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CASE REPORT

Intentional replantation for the management of an external cervical root resorption: a case report

ABSTRACT

Aim: *To present the operative procedures carried out to manage a case of external cervical root resorption with pulp tissue involvement via endodontic treatment and intentional replantation, and the related clinical results obtained up to an 18-months follow-up.*
Summary: *After accurate clinical and radiographic evaluations, a diagnosis of external cervical root resorption has been established for the second maxillary right molar of a 27-year-old male patient. The patient referred chewing pain started about one year before. Through the signature of an informed consent, the patient has undergone root canal treatment of the element, followed by atraumatic extraction, resorption management and intentional replantation procedures. The tooth has been splinted for 14 days with the adjacent first molar, and after the healing period, it showed an adequate stability; moreover, no symptoms have been referred by the patient.*
The follow-up visits carried out after 3, 6, 12 and 18 months from clinical procedures confirmed the successful outcome of the treatment, as no recurrence, mobility or symptoms associated with the element have been currently reported.
Key learning points:

- *3D image acquisition represents an essential tool to diagnose external cervical resorptions and to accurately determine the position and the extension of the defect. Moreover, it allows a better operative planification which in turn is useful to define the most suitable approach for the single case.*
- *CBCT scan and the use of dental operating microscope considerably increase the accuracy of diagnostic, endodontic and conservative procedures.*
- *Intentional replantation should represent an effective therapeutic option for the management of deep external cervical root resorption.*

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Introduction

External Cervical Resorption (ECR) is a dynamic resorptive process which starts from a cervical area and progresses in the coronal-apical direction, encircling the root canal. As a resorptive process, it is substantially characterized by an abnormal odontoclastic action resulting in the loss of dental hard tissues (1), mainly subepithelial cement. As extensively described by Mavridou et al. (2, 3), damages to periodontal ligament and the contribution of a stimulating factor to maintain osteoclasts activity may play a crucial role in the occurrence of ECR. Basing on existing literature, one single tooth is generally involved in ECR, although different cases of multiple cervical resorptions have been recently reported, in which more than one element was involved (4-6).

Different potential aetiological factors have been proposed over the years; nevertheless, the lack of evidence-based supportive literature resulted in a high percentage of missed diagnosis or inadequate defect treatment. The first cross-sectional study about the potential predisposing factors has been carried out in 1999 by Heithersay et al. (7). More recently, the relevant literature has been revised to better define the aetiological and pathogenetical aspects for ECR (8). It was found that, in the European population, orthodontic treatment and previous traumatic injuries are the major potential predisposing factors of ECR, followed by parafunctional habits, poor oral health, malocclusion, extraction of an adjacent tooth and - interestingly - viral infections related to the transmission of feline herpes virus (FHV) - although further investigations are necessary to well define that last correlation (2). Otherwise, a study by Jeng et al. (9) indicates trauma and periodontal treatment as major potential predisposing factors for ECR occurrence in Asian population. Concerning maxillary and mandibular second molars, different studies based on CBCT evaluations also found a correlation between external root resorption and impacted third molars, especially in those cases of mesio-angular impactions (10, 11). Nevertheless, no cause-effect relationship has been currently established, as it is still challenging to determine the exact nature of ECR defects when a combination of different predisposing factors in a single case is referred (12).

In the early stages of ECR, patients are commonly asymptomatic as the pulp tissue is vital and protected from resorption by the pericanalar resorption-resistant sheet (PRRS); on the contrary, in more advanced stages the resorption front may involve the pulp tissue, thus resulting in clinical signs and/or symptoms of pulpitis or apical periodontitis (1). For that reason, the clinical diagnosis is still unpredictable, and ECR defects are most frequently diagnosed as an incidental radiographic finding.

Before the clinical introduction of Cone Beam Computed Tomography (CBCT), periapical radiographs were the only radiographic support achievable to make ECR diagnosis. Nowadays, it is known that periapical radiographs present limitations due to image distortion (13), anatomical noise (14) and the impossibility to precisely evaluate the depth and the circumferential spread of the resorption (15); therefore, it may result in a misdiagnosis and a poor/no treatment of the defect. Due to the possibility to perform accurate three-dimensional analysis on dynamic images, and to adapt field of view and exposition to the region of interest, CBCT become almost essential over the years when diagnosis and treatment planification of complex endodontic treatments are required (16, 17). Regarding ECR, the 2014 European Society of Endodontology (ESE) position statement and the 2015 joint statement of American Association of Endodontists (AAE) & American Academy of Oral and Maxillofacial Radiology (AAOMR) indicate CBCT as an effective tool to improve diagnosis quality and treatment planification of potentially restorable resorptions (18, 19).

The increasing need to better define the three-dimensional features of ECR in order to help clinicians to formulate an adequate treatment plan, recently lead to the development of three-dimensional classifications basing on CBCT findings on coronal, sagittal and axial views; in particular, Patel et al. (15) considered the coronal-apical extension, the proximity to the root canal and the circumferential spread of defects to improve diagnostic accuracy and to define the best treatment option, while Rhode's classification considers the amount of dentinal tissue loss both in cervical area and on the external surface of the tooth (20).

As previously mentioned, a scrupulous diagnosis is mandatory to define an adequate operative protocol for the management of each single case.

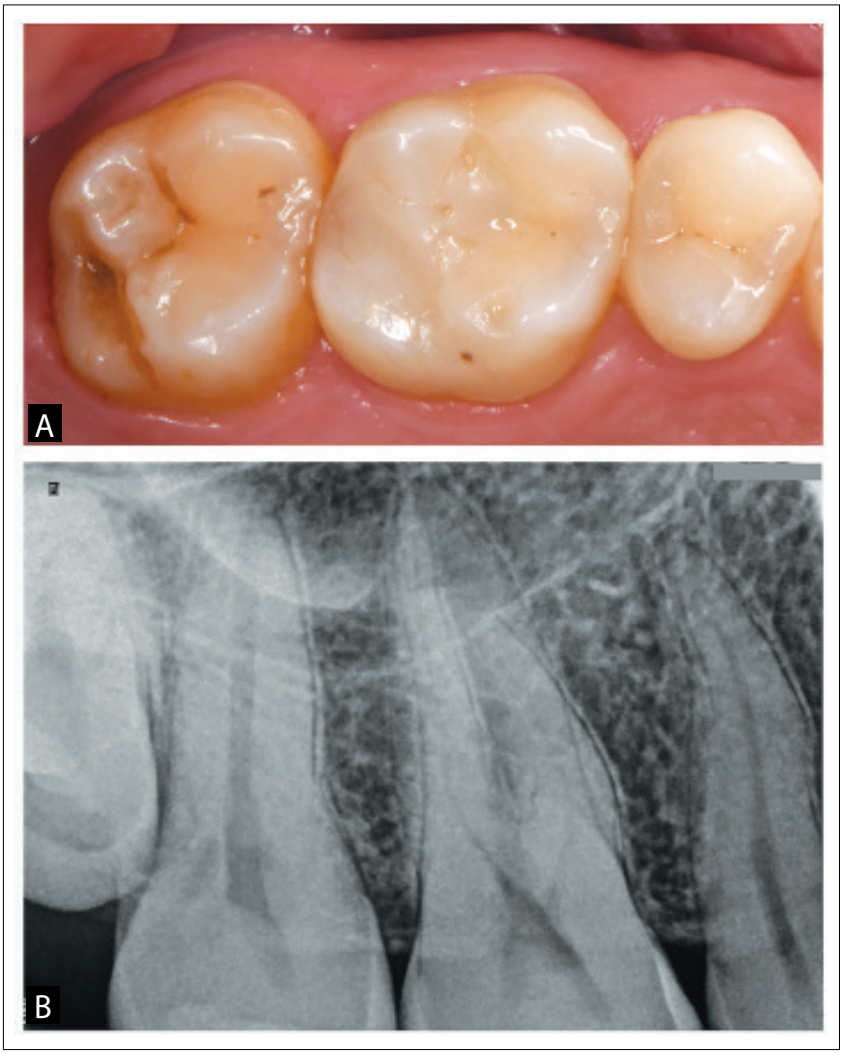


Figure 1
Clinical and radiographic situation at baseline: **A)** Occlusal view of teeth 1.5, 1.6 and 1.7; **B)** Periapical radiograph shows a radiotransparent area located on the distal side of element 1.7, with margins close to the pulp tissue.

The main objectives of ECR treatment are the excavation of the resorptive tissue and the restoration of the defect by using biocompatible materials (21). Tooth restorability and the accessibility and severity of the defect are among the main factors which direct the therapeutic choice. Different approaches have been reported in literature regarding the management of ECR (22, 23); the necessity to perform endodontic treatment as part of the resorption management procedures is established on the presence or absence of referred symptoms due to the involvement of pulp tissue in ECR defect.
In those cases of non-clinically accessible lesions, intentional replantation represents a valid therapeutic approach. It was originally described as the deliberate extraction of a tooth, followed by root surface evaluation, endodontic treatment and the reposition of the tooth in its socket (24). The technique is mainly indicated for single-rooted teeth, as the anatomical root conformation is more favourable for avulsion than that of multi-rooted teeth, thus resulting in easier procedure and minor damages to the root surface or risk of vertical fractures (23). The advantage of the procedure is that the entire coronal and radicular surfaces can be directly inspected and manipulated even in those areas where a conventional clinical approach is not achievable. The utmost attention must be paid during avulsion procedure to avoid mechanical damages to both periodontal ligament (PDL) cells and root surface. For that purpose, the use of elevators is not strictly recommended - or otherwise limited to gentle pressure gestures. To avoid excessive damage to gingival fibers during avulsion, it is suggested to place a sterile gauze on the tooth under the beaks of the forceps (25).
It is essential that the debridement of the defect is performed with the aid of a dental operating microscope (22), to both ensure more precision and a conservative approach; the meticulous removal of the entire resorptive tissue is essential to reduce the risk of recurrence.
In literature, favourable long-term outcomes are associated with the procedure (26,27), demonstrating that intentional replantation should be considered as a valid and cost-effective treatment when the conventional clinical approaches are not feasible (28).
Basing on these favorable findings, the aim of the authors is to present the report of the multidisciplinary endodontic-surgical approach carried out to manage an extensive ECR in an upper right second molar with aberrant anatomy.

Report

A Caucasian 27-year-old male patient referred to our private practice (Brescia, Lombardy, Italy) complaining occasional chewing pain started about one year before. The patient referred the symptoms in the molar region of the upper right maxilla, but he was not able to exactly indicate the tooth involved. The patient's medical and dental history were not relevant. Nevertheless, at the clinical interview the patient referred a severe motorcycle accident approximately ten years before, in which reported the fracture of the right cheekbone, fixed surgically. A visible scar was detected on the soft tissues in correspondence of tooth 1.7.

Figure 2
Cone Beam Computed Tomography has been performed to accurately define both location and extension of the defect: **A)** Sagittal view confirms the presence of an extensive resorption area on the distal side of tooth 1.7; **B)** Axial view indicates the close relationship between the pulp tissue and the resorption area.

At clinical evaluation, both teeth 1.5 and 1.6 normally responded to vertical percussion and thermal pulp tests; on the contrary, tooth number 1.7 resulted to be positive for vertical percussion test. Periapical radiograph showed a suspect radiotransparent area located on the distal side of element 1.7, with margins closely adjacent to the pulp chamber (Figure 1).
To accurately define the nature of the symptoms and to determine a specific diagnosis, CBCT scan (CS 8100, CareStream, Rochester, New York) has been performed through the signature of an informed consent. On both sagittal and horizontal planes, an extended resorption area was detected, and pulp tissue involvement was evidenced. The CBCT sections in which the mentioned findings are appreciable are reported in Figure 2.
Basing on symptoms, clinical inspection and x-ray analysis, it was established a diagnosis of external cervical root resorption affecting tooth 1.7. The defect was classified as class 3Bp of Patel's three-dimensional classification for external cervical resorptions (15).
In the specific case, the patient has been advised about his treatment options, including the extraction of both elements 1.7 and 1.8 followed by the autotransplantation of 1.8 in post extractive 1.7 socket, or the intraoral root canal treatment (RCT) of element 1.7 followed by atraumatic extraction, extra-alveolar management of ECR defect, and intentional replantation.
The patient has been informed on risks and benefits of each option, and the two alternatives have been analyzed and discussed. After talks, he opted for the RCT and intentional replantation procedure. A written informed consent was read, accepted and signed by the patient prior to starting the clinical phase.
Both intraoral and extraoral procedures have been carried out with the aid of a dental operating microscope (DOM) (Leica M320, Leica Microsystems, Schweiz, Switzerland). As widely referred in Literature, the use of DOM allows dental practitioners to perform treatments in conditions of higher quality and under increased safety conditions (29).
Before starting the root canal treatment, the tooth 1.7 was anesthetized with 1.8 mL 4% articain containing 1: 100.000 adrenalin. The endodontic access was firstly obtained by using a small round diamond bur; then, a truncated-cone diamond bur has been employed to define the cavity. Ultrasonic Start-X tip 1 (Dentsply Maillefer, Ballaigues, Switzerland) has been used to refine the access. Once obtained a straight access to the endodontic system, a single, buccolingually extended, root canal orifice was detected, validating what observed in the pre-operative CBCT during treatment planification (Figure 3).
At this moment, rubber dam isolation has been performed. Working length (WL) and apical patency were established using an electronic apex locator (Morita Denta Port ZX, Morita, Osaka, Japan). Root canal shaping was carried out by using Mtwo rotary nickel-titanium instruments (VDW, Munich, Germany) until the apical size of 60/.04. Between the use of a rotary instrument and the successive, the root canal has been irrigated with 5.25% sodium hypochlorite (NaClO) by using a polymeric needle (IrriFlex®, Produits Dentaires SA, Vevey, Switzerland) coupled to a 5 ml syringe. Gentle up and down movements have been made during this phase, inserting the needle until a maximum distance of 2 mm from WL, and extruding NaClO drop by drop. Once established the definitive apical size, passive ultrasonic irrigation was performed with the aid of an ultrasonic activator (Endo Cleaner, Dentalica, Milan, Italy), alternating 5.25% NaClO and 17% ethylenediaminetetraacetic acid (EDTA) solution. In particular, both the irrigants have been extruded for one minute and then ultrasonically activated for 30 seconds. Then, the root canal has been rinsed with 5 ml of sterile saline and then dried with the aid of sterile paper points, remaining a little moisture to promote the properties of the calcium-silicate based sealer. The obturation was carried out by using a single gutta-percha

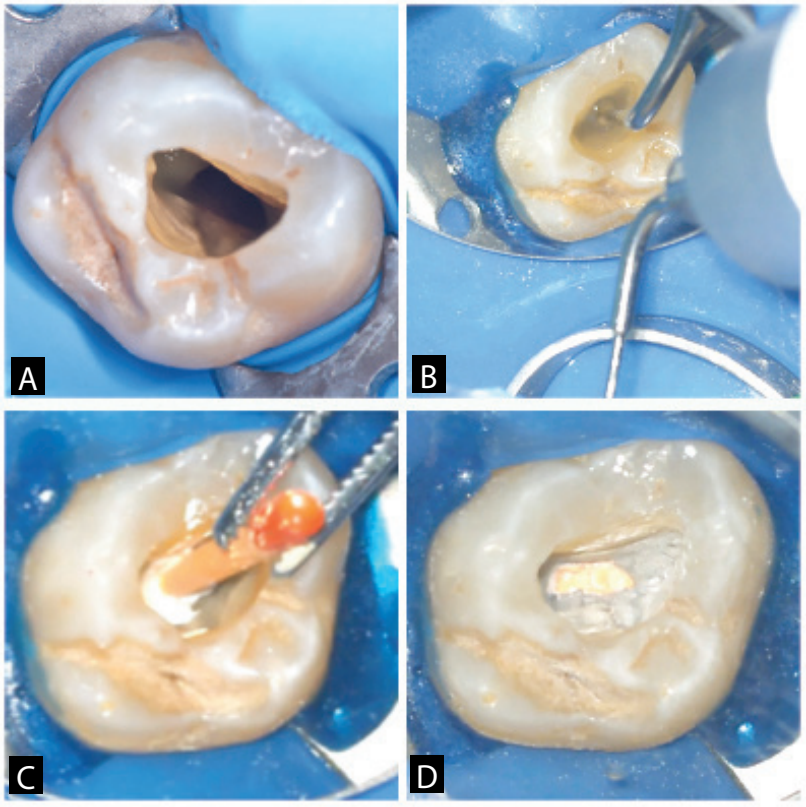


Figure 3
A) Access cavity and pulp chamber floor. The magnification obtained under dental operating microscope (Leica M320, Leica Microsystems, Schweiz, Switzerland) clearly shows a single, buccolingually extended, root canal orifice. **B)** Irrigants have been always ultrasonically activated during endodontic therapy by using a dedicated activator (Endo Cleaner, Dentalica, Milan, Italy). **C)** Root canal obturation has been performed by using a single gutta-percha cone and a bioceramic sealer (EndoSequence BC Sealer, Brasseler, Savannah, USA). **D)** Pulp chamber after obturation and debris removal.

cone in addition to bioceramic sealer (EndoSequence BC Sealer, Brasseler, Savannah, USA) (Figure 3). Once debris were removed from cavity, the tooth has been restored by light-curing composite resin (Filtek Supreme XTE, 3M ESPE, St. Paul, MN, USA).

The surgical phase of the treatment was entirely performed by using forceps, engaging the tooth exclusively on the crown and giving attention to perform the extraction as atraumatic as possible to both preserve alveolar bone integrity and reduce PDL cells trauma. After being extracted, the tooth was handheld by the crown by sterile gauze and sterile gloves, and the root was constantly irrigated with sterile saline to preserve surface hydration.

The extra-alveolar therapy has been entirely carried out with the aid of the DOM, and mainly consisted in the detersion of the resorption area and its restoration. The first phase has been performed by using a little round diamond bur until surrounding healthy tissue was reached; in the second phase, the resorption was filled with a light-curing, self-etching and self-adhesive hybrid composite material (Surefil one, Dentsply Sirona, Charlotte, NC, USA). The whole extraoral procedures lasted less than 15 minutes, as strongly recommended in Literature (23, 30). The quality of the apical sealing obtained by the previous RCT has been directly evaluated by DOM and was considered to be adequate.

To prevent the contamination of the site during the extra-alveolar procedures, blood-filled post-extractive socket has been preserved placing a sterile gauze.

The tooth was then re-implanted into the socket with forceps and properly repositioned by finger pressure, exerted both on the occlusal surface and then to the buccal and lingual bone plates together. To ensure stability, the elements 1.6 and 1.7 were splinted both buccally and palatally with a resin-coated metallic splint. Tooth 1.7 was then removed from occlusion to prevent occlusal forces to stress the element during the healing phase. Splint has been removed 14 days after the treatment, as recommended in the 2020 International Association of Dental Traumatology (IADT) guidelines for replanted teeth (31). Soft and hard tissues were correctly healing, and the patient referred a total absence of symptoms (Figure 4).

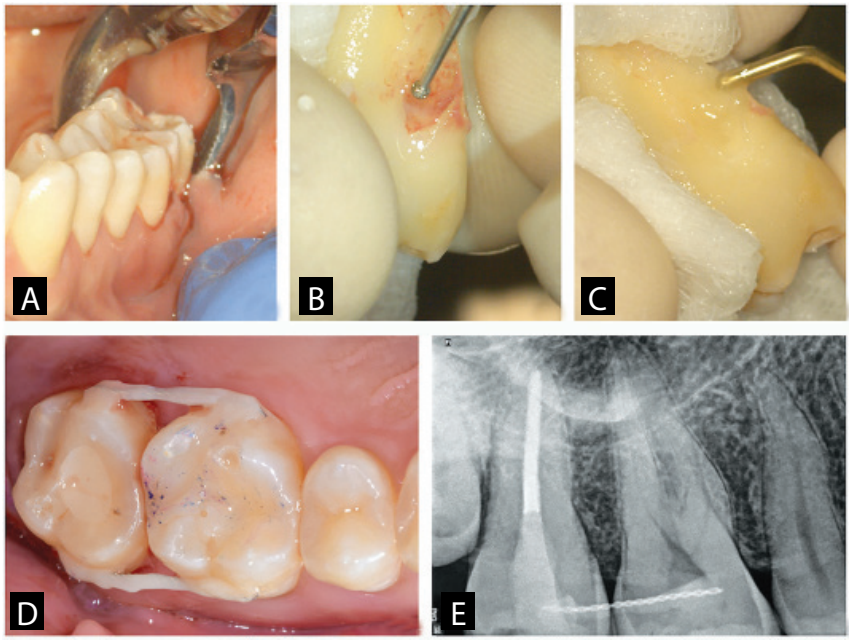
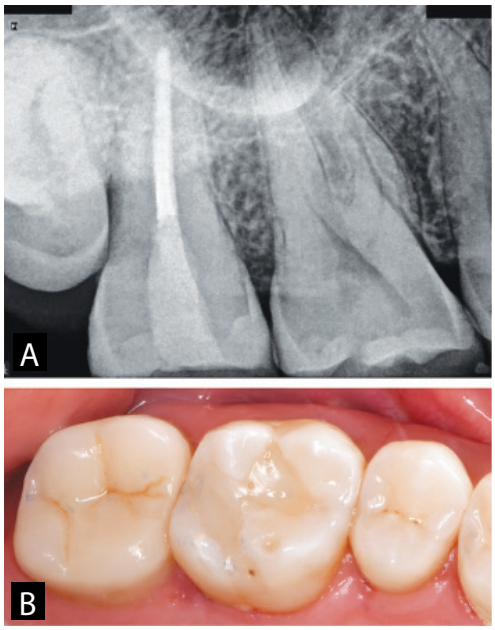


Figure 4
A) The avulsion of tooth 1.7 has been entirely performed by forceps and gentle, atraumatic movements. **B)** The tooth was handheld by sterile gloves and sterile gauze and constantly irrigated with sterile saline. The resorptive tissue has been removed by a small, round diamond bur under dental operating microscope (DOM) magnification. **C)** The defect has been restored under DOM magnification by using a self-etching and self-adhesive hybrid composite material (Surefil one, Dentsply Sirona, Charlotte, NC, USA). **D)** Intraoral photo taken after reimplantation shows teeth 1.6 and 1.7 splinted together by a double, resin-coated metallic splint. **E)** Post-operative periapical radiograph shows the excellent fit of element 1.7 in its alveolus after reimplantation, and the adequate restoration of the resorptive defect.

Figure 5
A) The periapical radiograph taken 3 months after does not reveal any complication during the healing process; **B)** Basing on the favourable outcomes, the tooth 1.7 has been restored through a conservative composite overlay to re-establish an adequate masticatory function.



During the 3-months-recall, a periapical radiograph has been taken, and a clinical evaluation has been carried out. No symptoms have been referred from the patient, and no clinical signs of recurrence were detected. Tooth mobility, percussion sounds, and periodontal probing depth were all within normal ranges. In accordance with the patient, to re-establish an adequate masticatory function, the element has been coronally restored through a conservative composite overlay (Figure 5).

In Figure 6 are reported the periapical radiographs acquired respectively at 6, 12 and 18 months from clinical procedures. No signs of periapical lesion are detectable, and a good periodontal condition has been clinically observed. Tooth 1.7 was not tender to palpation or percussion, and no associated symptoms were referred. Furthermore, no metallic percussion sound – frequently indicative of ankylosis - has been recorded.

Discussion

The present case report describes the clinical approach carried out to save a maxillary right second molar affected by ECR, and the relative 18-months follow-up outcomes.
Maxillary second molars, as reported in Patel et al. (8), present a low percentage of appearance of ECR, especially if compared with other teeth as maxillary central incisor or maxillary canine. In the present report, ECR diagnosis was established for the maxillary right second molar; interestingly, the element showed an aberrant root and endodontic anatomy, as one single root and one single root canal have been detected. Single-root and single-canal maxillary second molars are quite rare; the most recent CBCT studies available in literature about the incidence of such aberrant root and endodontic anatomy have been mainly conducted on different Asian populations, providing heterogeneous outcomes

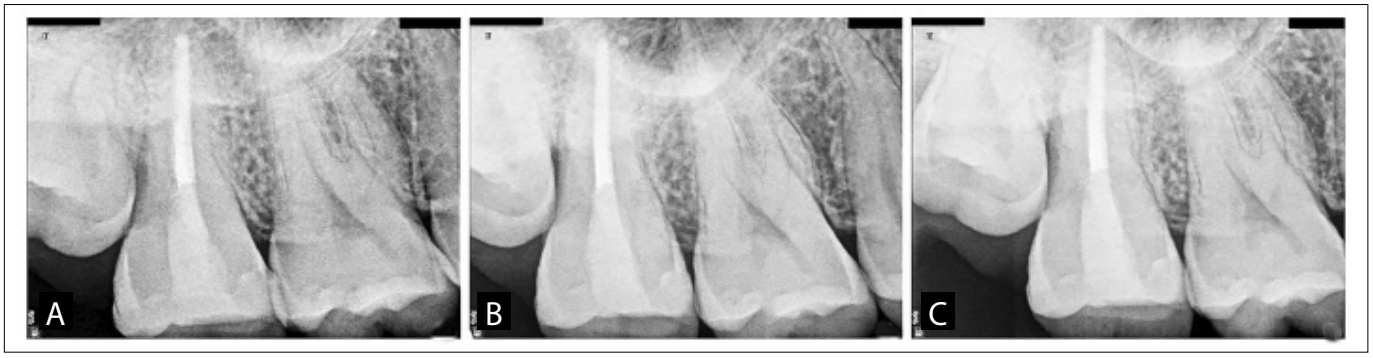


Figure 6
Follow-up visits confirm the successful outcomes of the treatment up to 18 months, as no symptoms have been referred and no clinical/ radiographic signs of recurrence or ankylosis have been found: **A)** 6 months, **B)** 12 months, **C)** 18 months.

(32-34). No studies about the incidence of that aberrant anatomy in the European population has been currently detected in literature.
In those cases of aberrant anatomy, iatrogenic errors when searching for missing canals should be avoided by a meticulous diagnosis and with the support of pre-operative CBCT and the use of DOM during RCT (35).
As reported in the previous section, the tooth was involved ten years before in a severe motorcycle accident, in which the patient reported right cheekbone fracture. As traumatic episodes are referred in Literature as major predisposing factors for ECR appearance (36), a possible cause-effect relationship should not be excluded in the present clinical case. In addition, considering the results of a recent meta-analysis in which emerged the influence of impacted third molars as a strong risk factor for second molars external root resorption (37), and the anatomical relationship existing in the present report between teeth 1.7 and 1.8, a possible correlation cannot be ignored. The complexity in determining the exact cause of the resorption confirms its multifactorial nature and thus the necessity to further investigate about the aetiological and pathogenic aspects underlying ECR.
Different therapeutic options such as defect restoration - when clinically accessible-, surgical extrusion, intentional replantation or autotransplantation are available for the treatment of ECR defects. Among them, intentional replantation is one of the last treatment options to save teeth involved in ECR. Torabinejad et al. found a mean survival rate close to 90% for root canal-treated and intentionally replanted teeth, with a mean prevalence of resorption lower than 11% (38). Further, although the different radicular and endodontic anatomy, a recent systematic review reported a survival rate of 88.64% for reimplanted single-rooted teeth, and of 85.57% for pluriradicular teeth; the reported overall survival rate for intentional replantation procedure is around 86,7%. No statistically significant differences have been reported from authors in terms of survival rates between single- and multi-rooted teeth (39). Concerning endodontically treated teeth with existing periapical pathosis, the mean survival rate recently reported by Javed et al. is around 85.9% (40); the authors also reported that factors such as an extra-alveolar therapy time shorter than 15 minutes, manipulation of the element exclusively by the crown and appropriate storage media seems to crucially influence the successful outcome of the therapy. The avulsion is probably the most crucial phase of the entire therapy, as gentle and fine movements are essential to both reduce damages to PDL cells and to prevent the risk of root fracture, which is reported as one of the major risk factors for that approach, especially when in presence of an extended resorption area (41).
When a tooth affected by ECR appears to be restorable following clinical and conventional radiographic examination, CBCT scan represents an essential supportive tool. Different studies have proven the superiority of CBCT rather than periapical radiographs in providing accurate information regarding size, location and circumferential spread of defects (13, 21). Moreover, CBCT imaging allows to better identify even the incipient lesions if compared to periapical radiographs (42), other than missed canals, vertical root fractures and complex anatomy (43). Concerning root resorptions, Dao et al. (44) recently found a high rate of incidental findings of resorption areas detected by CBCT scan of patients referred for a variety of indications, suggesting that conventional radiography is not

equally effective and therefore the defect is often underdiagnosed. As mentioned, it is essential that CBCT exams are justified over conventional techniques prior to being performed; ALADA principle must be applied (45), and the benefits of the three-dimensional examination must always overweight the risks (46).
Different materials such as glass-ionomer cements, fast-setting calcium silicate materials and composite resin have been proposed for the restoration of the resorption area; their application mainly depends on extension, morphology and location of the defect (18). As indicated by Plotino et al. (23), when composite resin is chosen, it is crucial to prevent damages to PDL cells, thus avoiding that both etchant gel and adhesive come in contact with the root surface, other than the risk of heat-induced damages during composite polymerization.
Basing on the previous considerations, in the present clinical case the entire treatment has been carried out under DOM magnification, to both ensure more precision during RCT and resorption management, and a greater visibility of the area to the operator. Patel et al. (22) reported that magnification and illumination are essential requirements to correctly distinguish between sound dentin and fibro-osseous deposit tissue.
As recommended in literature, a reduced extra-alveolar time is crucial for the positive outcome of the treatment (27, 30, 40). In the present case report, as clinical conditions were favourable due to the aberrant endodontic anatomy, the extra-alveolar time has been reduced performing the endodontic treatment intraorally, relying on the extraoral phase the only management and reconstruction of the defect. Moreover, to prevent the forementioned risk due to the use of both etchant and adhesive, a self-etching and self-adhesive hybrid composite resin has been employed for the restoration of the resorption, providing all the benefits of a reduced number of steps and a decreased probability of PDL damages.
Clinical signs of ankylosis such as metallic percussion sounds are generally detectable within 4-8 weeks after clinical intervention, although late complications should not be excluded (27). Currently, none of those signs has been detected in the present 18-months follow-up, supporting the favourable outcome of the treatment.

Conclusions

As the clinical diagnosis is still unpredictable, ECR represents a clinical challenge in modern Endodontics. Moreover, when resorption fronts develop in non-clinically accessible areas, the increased complexity of the treatment requires operative strategies different from the conventional clinical approaches. Among them, intentional replantation is well supported by literature and clinical results, and thus should be considered as an affordable treatment option for the management of deep root resorptive defects, and not merely an unpredictable approach for hopeless teeth. The objective of intentional replantation is the preservation of the dental element, avoiding – or reasonably delaying - the insertion of a dental titanium implant. As widely stressed, CBCT scan and dental operating microscope represents crucial tools to achieve respectively a specific and detailed diagnosis and a high quality of the treatment.
Basing on the mentioned favourable findings, the current observation period is considered by the authors to be long enough to indicate the successful outcomes of the multidisciplinary approach proposed in the present case report.

Clinical Relevance

Clinical and radiographic results obtained up to an 18-months follow-up indicates the proposed multidisciplinary approach as a viable treatment option to manage complex cases of non-clinically accessible ECR, thus allowing the preservation of the involved tooth in the oral cavity.

Conflict of Interest

The authors declare that no conflict of interest exist.

Acknowledgement

The authors deny any financial affiliation.

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