Combined Endo-restorative Treatment of a Traumatized Central Incisor: A Five-year Follow-up

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Purpose: The management of complicated crown-root fractures is challenging for endodontic restoration. The present case describes a patient who sustained trauma to the maxillary right central incisor.

Materials and Methods: Clinical and radiographic examination showed a complicated crown-root fracture and incomplete root development with periapical radiolucency and inadequate endodontic treatment with overfilling. Orthograde retreatment with MTA apical closure combined with a microsurgical approach to remove of extruded material was performed. Coronal sealing was accomplished with a direct adhesive restoration and marginal relocation.

Results: A 5-year follow-up showed complete healing of the periapical lesion and correct preservation of function and esthetic parameters.

Conclusion: A modern minimally invasive treatment protocol allows the maximum conservation of residual dental tissues.

Keywords: dental trauma, direct composite restoration, marginal relocation, permanent tooth prognosis, surgical microendodontics

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Epidemiological data has shown that the annual incidence of dental injuries in children is 1% to 3% of the population.[3] Some studies reported that 16% to 30% of 7- to 21-year-old patients have experienced multiple dental traumas.[3-6,8-15] Central and lateral incisors are usually the teeth involved in dental trauma, with trauma in the maxilla being 10 times more frequent than in the mandible.[3-6,8-15] Different clinical aspects related to the intensity and the direction of the trauma, tooth anatomy and root development can influence the diagnosis, therapy, and prognosis of such accidents.[15] Dentinal fractures may occur at different levels involving only the clinical crown or some portions of the root with margins of the fracture below the CEJ.[22] Therefore, identifying the real dimensions and margins of the fracture and dental and/or periodontal tissues involved is mandatory for planning the right treatment and improving the long-term prognosis of the element.[12] Nowadays, in case of enamel or dentinal-enamel fracture, if the fragment is still available, it can be bonded to the residual tooth.[4-6,8-12] Otherwise, the tooth is restored with a direct adhesive restoration using composite resin, or with indirect restorative techniques.[6] Besides restoration procedures, endodontic treatment is required in the case of luxation or other complicated fractures with massive pulp exposure, especially in teeth that have reached complete root development.[23] Indirect restorative techniques are the most frequent choice for the rehabilitation of anterior teeth when a great amount of sound tooth structure has been lost.[27-31]

Recently, however, due to the development of new composite resins and bonding techniques, direct restorations can achieve good esthetic and functional results with significant conservation of dental tissues.[24] This approach is far more compatible with modern minimally-invasive restorative concepts.[17] The aim of this paper was to evaluate functional and esthetic parameters of a direct restorative treatment with a 5-year follow-up.

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Fig 1a The maxillary right central incisor (tooth 1.1). Preoperative clinical image showing a complicated crown-root fracture after the removal of the previous inadequate composite restoration.

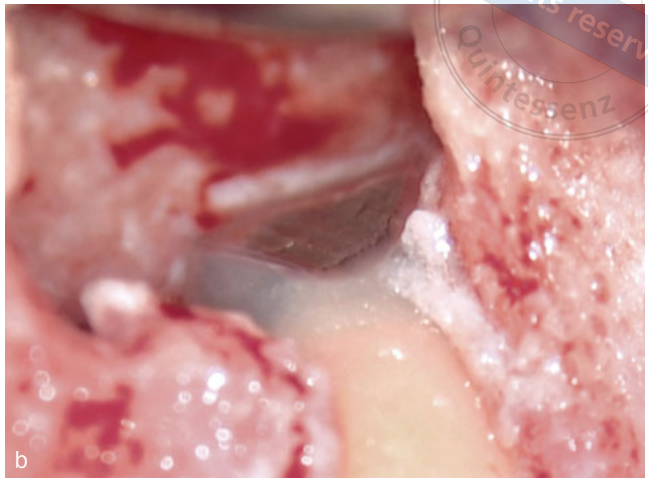
Fig 1b Preoperative periapical radiograph taken 1 week before the traumatic accident showing a direct restoration with evident distal marginal leakage and inadequate endodontic therapy and overfilling. Presence of a periradicular radiolucency associated with tooth 1.1 with residual pulp vitality of teeth 1.2 and 2.1.

MATERIALS AND METHODS

The patient, an 11-year-old boy, was referred to the Endodontics Department of the University of Turin Dental School due to pain and swelling in the right maxilla as the chief complaint. The patient reported experiencing dental trauma to the anterior maxillary teeth 14 months previously. At that time, endodontic treatment and a direct composite restoration were performed in a private practice. However, the patient reported a recurrent abscess after the initial treatment.

The patient's medical and dental status was collected. The pulpal and periradicular status of the anterior maxillary teeth was assessed for vitality using thermal and electric pulp tests (Diagnostic Unit, Sybron; Orange, CA, USA), palpation, and percussion. Periodontal charting was taken. A pre-operative periapical radiographic examination was performed with an XCP Rinn film holder (Dentsply Sirona; Bensheim, Germany). Clinical findings showed a periapical abscess with moderate swelling corresponding to the apical portion of the maxillary right central incisor. Tooth mobility was under a score of 1 and the percussion test was highly positive. An absence of pathological probing was noticed. Evidence of a residual class- IV composite restoration without marginal integrity and a secondary distal deep carious lesion on element 1.1 was present. The restoration on tooth 1.1 seemed to be the consequence of a complicated oblique crown fracture that extended subgingivally in the disto-buccal area with loss of tooth fragments. Radiographic examination of the same tooth revealed an osseous periapical lesion associated with an incongruous root canal filling and loss of coronal seal. Radiographically, the tooth displayed incomplete root formation and extraradicular endodontic material. Fracture margins were appreciable 2 mm above the bone crest. No signs of longitudinal root fracture were found clinically or radiographically (Fig 1). The diagnosis seemed compatible with a periapical abscess of endodontic origin.

The treatment protocol was explained, and informed consent was obtained. Centric and protrusive contacts were removed. The patient was dismissed with a prescription for antibiotics (amoxicilline and clavulanic acid cpr. 1g, dosage 1g/12h for 6 days) and optional analgesics (ibuprofen cpr. 600 mg twice a day for 3 days). Four days later, initial orthograde endodontic retreatment was performed. Two cartridges of a local anesthetic were administered (2% mepivacaine + adrenaline 1:100000), and the tooth was isolated with rubber-dam. After complete removal of the old restoration and caries, an access cavity was made and the root canal was located. The pulp chamber and the coronal part of the tooth were thoroughly cleaned with rotating instruments and an ultrasonic tip (Start-X #1, Dentsply Sirona). Previous endodontic filling remnants were retrieved chemically with solvents (Gutta-Percha Remover, OGNA; Muggio, Italy) and mechanically with K-file #15 up to 1 mm short of the estimated working length as ascertained from the preoperative radiograph. Chemomechanical preparation involved preflaring the canal and obtaining a working length (WL) with the aid of an apex locator and an intraoral radiograph. Instrumentation was conducted with K-Files and ProTaper Universal NiTi rotary system S1-S2-F1-F2-F3-F4-F5 up to the WL (Dentsply Sirona). Apical gauging was established as > #60, due to incomplete root formation. Irrigation was carried out with 40 ml of buffered 5% NaOCl solution (Niclor 5, OGNA) and 40 ml of 10% EDTA. An EndoVac (Sybron) device was placed to constantly deliver 5% NaOCl solution



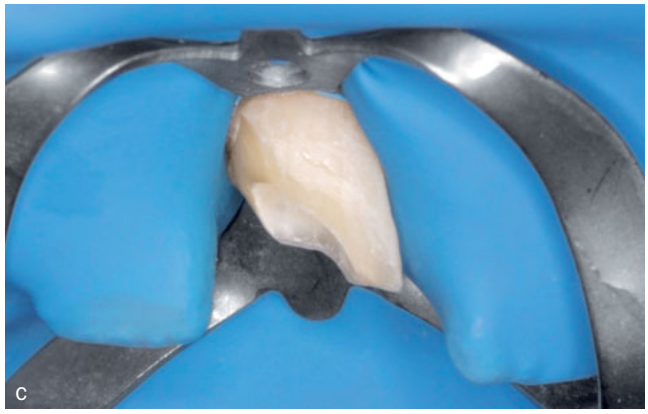


Fig 2a Postoperative periapical radiograph of the 3 mm apexification with MTA before gutta-percha backfilling.
Fig 2b Intraoperative clinical photograph with operative microscope at 12X magnification showing the 2-mm root end resection and the presence of an MTA apical seal after removal of the extraradicular endodontic material.
Fig 2c Tooth isolation with rubber-dam during surgery with flap elevated and creation of marginal relocation using flowable composite.

with the macrotip for 5 min up to the WL. This was followed by 3 cycles of microtip irrigation at WL for 6 s and then withdrawn 2 mm from the WL for 6 s.[21] Apexification with a 3-mm layer of white MTA (ProRoot MTA, Dentsply Maillefer; Ballaigues, Switzerland) Tulsa Dental) was performed to obtain a perfect apical seal. A slightly wet cotton pellet was introduced into the root canal and the tooth was then temporized with a 4-mm layer of GC Fuji IX (GC; Tokyo, Japan). A periapical radiograph was taken (Fig 2a).

After 1 week, MTA curing was verified, and endodontic treatment was completed with warm gutta-percha backpacking using the Obtura system (Kerr Dental; Orange, CA, USA). A thin coat of endodontic sealer (Pulp Canal Sealer EWT, Kerr Dental) was placed in contact with the root canal walls. Then, warm gutta-percha was placed inside the root canal in contact with the MTA apical plug. The gutta-percha was compacted with endodontic Schilder pluggers #9 and #10 (Denstply Sirona; Konstanz, Germany). A provisional glass-ionomer restoration was then placed. The patient was subsequently scheduled for apical microsurgery to remove excess material and the expected fibrous tissues.

Surgery was performed under microscopic vision (OPMI Pro Ergo, Carl Zeiss; Jena, Germany). After local anesthesia using mepivacaine 2% with adrenaline 1:100000 and further hemostasis using lidocaine 2% with adrenaline 1:50000, a sulcular mucoperiosteal flap was elevated. The papilla base preservation technique was used, except for the papilla between elements 1.1 and 1.2. The extruded filling material and the surrounding fibrous tissues were located, dissected from the healthy soft tissues, and removed. The root apex was then resected with a bur (Lindemann surgical bur, HU-Friedy; Chicago, IL, USA) within the bony crypt in order to eliminate thin apical root canal walls, which showed cracks after staining with methylene blue, especially distally (Fig 2b). The integrity of apical sealing with MTA was checked at high magnification and with a micromirror. Once the flap was raised, the coronal fracture margin was exposed: the vertical difference between the alveolar bone crest and the fracture line was 2 mm, without massive injury to supracrestal tissue attachment. The surgical flap was utilized to define the fracture margins and allow isolation with rubber-dam (Fig 2c). The coronal and radicular frac-

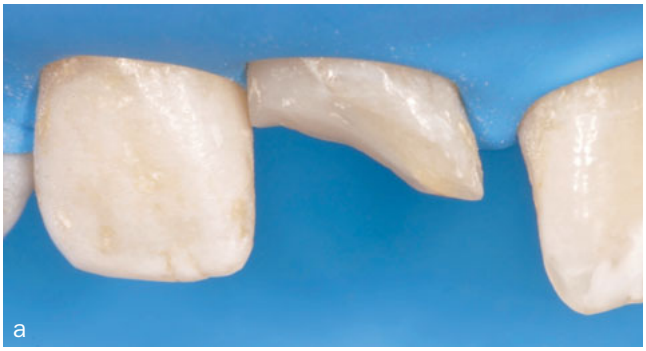


Fig 3a Tooth isolation with rubber-dam after marginal relocations and before placing the direct composite restoration.
Fig 3b Five-year follow-up: clinical conditions.
Fig 3c ive-year follow-up: periapical radiograph with complete healing of the periapical lesion.

ture margins were finished with a round, fine-grit diamond bur. A 5-mm space for intracanal retention was prepared using Laargo #3 and dedicated burs (Dentsply Sirona).

After preparation, the intracanal space was cleaned with 10% EDTA solution and dried with absorbent paper points. To ensure optimal adhesive bonding, a 3-step etch-and-rinse adhesive was used (Optibond FL, Kerr). First, the cavity was etched for 40 s in enamel and 15 s in dentin with 35% orthophosphoric acid (Ultradent; South Jordan, UT, USA) The tooth was then washed for 40 s and dried with paper points. Thereafter, primer and bonding were applied with microbrushes and polymerized using an LED lamp (Valo, Ultradent) for 40 s. After positioning an interproximal metal matrix, the margins were relocated using flowable composite (Clearfil ES-2, Kuraray Noritake; Tokyo, Japan) 1 to 1.5 mm thick at the cervical level and 0.5 mm thick to completely line the remaining part of the dentinal cavity. The intracanal space was filled with two 2-mm horizontal layers of nanohybrid composite (Clearfil ES-2, Kuraray). After polymerization, the rubber-dam was removed and the flap was repositioned, sutured with a non-absorbable 5-0 Deknatel Tevdek (Teleflex Medical; Wayne, PA, USA), and gently compressed with gauze.

Postoperative management consisted of ice packs, soft diet, optional analgesics, and 0.12% chlorhexidine mouthrinses twice daily for 2 weeks. After suture removal at 1 week, the patient still felt moderate discomfort, but no swelling. At the 2-week recall, he reported complete resolution of the symptoms and had good soft-tissue healing. Four weeks after endodontic microsurgery, the tooth was treated with a composite restoration.

The treatment plan was realized following established esthetic guidelines, including impressions, diagnostic casts, and diagnostic wax-up. A diagnostic wax-up was used to realize a palatal putty stent for correct composite placement. First, the shade was selected – A1 (Vitazahnfabrik; Bad Säckingen, Germany) – as a reference for the teeth to be restored. After local anesthesia and rubber-dam isolation, sandblasting was performed and a 3-step etch-and-rinse adhesive was applied while protecting the adjacent teeth with a Teflon band (Fig 3a). Before applying the adhesive, silane (Porcelain silane, B.J.M. Laboratories; Or Yehuda, Israel) was applied that was compatible with the composite mass. After that, a thin layer of enamel A1 was placed with the aid of the putty stent to realize the palatal surface (Clearfil ES-2; Kuraray). Nanohybrid composites were used for all the procedures. Interproximal surfaces were created with transparent strips fixed to the adjacent tooth by interproximal wedges. The internal surface was then realized using shade A1D composite resin as dentin layer and a thin layer of

shade A1E as enamel. Labial and buccal surfaces of the restorations were smoothed using finishing diamond burs (8379.314.023 and 8862.314.012 Komet, Gebr. Brasseler; Lemgo, Germany) and disks (Ultra Gloss Composite Polishing System, Kerr; Orange, CA, USA) were used for detailed polishing from rough to fine grains using a low speed handpiece. Static and dynamic occlusal contacts were checked with articulating paper (Bausch; Ravensburg, Germany). Clinical follow-up, performed using a standard protocol for clinical testing of restorative materials and procedures (USPHS),[27] showed that esthetic and functional parameters were maintained. Moreover, periodontal analysis revealed no signs of inflammation of marginal mucosa and the preservation of a correctly scalloped gum line (Fig 3b). At the 5-year follow-up, the radiograph revealed a healthy periodontium with no signs of periradicular pathosis and or secondary caries (Fig 3c).

DISCUSSION

Dental trauma forces the clinician to act promptly with a multidisciplinary team in order to guarantee a durable rehabilitation.[24,25] The maintenance of a compromised anterior tooth with substantial loss of sound structure is of primary importance, due to its functional, esthetic, and social role.[25] In terms of endodontically treated teeth, some elements are more challenging to restore, particularly given subgingival caries or crown fractures.[5] Studies have described direct vs indirect treatment approaches to maintain traumatized teeth for as long as possible.[11] However, reversible treatments may be considered due to the need to ensure therapeutic alternatives in case of repeated traumatic dental injuries.[11] Direct composite restorations are considered the ideal choice for the rehabilitation of a traumatized anterior tooth, especially in young patients, who are more prone to trauma than adults.[20] The main advantage of a direct composite restoration of a traumatized anterior tooth is its minimal invasiveness: cavity preparation is almost absent and it saves as much sound hard tissue as possible, thus allowing re-intervention without significantly sacrificing additional tissue.[2,24-27] Direct techniques could be completed in one appointment, ensuring the patient a fast result both esthetically and functionally.[2-6,8-16]

In the case of large apices, it has been widely demonstrated that gutta-percha may be not sufficient to create a hermetic apical seal, which is fundamental to avoid the onset of periapical disease.[32-34] In the present clinical case, it was necessary to initially take an orthograde approach to remove the endodontic material used immediately after the trauma occurred, and disinfect the root canal with subsequent apical sealing with MTA. Sometimes a medication with calcium hydroxide may be suggested to increase the periapical tissues' pH before MTA placement.[33] However, in this case, the root canal was dry after endodontic disinfection with EndoVac and therefore the operator proceeded with MTA placement. Moreover, the regeneration of the periodontium was delayed after the scheduled apical surgery; subsequently, a retrograde approach was employed to remove the over-apex endodontic material and regularize the shape of the apex to ensure a clinical condition more conducive to healing.[18,20-32]

Crown-root fractures that extend below the cemento-enamel junction and invade the supracrestal tissue attachment present some clinical difficulties, as it is impossible to effectively isolate with rubber-dam.[28] The coronal margin relocation technique represents a non-invasive alternative to classical surgical crown lengthening through the apposition of a 1-mm-thick increment of composite over the pre-existing slightly subgingival margins.[14] This technique requires the use of flowable resins, as they present a lower Young's modulus and a higher level of elastic deformation in order to act as a stress absorber.[13,14] Moreover a correct fluid adaptation to the cavity floor may be useful, particularly in deep margin conditions after correct isolation of the operating field.[13] A previous study reported that flowable resin composite placed under hybrid resin composites was able to achieve better marginal adaptation than hybrid resin composites.[14] Some studies reported that class-IV anterior restorations showed an average life of 3.9 years,[10-18, 22-30] while other studies showed a 50% survival rate after 5 years of follow-up.[1-8] Modern composites are made with nanoparticles, with filler consisting of 25-nm particles and 75-nm zirconia or silicate nano-aggregate.[13] These materials are more moldable due to the nanodimensions of the particles, which also increase the polishing properties in addition to long-term resistance and longevity. A recent meta-analysis reported an overall success rate of 90% (without replacement) after 10 years for class IV restorations.[20] However, when the patient reaches adulthood, definitive approaches such as ceramic veneers would be ideal. These restorations provide long-term stability and, in case of additional trauma, still behave more similarly to the natural tooth when compared to teeth restored with full crowns.[8]

CONCLUSION

Nanofilled composite resins combined with the use of an etch-and-rinse technique and three-step adhesives positively influence the longevity of direct composite restorations, making this a reliable minimally invasive approach with maximum conservation of sound tooth structure in cases of endo-restorative treatment after trauma.

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Clinical relevance: Modern endodontic microsurgery has the potential to manage endodontic failures with a minimum of tissue loss. The adhesive systems and resin composites allow esthetic and functional results through direct restorations with significant conservation of dental tissues.