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CASE REPORT

# Management of a Flared Root Canal with an Iatrogenically Widened Apex

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## ABSTRACT

Overinstrumentation during root canal treatment is one of the causes for iatrogenic enlargement of the root apex. It also leads to unwarranted coronal third widening, which results in thinning of the dentinal walls and makes the tooth susceptible to fracture. Another difficulty arises during control of obturation material within the canal. Such cases can be managed with obturation using mineral trioxide aggregate (MTA) followed by of root reinforcement for the weakened dentinal walls. In the present case, a 5 mm MTA plug was placed and root reinforcement was done with the help of Giomer. Postendodontic restoration was done with a cast post and a full coverage porcelain fused to a metal crown was cemented in place.



**Keywords:** Apexification, Giomer, Mineral trioxide aggregate, Overinstrumentation, Root reinforcement.

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## INTRODUCTION

One of the aims of root canal treatment is to fill completely the root canal system in order to prevent reinfection. The apical constriction (minor apical diameter) is the apical portion of the root canal, which has the narrowest diameter. This position varies, but is usually 0.5 to 1.0 mm short of the apical foramen. The minor diameter assumes a funnel shape as it widens apically toward the major diameter. It also is the reference point clinicians refer to as the apical terminus for shaping, cleaning, and obturation.[1] Posttreatment discomfort, generally, is greater when this area is encroached upon by instruments or obturation materials, and the healing process may be compromised.[2]


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In teeth with wide open apex either due to incomplete root development or as a consequence of pulp necrosis through trauma, caries, or iatrogenic overenlargement of the canal or the absence of a natural constriction at the end of the root canal, termination of obturation materials is a difficult task. Apexification or root-end closure has been advocated as an alternative to standard root canal treatment, when there is a lack of an apical constriction.

Apexification is defined as a method to induce a calcified barrier in a root with an open apex, or the continued apical development of an incomplete root in teeth with necrotic pulp.[3]

Mineral trioxide aggregate (MTA) has been proposed as a material suitable for one-visit apexification, as it combines biocompatibility[4] and a bacteriostatic action with favorable sealing ability when used to repair root/pulp chamber perforations or as a root-end filling material.[5,6]

Faulty method of cleaning and shaping can lead to excess removal of dentin. The coronal part of the root canal may be left widely flared and encircled only by a narrow rim of intact radicular dentin, which is too weak to withstand normal masticatory forces and is prone to fracture. Endodontically treated teeth usually demonstrate restorative problems because of frequent insufficient sound coronal and radicular tooth structure. Thus, it is important to maintain the natural taper during cleaning and shaping.

The restoration of such teeth with loss of exorbitant amount of dentin presents a challenge to clinicians. Pontius and Hutter[7] suggested two methods for the restoration of weakened roots canals, which were conventional and intraradicular reinforcement methods.

The lack of dentin substance at the coronal portion of the root makes it impractical to place a retentive pin. The use of cast metal posts fails to strengthen or reinforce the tooth, instead leading to wedging forces at the already thin and weakened portions of the root and, thus, increasing the susceptibility to fracture. To ensure a better prognosis in such cases, a technique called as the "reinforcement technique" was introduced by internally strengthening the thin dentinal wall of the pulpless teeth.[8]

The intraradicular reinforcement method involves placement of a thick intermediate layer of adhesive material, which is sandwiched between the root dentin and

**Fig. 1:** Preoperative intraoral periapical radiograph of 12

**Fig. 2:** Preoperative intraoral photograph showing 12

a small-diameter metal post or dowel, to enhance the fracture resistance of such roots. Internally rebuilding the weakened root with suitable adhesive dental materials helps in dimensional and structural reinforcement to support and retain a post and core for the continued function of the tooth.[9]

This case report describes the management of an iatrogenically widened apex by placing MTA and reinforcement of the weakened root structure with Giomer followed by custom cast post.

## CASE REPORT

A 42-year-old female patient was referred by a general dentist to the Department of Conservative Dentistry and Endodontics to manage an iatrogenic error-overinstrumentation with loss of the apical constriction (Fig. 1). The patient had visited her general dentist with the chief complaint of pain with her right upper front tooth region since 2 to 3 weeks (Fig. 2). Pain was continuous, throbbing, localized, and aggravated on intake of hot and cold foodstuff. Medical history was noncontributory.

Intraoral clinical examination with respect to permanent maxillary right lateral incisor, i.e., 12, revealed approximately 2 mm of remaining crown structure with temporary restoration in the access cavity (Fig. 2). There was no associated mobility, pain on percussion was positive, and periodontal probing depths were within normal limits. Radiographic examination revealed a wide apex suggestive of overinstrumentation (Fig. 1). A diagnosis of previously initiated root canal treatment with symptomatic apical periodontitis in relation to 12 was arrived at.

A tentative treatment plan was formulated, which included cleaning and shaping with 12 and obturation with a 5-mm MTA plug, osseous crown lengthening procedure (CLP), reinforcement of the weakened root structure using a light-transmitting post and Giomer, custom cast post, and a full coverage porcelain fused to metal crown.

All procedures were performed under rubber dam isolation. Following oral prophylaxis, rubber dam application, and removal of temporary restoration, it was observed that there was no straight line access. Hence, the access cavity preparation was modified. The root canal was explored with a #25 K-file (Mani, Tamil Nadu, India). Apical gauging was done and the working length determined with the apex locator and was confirmed radiographically, which was 19 mm, and the file binding at this length was #100 K-file (Fig. 3). Circumferential filing was done gently with the #100 K-file at the determined working length. The canal was irrigated intermittently with 3% sodium hypochlorite (NaOCl) (Prime Dental Products Pvt. Ltd., Maharashtra, India). Finally, passive ultrasonic irrigation (PUI) was carried out with #25 K-file (Satellec Acteon Group, New Delhi, India), at 16 mm, at a power setting of 4.0 with NaOCl as the irrigant for 60 seconds. The root canal was then dried with sterile absorbent points

**Fig. 3:** Apical gauging with 12

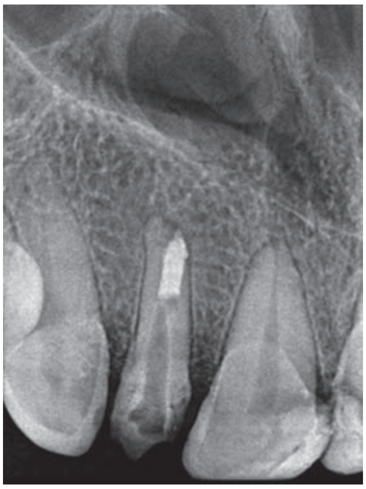

**Fig. 4:** 5 mm MTA plug and reinforcement with giomer in 12

**Fig. 5:** Twelve – etching of the intracanal

(Sure Endo; SureDent Co. Ltd., Gyeonggi-do, Korea). An intracanal medicament of calcium hydroxide (CaOH) (Deepashri Products, Ratnagiri, India) mixed with saline in a thick paste-like consistency was placed in the root canal, and the patient was recalled after 1 week and the access cavity was sealed with intermediate restorative material (IRM) (Dentsply, Caulk, USA).

The next phase of treatment consisted of removal of the temporary restoration, removal of CaOH medicament using H-files (Mani, Tamil Nadu, India) and PUI as described earlier. The root canal was then dried with sterile absorbent points. White Pro-Root MTA (Dentsply, Ballaigues, Switzerland) was mixed with sterile water as per manufacturer's instructions and placed in the apical third in increments, using hand pluggers and compacted with absorbent points. It was further compacted using indirect ultrasonics at a power setting of 4.0 for 30 seconds for each increment. Thus, a 5 mm MTA apical plug was obtained and a radiograph was taken to evaluate the placement of a dense MTA plug (Fig. 4). A moist cotton pledget was placed in the canal and the access cavity was sealed with IRM.

Patient was completely asymptomatic when recalled after 24 hours. The temporary restoration and the cotton pledget were removed and the set of MTA was confirmed with the help of hand pluggers, and the access cavity was again sealed with IRM. The patient was then scheduled for an osseous CLP, carried out in the Department of Periodontics.

The patient was recalled 3 weeks after the CLP and further treatment was carried out. Root reinforcement was done as follows: The access cavity restoration was removed, and the canal was irrigated with 3% NaOCl, followed by saline and dried. A nonserrated (smooth) Luminex light transmitting fiber-post (Luminex system, Dentatus Ltd., USA), which was marked to 14 mm on the labial surface to ensure that it went up to the full length and which did not bind in the canal, was selected, coated with petroleum jelly, and kept aside. Etchant containing 37% phosphoric acid (Meta Etchant, Meta Biomed, USA) was injected into the canal and was rinsed after 30 seconds (Fig. 5). The canal was dried using paper points. Seventh-generation bonding agent (BeautiBond$^{TM}$, Shofu Dental Corp, USA) was applied using an applicator tip and was light cured for 20 seconds. Flowable Giomer (BEAUTIFIL Flow, Shofu, USA) was injected into the root canal following which the previously selected fiber post was placed in the canal, and this assembly was light cured for 20 seconds each from all sides (Fig. 6). Following light curing, the fiber post was withdrawn from the canal and the fiber post was reinserted to verify the length. This procedure helped in reinforcing the root canal and a new post space of a reduced diameter was thus achieved (Fig. 7).

Direct wax pattern fabrication was done using a plastic post and Type 1 inlay wax (FC Inlay wax, GC Europe) (Fig. 8). The laboratory procedures including investing of the wax pattern, burnout, and casting with cobalt–chromium alloy

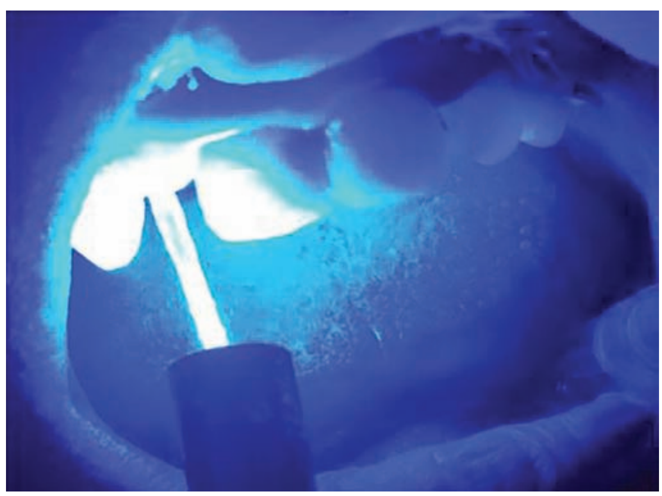

**Fig. 6:** Twelve – light curing of the fiber post and giomer

were carried out (Fig. 9). After checking the fit of the post and core clinically and radiographically, and finishing and polishing of the post and core, the canal was dried with absorbent points and the custom cast post was cemented using type 1 glass ionomer cement (GIC) (GC Fuji I®, GC America, Inc.), which was mixed according to the manufacturer's instructions (Figs 10 and 11).

Following crown preparation, a provisional acrylic crown was cemented with zinc oxide eugenol cement (Deepak Enterprises, India) (Fig. 12).

**Fig. 7:** Twelve – post space seen after reinforcement

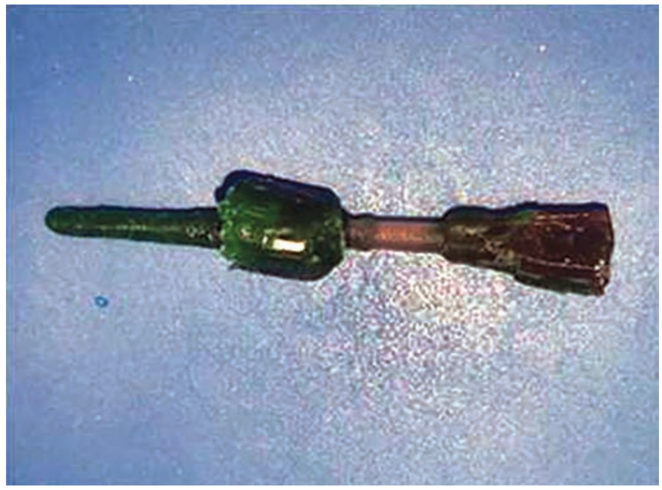

**Fig. 8:** Direct wax pattern fabrication of the post space and core

**Fig. 9:** Post and core casting

**Fig. 10:** Twelve – custom cast post cemented

**Fig. 11:** Twelve – custom cast post cemented

**Fig. 12:** Twelve – provisional crown cemented

**Fig. 13:** Twelve – metal try-in

**Fig. 14:** Twelve – final PFM crown cementation


**Figs 15A and B:** Twelve – preoperative and postoperative photographs

Metal try-in for the crown prepared was done (Fig. 13) and the final porcelain fused to metal crown was cemented (Figs 14 and 15A and B) with the help of resin cement (Relyx Luting Cement, 3M ESPE, USA).

## DISCUSSION

Conventional root canal obturation techniques depend on the presence of a constriction at the apical level of the canal; therefore, the absence of this constriction as a result of incomplete root development, aggressive apical resorption, or iatrogenic enlargement becomes challenging to manage. Routinely, the apical gauging for an upper lateral incisor is around #35 to 40 K-file. Apical gauging is defined as the measurement of the terminal diameter or shape of the canal after initial crown-down shaping. It is important because it gives us a fairly good approximation of the canal diameter in the critical apical 3 to 5 mm,[2] which avoids over- and underinstrumentation.

In the present case, the apical diameter was increased to #100 K-file due to inadvertent cleaning and shaping, which could have occurred either due to incorrect determination of the working length or failure to use the files in a sequential manner. A vital determinant in providing predictable endodontic results is the ability to accurately locate the minor apical constriction, maintaining the correct working length during cleaning and shaping, recapitulation, and copius irrigation.

The technique of ultrasonic activation of an irrigant after instrumentation has been completed and has been referred to as PUI. The term passive is used to denote the intention to simply activate the irrigant, and not to cut or contact the dentin with the activated file.

During PUI, the irrigant is intermittently replenished using a conventional irrigation syringe. Recent studies have demonstrated an improved smear layer removal,[10] debris removal from small anatomical irregularities,[11] and synergistic behavior with irrigants to kill biofilm bacteria.[12] Similarly, Spoleti et al,[13] and Lee et al[14] showed that PUI is more effective than syringe irrigation in removing remnants of debris[13] and bacteria.

Placement of the obturation material in a canal with an open apical foramen involves the risk of extrusion[15] of the material into the periapex, which may compromise the long-term outcome of treatment.[16,17] To avoid extrusion, compaction may be minimized, ultimately ensuing in an inadequate adaptation and seal.[3,18]

Hence, conventionally used gutta-percha obturation is contraindicated in such cases. A need for the choice of a material that can be used by orthograde means to obturate the canal arises in this scenario. The MTA has been advocated for the immediate obturation of open root apices, which has become popular as a one-visit apexification technique as an osteoconductive apical barrier. The MTA can induce cementum-like hard tissue when used adjacent to the periradicular tissues. It has superior sealing property, sets in the presence of blood, and is extremely biocompatible. Moisture contamination at the apex of tooth before barrier formation is troublesome with other materials used in apexification. As a result of its hydrophilic quality, the presence of moisture does not affect its sealing ability.[19]

In a study done by Hachmeister et al,[20] they showed that 4 mm of MTA resisted displacing forces better than 2 mm. Al-Kahtani et al[21] observed that 5 mm provided a good seal in immature permanent teeth with open apices, and imparted enough depth to resist displacement and also completely prevented bacterial leakage. Previous studies[22,23] have incorporated the same method with successful results.

Further, teeth that warrant intraradicular reinforcement are usually accompanied by a large communication between the root canal and the periodontal ligament. This typically happens when a large root canal has been overprepared apically, which leads to damage to the apical constriction and loss of an apical stop for conventional obturation.[24]

Indirect ultrasonic activation has been suggested for use to vibrate MTA in order to improve the adaptation of the material into the root canal space and remove any voids in the material. The indirect technique generally involves placement of MTA using an appropriate carrier into the root canal, and indirectly activating a condenser placed in contact with the bulk of the MTA material by pressing an ultrasonic tip in contact with the condenser. A recent scanning electron microscope (SEM) study examining the marginal adaptation of MTA found that indirect ultrasonic activation in conjunction with smear layer removal resulted in significantly improved marginal adaptation.[25] Indirect ultrasonic agitation during placement also improved the compressive strength of MTA[26] as well as the resistance to bacterial leakage.[27]

For successful outcome of the endodontic treatment, a good postendodontic restoration is a must, which requires at least 1.5 mm of a ferrule all around the tooth, which was not available in the present case. Hence, an osseous CLP was advised for postendodontic rehabilitation of the tooth.

Following root canal treatment in case of flared canals, the remaining dentinal walls of the root are extremely thin, which makes it prone to fracture. Thus, in such cases, there is a need for a postendodontic restoration. Failures in endodontically treated teeth with overflared canals are more likely due to postendodontic restorative failures than the endodontic treatment itself. The post does not reinforce the root, but only helps in retention of the core.

Moreover, post selection has an effect on the stress pattern in the root canal. In a weakened root, a cast post can concentrate the wedging forces at the coronal portion.[28] The use of prefabricated metal post entails the pooling of large defects in the canal within the luting medium, thus creating a weak bond between the entire post–core–crown–tooth complex.[29] Hence, for a flared canal, it is vital that lost dentin is rebuilt with a strong dentin-like material for successful outcome.

Increasing the thickness of the walls with an appropriate dentin substitute may reduce this risk. The elastic moduli of many universal and posterior resin-based composites and GICs are similar to that of dentin,[30,31] which may allow a bonded cement to strengthen the remaining root and, together with a lower modulus resin-based luting cement, reduce the transmission of mechanical stresses from a rigid metal post to the remaining root dentin. These resin-based materials may act as “mechanical buffers” by dissipation of cervical stresses created by the mismatch of properties between metal and dentin.[32]

The objective behind the use of adhesive materials is to enable them to act as a dentin substitute before cementing a small-diameter metal post in teeth and augment the fracture resistance by increasing the internal thickness of the root.

Recently, a new group of hybrid composite restorative materials known as “Giomers” has been introduced to the market.[33] Giomer has a modulus of elasticity of about 13 to 14 MPa, which is close to that of dentin; this makes it a favorable material for the present case.

Thus, this technique has advantages like reinforced root strength as the Giomer internally strengthens the root structure, providing maximum shear load support and retention.[9] Thus, this technique can be used to restore even grossly mutilated teeth to best serve the requirements of the patient.

## CONCLUSION

Abiding by the rules of cleaning and shaping, iatrogenic mishaps can be avoided. In such cases that they occur, recent advancement in materials, such as MTA used for single-visit apexification and the technique of root reinforcement have helped salvage grossly flared canals with extremely thin dentinal walls, which otherwise will be susceptible to fracture. Thus, it is important to plan the treatment not only with respect to the endodontic technique, but also the feasibility of a successful postendodontic restoration.

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