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CASE SERIES

Intentional replantation of severely compromised teeth

ABSTRACT

Aim: *The present case series aims to show the applicability of intentional replantation to successfully solved cases with root perforations, external cervical resorption, and chronic pain due to material extrusion to the periapical tissues.*

Summary: *After medical and dental history review, the signs, symptoms and imaging examinations were analysed in order to perform a correct diagnosis. All cases had indication for intentional replantation procedures which were addressed according to the best practices. The teeth were extracted in the most atraumatic way possible while avoiding the handling interaction with the periodontal ligament. Hard tissues repair was conducted by using ultrasonic tips and mineral trioxide aggregate (MTA) application before getting the teeth positioned back in their original socket. Extra-oral time was less than 15 minutes and the operating microscope was used in all cases. After a period of two years all teeth were asymptomatic and functional.*

Key learning points

- *Root perforations, external cervical resorption, and chronic pain due to material extrusion may be solved using intentional replantation techniques*
- *Reduced extra-oral time and careful periodontal ligament handling is mandatory*
- *Intentional replantation techniques appears to be a reliable clinical procedure*

Beatriz Pereira[1]
Mariana Domingos Pires[1]
Abayomi O. Baruwa[1]
Jorge N.R. Martins[1,2]
António Ginjeira[1,2]

[1]*Department of Endodontics, Faculty of Medicina Dentária, University of Lisbon, Lisbon, Portugal*

[2]*Unity of Investigation of Oral and Biomedical Science (UICOB). Faculty of Medicina Dentária, University of Lisbon, Lisbon, Portugal*

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Corresponding Author
Abayomi O. Baruwa | Department of Endodontics, Faculty of Medicina Dentária, University of Lisbon, 1600-227 Lisbon | Portugal
Tel: (+351) 918799418 | E-mail: baruwaabayomi@gmail.com

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Introduction

Obtaining proper root canal disinfection, preventing re-infection, achieving a healthy periapical tissue, and keeping a tooth in function, thus contributing to its longevity, are among the objectives of a root canal treatment. However, when the treatment is performed according to a high standard of care and there is still persistence of symptoms and apical pathology, derived by either persistent bacteria, extrusion of endodontic sealer (1) or even by the presence of a root perforation, the root canal treatment should be re-evaluated and alternative treatments considered.

When initial root canal treatment fails, root canal retreatment and endodontic microsurgery are the subsequent treatment options to be considered (2). Root canal retreatments have been reported to present an overall success rate of approximately 78% (3, 4) while for the surgical option it may be as high as 95% (5). Nonetheless, when a root canal retreatment cannot be performed, for instances due to tooth inner anatomical complexity leading to inherent limitations of chemomechanical preparations (6), or when endodontic microsurgery is contraindicated, for instances due to proximity to anatomic landmarks such as the mental foramen, mandibular canal or thick mandibular bone, the intentional replantation may be considered (7).

Originally described by Grossman (8), intentional replantation consists of the deliberate extraction of a tooth in order to directly evaluate the root surfaces, conduct an endodontic manipulation and repair of the problematic area and placement of the tooth back into its original socket. This procedure has a reported survival rate of approximately 89% (2) and can be applied for treatment of vertical root and crown-root fractures, external root resorptions, persistent chronic pain, or previous failure of root canal retreatment and endodontic microsurgery (2, 9, 10). Yet, intentional replantation should not be considered an option when there is periodontal and furcation involvement, an extensive carious lesion, very long and curved roots, or in case of septal bone loss (8, 9).

Despite the growing reports of favourable outcomes (2), intentional replantation as a treatment option is not widespread in the clinical community (11). Thus, the objective of this case series is to illustrate the intentional replantation technique by presenting four surgical cases in which this modality was successfully chosen to treat previous root canal treatment failures.

Report

General clinical procedures

All patients were referred for an endodontic appointment and had their medical histories reviewed and considered as non-contributory. Signs and symptoms were analysed, and complementary imaging examinations requested. Periodontal pockets and tooth mobility were considered within normal limits in all cases. Periapical radiolucencies were detected with periapical radiographs and confirmed through cone-beam computed tomography (CBCT), which was used to establish a proper treatment plan. Pulpal and periapical diagnosis was made based on clinical findings, pulp tests and imaging analysis. Once verified the inaccessibility to perform endodontic microsurgery, intentional replantation was recommended and accepted as the treatment option by all patients, who signed informed consents.

All cases were performed by the same clinician (AG) under a dental operating microscope (M320, Leica Microsystems, Wetzlar, Germany) with an effort of preserving the viability and integrity of the periodontal ligament (PDL) by reducing the extra-oral time to the minimum and never exceeding 15 minutes. After proper local anesthesia with articaine (Artinibsa, Inibsa, Barcelona, Spain), teeth extractions were done in the most atraumatic way possible with nº 150 universal apical extraction forceps, and never interacting with the PDL. The perforation repair cases were performed using a microsurgical ultrasonic tip KiS nº 1 (Obtura-Spartan, Algonquin, USA) with water irrigation to clean and

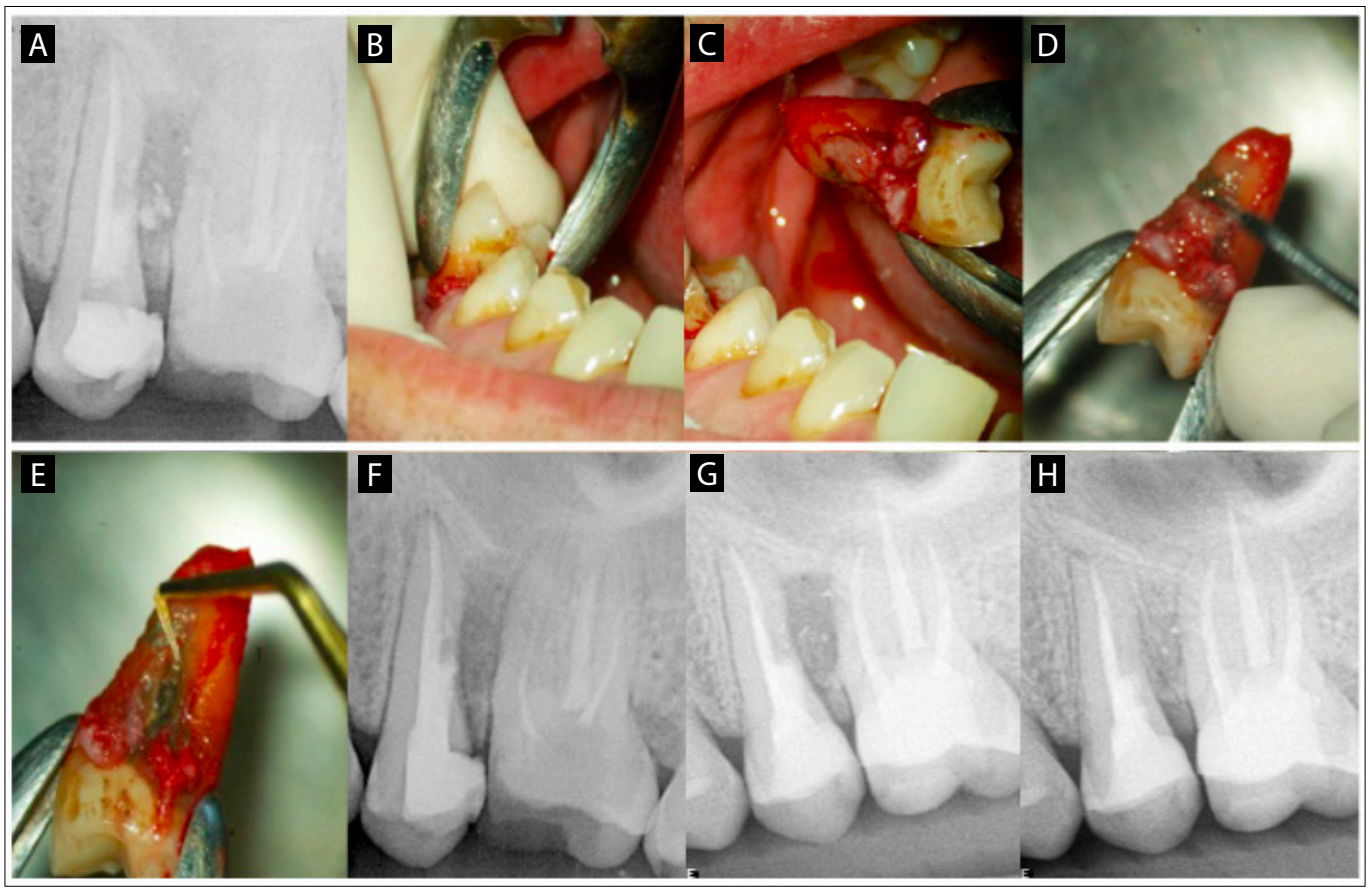

Figure 1
Representative images of the surgical procedure conducted on tooth 25 presenting a preoperative root perforation: **A)** initial radiograph; **B)** photograph of atraumatic tooth extraction; **C)** photograph of granulation tissue on the perforation site; **D**) clinical photograph of the granulation tissue removal; **E)** photograph of ultrasonic preparation of perforation before sealing with Grey MTA; **F)** post-operative radiograph; **G)** 9 months follow-up radiograph; **H)** 3-year follow-up radiograph.

prepare for mineral trioxide aggregate (MTA) placement. As for the other case, after extraction, a 3 mm root end resection was performed under water irrigation, followed by the root end preparation with a microsurgical ultrasonic tip KiS nº 1 (Obtura-Spartan, Algonquin, USA) with water irrigation and subsequent retro-fill with MTA. After teeth reposition in the sockets, sutures were performed and post-surgical instructions were given. Sutures were removed a week later and the follow-up appointments showed an improvement of the clinical condition of all cases without any sign of structural failure.

Case 1
A 37-year-old male patient was referred for a disto-palatal root perforation repair on the maxillary left second premolar (tooth 25) (Figure 1A). The dental history revealed a failed attempt to repair it during a previous root canal treatment. The patient was asymptomatic and the clinical diagnosis was previous endodontically treated tooth with a large persistent radiolucency, corresponding to asymptomatic apical periodontitis. The intentional replantation was performed to access and repair the disto-palatal perforation using grey MTA (Grey ProRoot MTA, Dentsply Tulsa Dental, USA) (Figures 1B to 1F). At 9 months (Figure 1G), and 3 years follow-up appointments (Figure 1H), the tooth was functional, asymptomatic and showing signs of radiolucency healing. The patient skipped the 5 years recall, however mentioning that the tooth was still asymptomatic and functional.

Case 2
A 55-year-old female patient with a diagnosis of pulp necrosis and asymptomatic apical periodontitis on the maxillary left first molar (tooth 26) was referred for root canal treatment, which was accomplished at that time (Figures 2A and 2B). The pa-

tient returned 5 years later with a post and crown and complaining of a palatal swelling (Figure 2C). The CBCT analysis revealed a perforation on the distal aspect of the palatal root, which was inaccessible by conventional endodontic microsurgery due to the position of the disto-buccal root (Figures 2D to 2F). Intentional replantation was advised and performed (Figures 2G to 2I). The perforation sealing and retro-obturation was performed with white ProRoot MTA (White ProRoot MTA, Dentsply Tulsa Dental, USA) (Figure 2L). Six months later, the patient was recalled for control (Figure 2M) and the tooth was asymptomatic and functional. The 2 years radiographic follow up revealed complete bone healing (Figure 2N).

Case 3

A 44-year-old male patient was referred for an endodontic appointment with a previous endodontic treatment and symptomatic apical periodontitis on the maxillary left central incisor (tooth 21) (Figure 3A). The tooth had a cast post and a ceram-

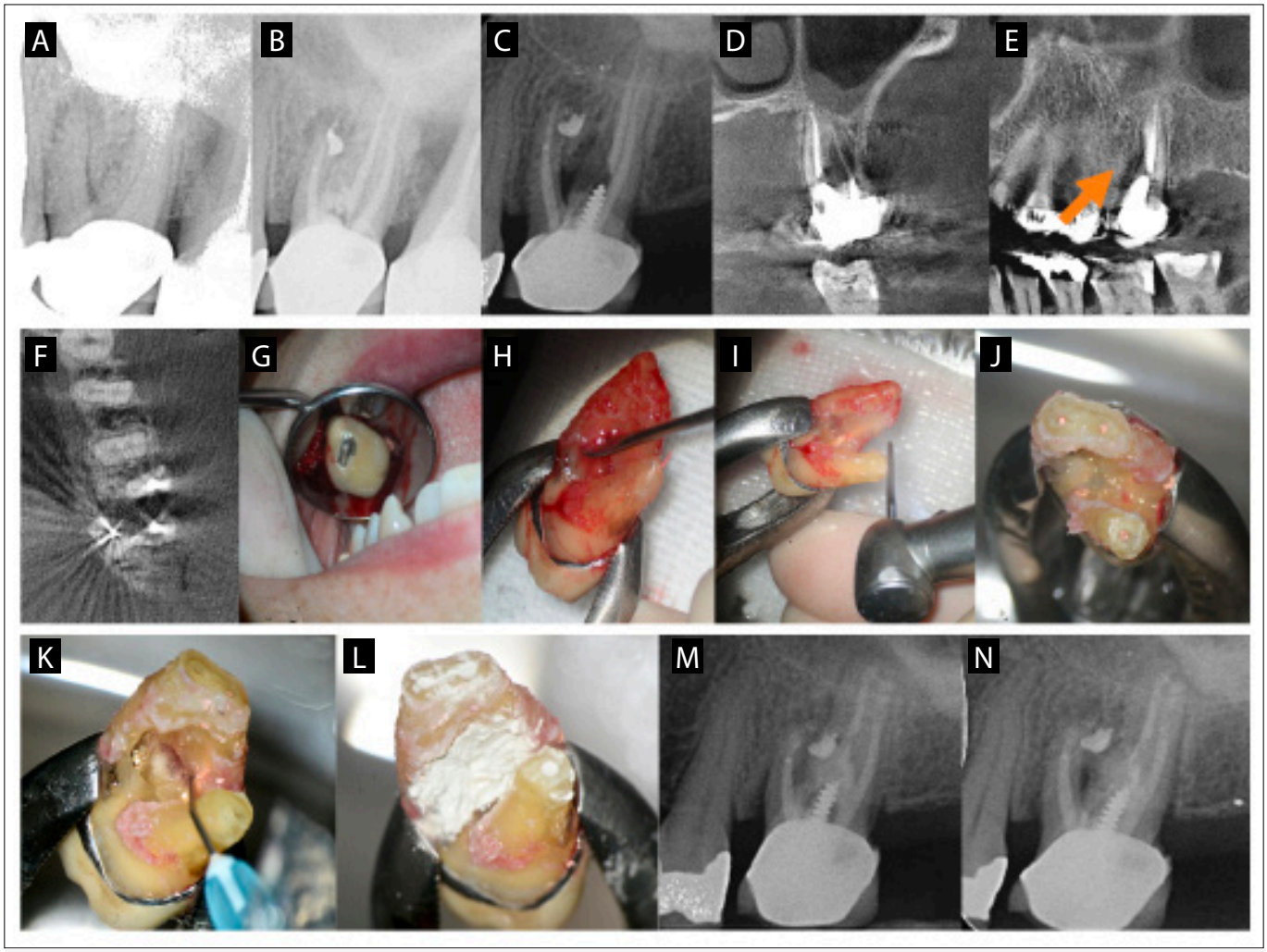

Figure 2
Documentation of the intentional replantation conducted on tooth 26 presenting a root perforation: **A)** initial radiograph; **B)** endodontic treatment final radiograph; **C)** 5 years post endodontic treatment radiograph showing root perforation; **D)** pre-operative CBCT frontal view; **E)** pre-operative CBCT sagittal view with an orange arrow pointing towards the perforation site; **F)** pre-operative CBCT axial view; **G)** photograph before atraumatic extraction; **H)** photograph of granulation tissue removal; **I)** clinical photograph of root resection; **J)** examination after root resection; **K)** photograph of the perforation handling; **L)** photograph of the MTA obturation and sealing of the perforation; **M)** 6 months follow up radiograph; **N)** 2 years follow up radiograph.

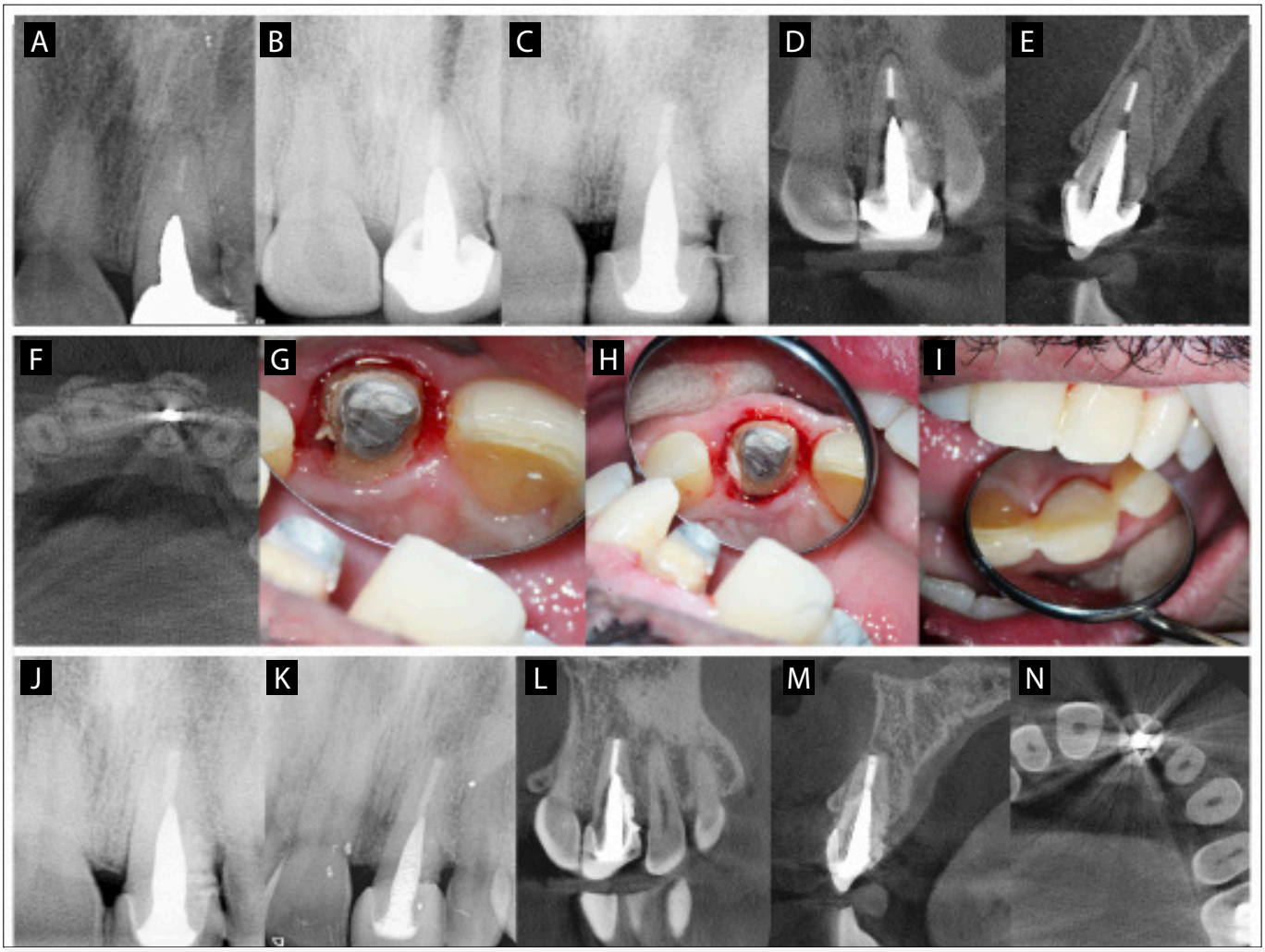

Figure 3
Clinical procedures of the surgical treatment of tooth 21: **A)** initial radiograph; **B)** post-operative radiograph of the microsurgical endodontic procedure which included root apicectomy; **C)** 4 months post-operative radiograph of the first surgical procedure; **D)** pre-operative CBCT frontal view; **E)** pre-operative CBCT sagittal view; **3F)** pre-operative CBCT axial view; **G)** clinical photograph exhibiting resorption site; **H)** post intentional replantation photograph of the resorption treated and sealed with MTA; **I)** photograph of tooth splinting; **J)** 8 months follow up radiograph; **K)** 2 years follow up radiograph; **L)** 2 years follow up CBCT frontal view; **M)** 2 years follow up CBCT sagittal view; **N)** 2 years follow up CBCT axial view.

ic crown. The initial treatment plan involved the orthograde root canal retreatment, however it was not possible to remove the cast post, so endodontic microsurgery was proposed and accepted (Figure 3B to 3F). Four months later, a disto-palatal cervical invasive root resorption was diagnosed (Figures 3G), and the intentional replantation proposed. A 90% aqueous trichloroacetic acid was applied as per guidelines (12), and the sealing was done with white ProRoot MTA (White ProRoot MTA, Dentsply Tulsa Dental, USA) (Figure 3H). The tooth was then splinted with flowable composite (Tetric EvoFlow, Ivoclar Vivadent, Schaan, Liechtenstein) (Figure 3I). The patient returned after 8 months for a follow-up and had the tooth asymptomatic and functional (Figure 3J). Complete bone healing was observed in the 2 years recall (Figures 3K to 3N).

Case 4

A 37-year-old female patient presented with pain on the maxillary left second molar (tooth 27). The diagnosis of the in-

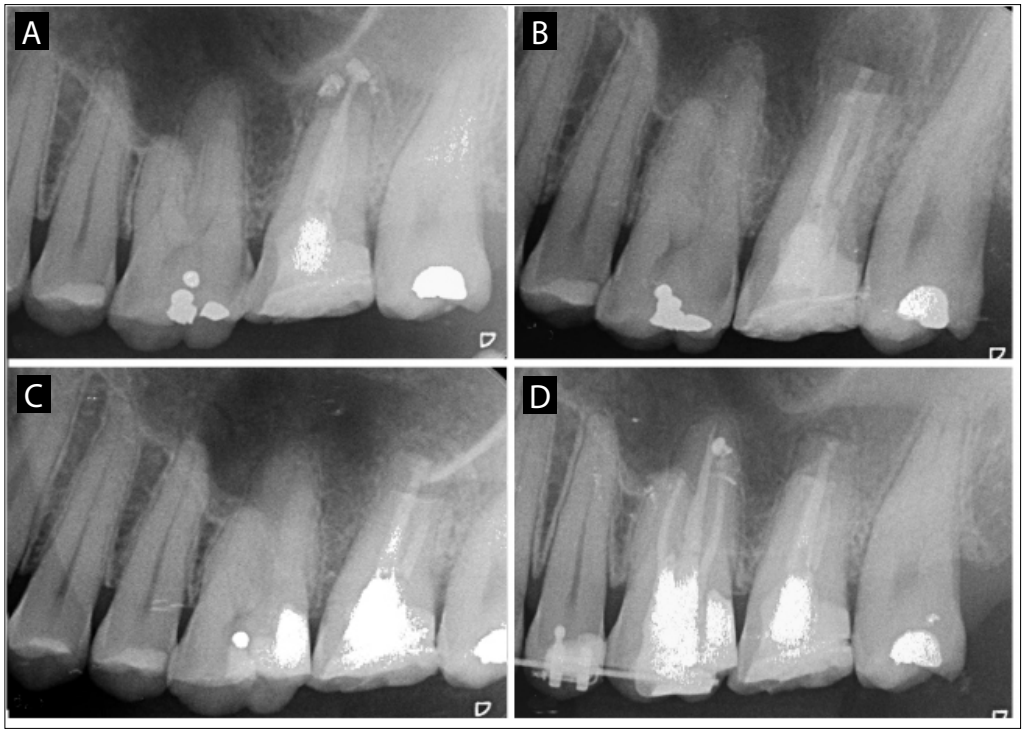

Figure 4
Representative radiographs of the clinical case of tooth 27: **A)** initial radiograph exhibiting large sealer extrusion; **B)** Post intentional replantation radiograph; **C)** 3 months follow up radiograph; **D)** 2 years follow up radiograph.

volved tooth was previous root canal treatment with symptomatic apical periodontitis. The previous root canal therapy had been concluded a few weeks before and the access cavity was still restored with a provisional restoration (Figure 4A). Since the previous root canal obturation resulted in a heavy extrusion of endodontic sealer to the periapical tissues, intentional replantation was proposed and performed (Figure 4B). White ProRoot MTA (White ProRoot MTA, Dentsply Tulsa Dental, USA) was used as a retro-filling material. The patient returned 3 months later for a follow-up appointment which revealed an asymptomatic and functional tooth (Figure 4C). The same outcome was observed at the two years recall (Figure 4D).

Discussion

As life expectancy of the population is increasing globally (13), all viable treatment options should be considered to prolong the survival of the natural dentition (14). Intentional replantation has often been regarded as an unreliable procedure in endodontics (15) and overlooked as a viable treatment option, especially given the high survival rate of tooth implants (2).

As a treatment performed since the 18th century (10, 16), the intentional replantation procedure and its indications have changed over time (17). Recent literature presenting treatment protocols based on the understanding of root resorption and splinting protocols have proven this procedure to be more predictable than previously considered and a viable treatment option to be considered in specific cases (7, 10, 11, 14). With modern treatment protocols using updated equipment, instruments and materials, this surgical procedure has been shown to have a success rate ranging from 72% to 94% (2, 17), similar to that of unitary implant rehabilitation.

Intentional replantation treatment protocols advocate a minimally traumatic extraction (18, 19) and an extra oral dry time shorter than 15 minutes (7, 11, 14, 19, 20, 21). These are considered key prognostic factors for the treatment success as the preservation of viable cementum and periodontal fibers is of the utmost importance to reduce the likelihood of external replacement resorption (10). Also, the tooth

type (19), apical anatomy (22), root surface hydration (11, 22), illumination and magnification (10, 22) and meticulous instrumentation are important factors that weigh in the success of the treatment (22).
When the extra oral dry time exceeds 15 minutes, previous literature shows that the risk of complications is 1.7 times higher when compared to shorter periods which are associated with a higher survival rate and fewer complications (2, 11). A systematic review by Mainkar in 2017 compared the survival of intentionally replanted teeth with single-tooth implants stated the risks of external replacement resorption (ranging from 0% to 7%) or external root resorption (from 3 to 5%) were lower when extra oral dry time was kept to a minimum (2). Additionally, since these complications occur mostly in the first year after treatment (11, 14), it is prudent to perform regular follow-ups during this time frame, in accordance with European Society of Endodontology guidelines (23).
In presented cases 2 and 3, which were related with root canal perforations in the distal aspect of teeth 21 and 26, a CBCT scan was made to localize the exact perforation site and plan for appropriate treatment.
CBCT imaging overcomes several limitations of conventional radiographs such as the anatomical noise, radiographic two-dimensional nature, or geometric distortion that may impede the correct detection of periapical lesions in cancellous bone (24). In endodontics, a CBCT small field of view examination can be considered if the additional information obtained aids in the diagnosis and treatment planning and ultimately enhances the prognosis of clinical management (24).
In case 3, an external cervical resorption was detected 4 months after endodontic microsurgery. Patel et al. (14) point out that the treatment of this type of resorption will depend on the severity and location of the defect and its restorability (14). According to a newly proposed 3-dimensional classification, the lesion was classified as 3Ap because it extends to the mid-third of the root with a total area less than 90° with pulpal involvement (25), and the CBCT analysis proved that the location of the defect was not accessible through endodontic microsurgery, thus the intentional replantation was considered. In this case, after curettage of the granulation tissue, the application of 90% aqueous trichloroacetic acid was made to obtain coagulation necrosis of the resorptive tissue and halt the pathologic process (26), given that incomplete removal is likely to result in the recurrence of external cervical resorption (27). After debridement, external cervical resorption defects can be restored with a glass ionomer cement or composite (14). However, the use of bioactive materials such as MTA (11, 18) as opposed to other repair materials (such as amalgam, IRM and Super EBA) has been shown to improve the outcome of intentional replantation (28). White ProRoot MTA was used to seal the defect as it presents an excellent sealing capacity (29, 30) associated not only to its mechanical seal but also to a chemical adhesion provided by by-products of the setting and hydration reaction of the material (30).
A wide range of indications were listed by Grossman (8) including natural or iatrogenic root canal obstructions, complex root canal morphology, presence of periapical irritants and/or extruded materials and perforation sealing when apical surgery was not viable (31). Extruded material in the periapical tissues has been stated previously as one of six biological factors that may lead to asymptomatic radiolucency persisting after root canal treatment (1). As microsurgery was impracticable, intentional replantation was performed in case 4 in order to remove all the remnants of root canal sealer and control the pain which led the patient to look for clinical help.

Conclusions

Intentional replantation may be considered a suitable option to successfully maintain which were once deemed untreatable through conventional endodontic procedures, especially considering the favourable prognosis and outcomes recently reported in the literature.

Clinical Relevance

Intentional replantation requires the deliberate extraction of a tooth allowing its manipulation and repair through an endodontic surgery outside the socket, followed by the tooth placement back into its original position. As emphasized by recent literature, with a well-designed treatment protocol this procedure may be considered a viable option for teeth otherwise considered lost, presenting high success and survival rates.

Conflict of Interest

None.

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None.

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