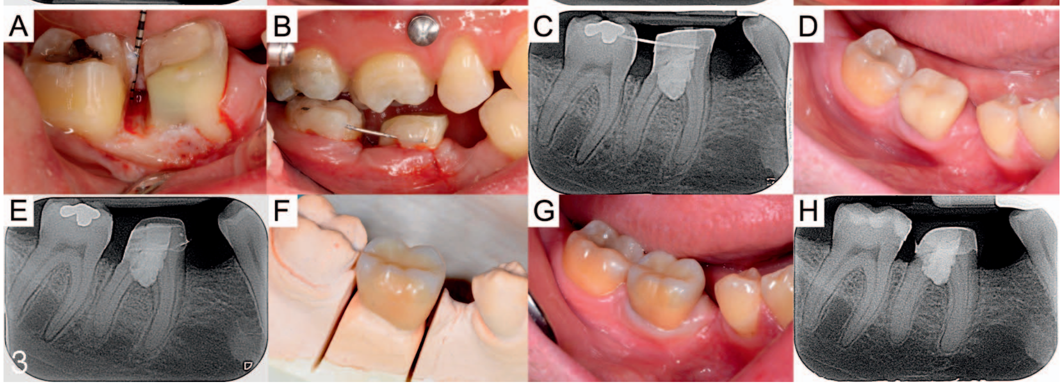


Figure 2. *Phases of the orthodontic extrusion of tooth 30. (A): An orthodontic miniscrew was placed between tooth 3 and tooth 5. (B): The extrusion force was applied by a rubber band connected to a bonded hook after fiberotomy. (C and D): After two months, the extrusion was deemed sufficient.*

Figure 3. *(A): Minimally invasive surgical crown lengthening. (B): A bonded retainer was placed to maintain the achieved position. (C): Postsurgical radiograph. (D and E): The provisional crown of tooth 30 was kept in place for six months to allow soft-tissue stabilization. The composite crown on (F): the stone model and (G and H): immediately after placement.*

difficulties coexist, a simplified but effective endodontic treatment may become the preferable option. Although pulpotomy has been advocated as an alternative to full root-canal treatment for limited circumstances,[12] its potential should be explored in a wider array of clinical situations because its success rate can be surprisingly high in selected cases.[12] It is surely known that complete root-canal treatment has predictable outcome on teeth with vital pulp.[15] Nevertheless, endodontically treated teeth are characterized by lower survival rates than vital teeth, with a 7:1 hazard ratio in molars.[16] A possible explanation to this finding may be the deprivation of defensive sensitive mechanisms, such as proprioceptive function,[17] damping property,[18] and tooth sensitivity. Considering the aforementioned aspects, there is an emerging conservative trend to preserve pulp vitality as much as possible.

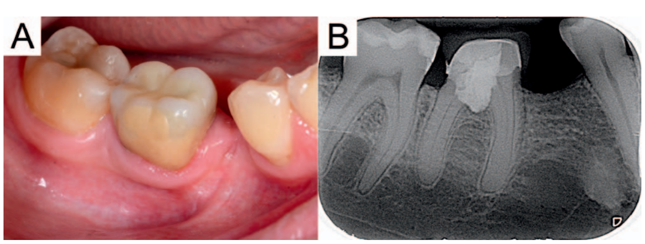


Figure 4. *Eight-year clinical (A) and radiographic (B) appearance of tooth 30 after the multidisciplinary treatment.*

To prevent an undesirable MTA extrusion in large perforations, the clinician should consider the internal matrix technique, which consists of intracanal placement of an extraradicular barrier.[1] Notwithstanding, the current case report demonstrates that, in the first place, an extensive MTA overfilling does not appear to interfere with bone healing and orthodontic movement and that, secondly, an orthodontic extrusion force may be applied to a tooth subjected to perforation repair and full pulpotomy without jeopardizing the outcome of the endodontic treatment. To the best of the authors' knowledge, even if the performance of MTA in static conditions is well known, no other examples of similar endodontic-orthodontic management attesting to the dynamic properties of MTA are available in the literature. Once set, MTA cement is a firm mass that can effectively adapt to the dentin substrate[19]; this compactness was sufficient to prevent fragmentation of the extruded material during the orthodontic extrusion. When radiographically monitoring the orthodontic extrusion of a tooth in which periapical complications are possible or even likely, as in the case being presented here, the radiolucency left by the root apices may mimic a periapical lesion of endodontic origin (Figure 3C). In these cases, the differential diagnosis should encompass both clinical tests and further periapical radiographs to monitor the radiolucency.

The endodontic management of a tooth with root perforation may be useful in light of eventual orthodontic and/or prosthetic treatments. In the present case, which involved the management of a strategically important tooth in a young adult patient, the endodontic treatment was performed to prepare for orthodontic extrusion, which, in turn, was aimed at the final restoration. In orthodontics, miniscrews can be used for temporary anchorage and removed after the desired movement has been achieved, representing a well-tolerated treatment option that does not require special compliance from the patient. Orthodontic forced tooth eruption is an alternative to crown-lengthening surgery because it exposes sound tooth structure for the placement of restorative margins, thereby preventing marginal bone loss and maintaining esthetics.[20] In the presented case, applying the bracket to the buccal side of the tooth also allowed for the correction of the Wilson curve, thus facilitating the final restoration in occlusion.

The idea of resecting the fibers of marginal periodontium in orthodontic cases is not new; indeed, as early as 1899, Angle[21] proposed gingival surgery in the cervical third of the root to increase tooth mobility and shorten the retention period. Severing the gingival fibers was intended to achieve periodontally accelerated orthodontic tooth movement and enhanced posttreatment stability.[22] We decided to perform fiberotomy with the aim of exposing the restorative margin and minimizing the risk of furcation defect. Since the distal margin was not satisfactorily exposed, a minimally invasive biologic width realignment was carried out to preserve the furcal bone.

Choosing a composite crown for the final restoration in the reported case was justified for several reasons. Generally, there is increasing interest in composite crowns as an alternative to traditional crown restorations.[23–27] In the past, composite crowns were seen as long-term temporary restorations, which are especially suitable for patients with uncertain prognosis because their esthetics and wear resistance are generally inferior to that of traditional ceramic prostheses.[25,28] Eventually, some researchers have started advocating their use as permanent restorations thanks to the evolution of dentinal adhesives, the development of resin composites with improved mechanical properties, the lower costs compared with metal-ceramic crowns, and the possibility of computer-aided design/computer-aided manufacturing production.[28–30] Composite full-coverage indirect restorations of adequate occlusal thickness may be capable of high fatigue resistance,[31] which may be even better than modern ceramic materials for indirect posterior restoration.[26,27] Unfortunately, the published clinical studies on the performance of composite crowns are sporadic and dated; nonetheless, 96% and 88.5% survival rates have been reported after 3 and 5 years, respectively.[25,32] Moreover, there is no evidence on the clinical behavior of composite crowns fabricated and luted with modern materials and techniques; further research is necessary.

The choice of traditional acrylic resin for long-term provisional restoration and a radiotransparent composite for the permanent restoration material in this specific case allowed for the constant radiographic analysis of the integrity of the MTA mass, the buildup materials, and preparation margins. A radiopaque material would have covered some sites of interest, namely the furcal area and the coronal third of the roots, where pulp canal obliteration might take place and be detected.

CONCLUSION

The present case report is an example of how a severely compromised tooth can be recovered with a series of multidisciplinary steps, by following the concepts of modern restorative dentistry, to provide the patient with minimally invasive treatments.

Regulatory Statement

This study was conducted in accordance with all the provisions of the local human subjects oversight committee guidelines and policies of the University of Trieste.

Conflict of Interest

The authors of this manuscript certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

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