

A Novel Approach for Orthodontic Extrusion Prior to Intentional Replantation: A Case Report

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ABSTRACT

Aim: This case report aimed to present a novel surgical technique involving orthodontics luxation of the offended tooth using miniscrew prior to performing intentional replantation (IR) to remove an extruded separated instrument that injured the inferior alveolar nerve (IAN).

Background: Intentional replantation is a dental procedure that involves extracting a tooth, managing the root canal, and then reinserting the tooth back into its socket. This procedure is typically used as a last resort when other treatment options have failed or are not possible. Intentional replantation can be successful in preserving the tooth and preventing tooth loss, but it is important to note that there are risks involved. Maintaining the viability of the periodontal ligament (PDL) is a pivotal step to achieve a favorable outcome.

Case description: A 15-year-old female patient came to the clinic complaining of electric-like pain in the left mandibular posterior area that radiated to the left ear and sometimes caused a headache. Upon clinical and radiographic evaluation, extruded endodontic file from the mesial root of the left first molar that penetrated the IAN canal was noticed. Nonsurgical root canal retreatment was performed, which failed to retrieve the separated file. Orthodontics luxation of the offended tooth was done 2 weeks before the surgical intervention using a miniscrew to induce PDL inflammation, which increased the tooth mobility and PDL volume, facilitating the atraumatic extraction and reduced the risk of complications, such as root resorption and ankylosis. Then, IR was performed, and the extruded file was successfully retrieved. Three months follow-up showed complete recovery of the endodontics-related IAN injury symptoms. Preapical radiographic evaluation and cone-beam computed tomography scan showed complete healing of the periapical radiolucency/area of low density and complete formation of the PDL space and lamina dura around the resected roots.

Conclusion: This novel approach using a miniscrew suggests a noninvasive technique that minimizes the damage to the offended tooth surrounding tissues as well as minimizing the morbidity of the adjacent teeth and the vital anatomical structures.

Clinical significance: Multidisciplinary comprehensive preplanning of complicated cases is essential to maximize treatment efficiency. The orthodontic extrusion facilitates the extraction process that helps in preserving the PDL, and ultimately increases the survivability of the teeth.

Keywords: Case report, Intentional replantation, Miniscrew, Orthodontic luxation.

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INTRODUCTION

The reported incidence of endodontics file separation during root canal treatment ranged between 0.25 and 10%.¹⁻³ Separated instrument could impede root canal treatment procedures and blocks access to the apical third, which might affect the treatment outcomes.^{4,5} Retrieval of the separated instruments is challenging, especially when it is located in the apical third.³ Several management protocols for separated instruments are proposed. The first line of management is being conservative and attempting to retrieve the file from the canal or bypass it.¹ Follow-up after chemo-mechanical preparation and obturation of the canal up to the level of file fragment is another conservative option.² Finally, surgical intervention could be a conservative option in some cases, especially when nonsurgical treatment is unpredictable.^{1,6-9}

Serious complications of separated endodontic instruments are infrequent. However, some case reports showed serious neurological injuries due to endodontic file separation.⁶⁻⁹

Inferior alveolar nerve injury is one of the infrequent complications of dental treatment.¹⁰

Extraction of impacted mandibular third molars was reported as the most iatrogenic cause of IAN injuries,^{11,12} followed by implant placement,¹³ orthognathic surgery,¹⁴ and mandibular fracture.¹⁵ Endodontics-related IAN injuries were reported in 8–35% of the iatrogenic nerve injury cases.^{15,16} Several mechanisms have been proposed regarding endodontics-related IAN damage, including

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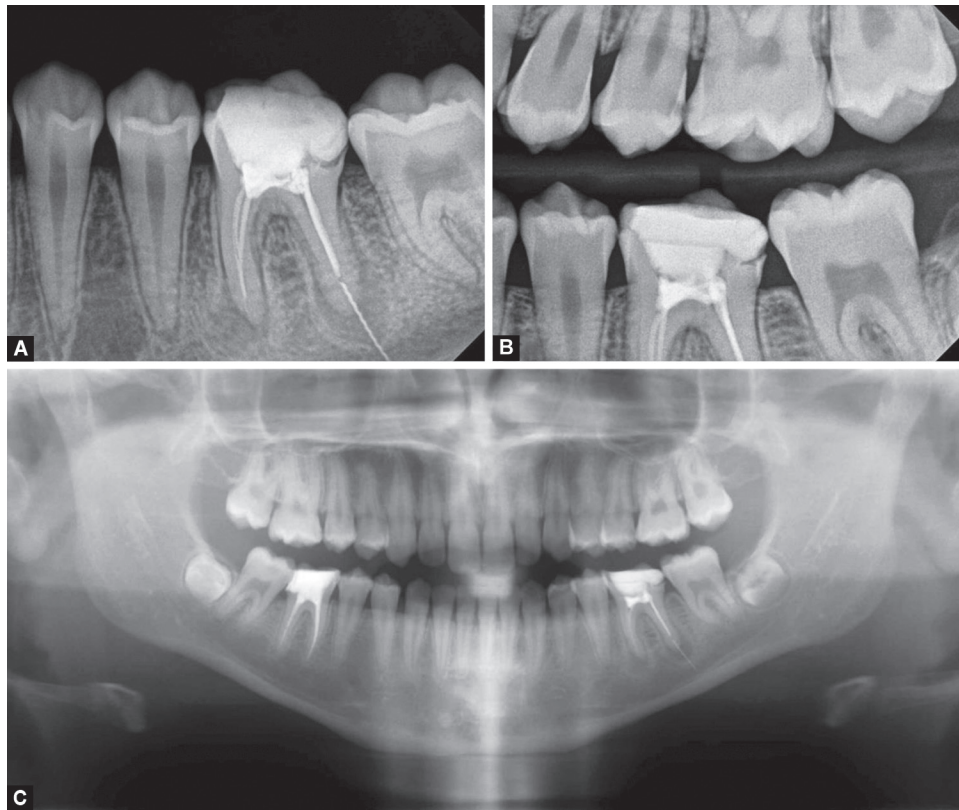
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Figs 1A to C: Preoperative 2D radiographs: (A) Preoperative PA radiograph shows low-quality root canal obturation of tooth #36 with extruded file beyond the apex in the distal root; (B) Bitewing radiograph showed defective coronal restoration of tooth #36; (C) Panoramic radiograph showed preapical rarefaction related to both roots of #36 and extruded file in the distal root that reached the inferior alveolar canal

the indirect neurotoxicity of endodontics materials that penetrate the IAN canal, direct mechanical irritation of overextended materials into the IAN canal, direct nerve damage of over-instrumentation with endodontic files, or thermal irritation when temperature proximal to the IAN increase greater than 10°C.^{17,18} Although endodontics-related IAN injuries are rare, it is considered a serious complication with unfavorable consequences, especially with late diagnosis and intervention.¹⁹ Thus, IAN injuries may result in unpleasant neurosensory disturbances, such as neuropathic pain, paresthesia, or anesthesia.²⁰ The proximity of the IAN canal to the mandibular molars and premolars apices is an important risk factor for nerve damage. The roots of the second mandibular molar are considered the closest apices to the superior border of the IAN canal. However, in younger ages (<18 years old) first mandibular molar showed the most proximity to the IAN canal. Additionally, female patients showed a closer distance between the mandibular posterior teeth apices and the IAN canal than male patients from the same age-group.²¹

Intentional replantation (IR) is defined as the deliberate extraction of a tooth and returning it to its original socket after root surface evaluation and endodontic treatment.²² A recent systematic review showed the survival rate of IR ranged between 81 and 94%.²³

Hayashi introduced the concept of "orthotransplantation."²⁴ He proposed using orthodontic forces to extrude the donor tooth to increase the volume of the periodontal ligament (PDL) cells and minimize the chances of external inflammatory or replacement resorption after autotransplantation. The same philosophy was adopted by Choi et al.²⁵

The conventional way of tooth extrusion utilizes sectional mechanics in which the extruded tooth will be suspended between

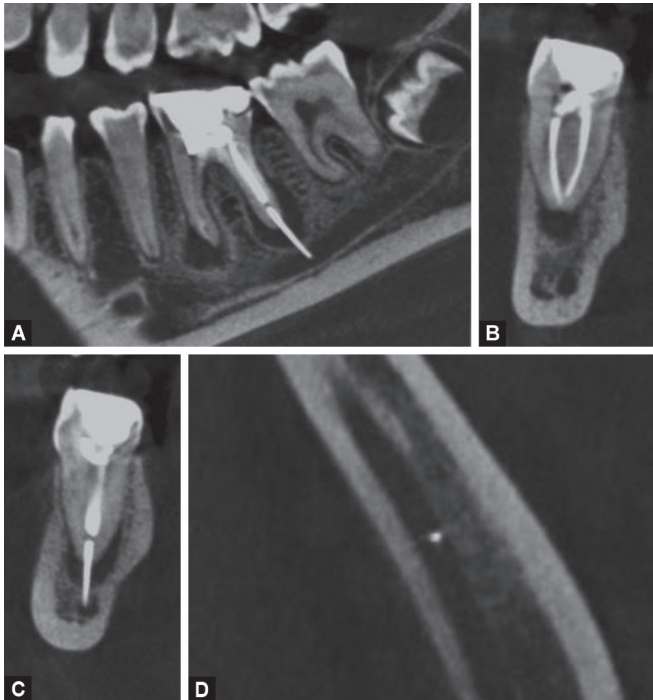
two adjacent teeth allowing the tooth to be extruded in which it will have intrusion force on them.²⁶ On the other hand, skeletal anchorage with a temporary anchorage device (TAD) allows the dentist to move teeth via atraumatic biomechanics.²⁷ This system could be used for comprehensive fixed orthodontic treatment and adjunctive cases.

This case report aimed to present a novel surgical technique involving orthodontics luxation of the offended tooth prior to IR using miniscrews to remove an extruded separated instrument that injured the IAN.

CASE DESCRIPTION

Clinical and Radiographic Evaluation

A general dentist referred a 15-year-old female with non-contributory medical history for endodontic evaluation to the dental hospital of King Abdulaziz University in 2022. The patient complained of sharp shooting pain (electric-like pain) in the left mandibular posterior teeth that radiated to the left ear and sometimes caused a headache. Nonsurgical root canal treatment of #36 was done 4 years prior to her dental visit. Clinical examination revealed that tooth #36 was tender to percussion and palpation. Mobility was within the physiological limit. Periodontal probing depth ranged between 2 and 3 mm. Preapical (PA) radiographic examination showed substandard root canal treatment of tooth #36 with extruded radio-opaque material indicative of a separated endodontic file beyond the apex in the distal root. Both mesial and distal roots had PA lesions approximately measured 4 × 6 mm (Fig. 1), and cone-beam computed tomography (CBCT) showed



Figs 2A to D: Preoperative 3D radiograph: (A) Coronal view showed area of low density associated with both roots of tooth #36 and extruded radiopaque material indicative of endodontic file inside the IAN canal; (B) Corrected sagittal view of mesial root showed two canals; (C) Corrected sagittal view of distal root showed one canal and the extruded separated instrument; (D) Axial view shows the separated instrument within the IAN canal

that the separated file was invading the IAN canal (Fig. 2). The tooth was found to have symptomatic apical periodontitis, which had been previously treated. Treatment options and their possible complications were discussed with the patient and her mother. They both agreed to start nonsurgical root canal retreatment as a first attempt to remove the separated file. If the attempt was unsuccessful, IR would be the treatment of choice. The mother signed the consent.

Treatment Procedure

After achieving local anesthesia, the rubber dam was placed. All of the procedures were performed under a dental surgical operating microscope (DOM) (Pico, Carl Zeiss, Oberkochen, Germany). Access was made, the previous root canal filling material was removed, and the separated file could not be retrieved. Irrigation was done using 4% sodium hypochlorite with passive ultrasonic irrigation, followed by 17% ethylenediaminetetraacetic acid (MD-Cleanser; Meta-Biomed Co. Ltd., South Korea). Obturation was done using gutta-percha and Bioceramic (BC) sealer (Brasseler, Savannah, GA), followed by composite resin buildup (Filtek, 3M Oral Care, St. Paul, MN, USA) (Fig. 3).

The patient did not report any improvement in the symptoms after completing the treatment, the decision was made to proceed with IR due to the failure to retrieve the separated file.

The patient was referred to the orthodontist to start the luxation process. A 10 mm miniscrew (VectorTAS 10 mm miniscrew, ORMCO, OR-601-0022) was placed at a 45-degree angle inferior to the mucogingival line under local anesthesia. A periapical radiograph was taken to evaluate the screw placement (Fig. 3B).

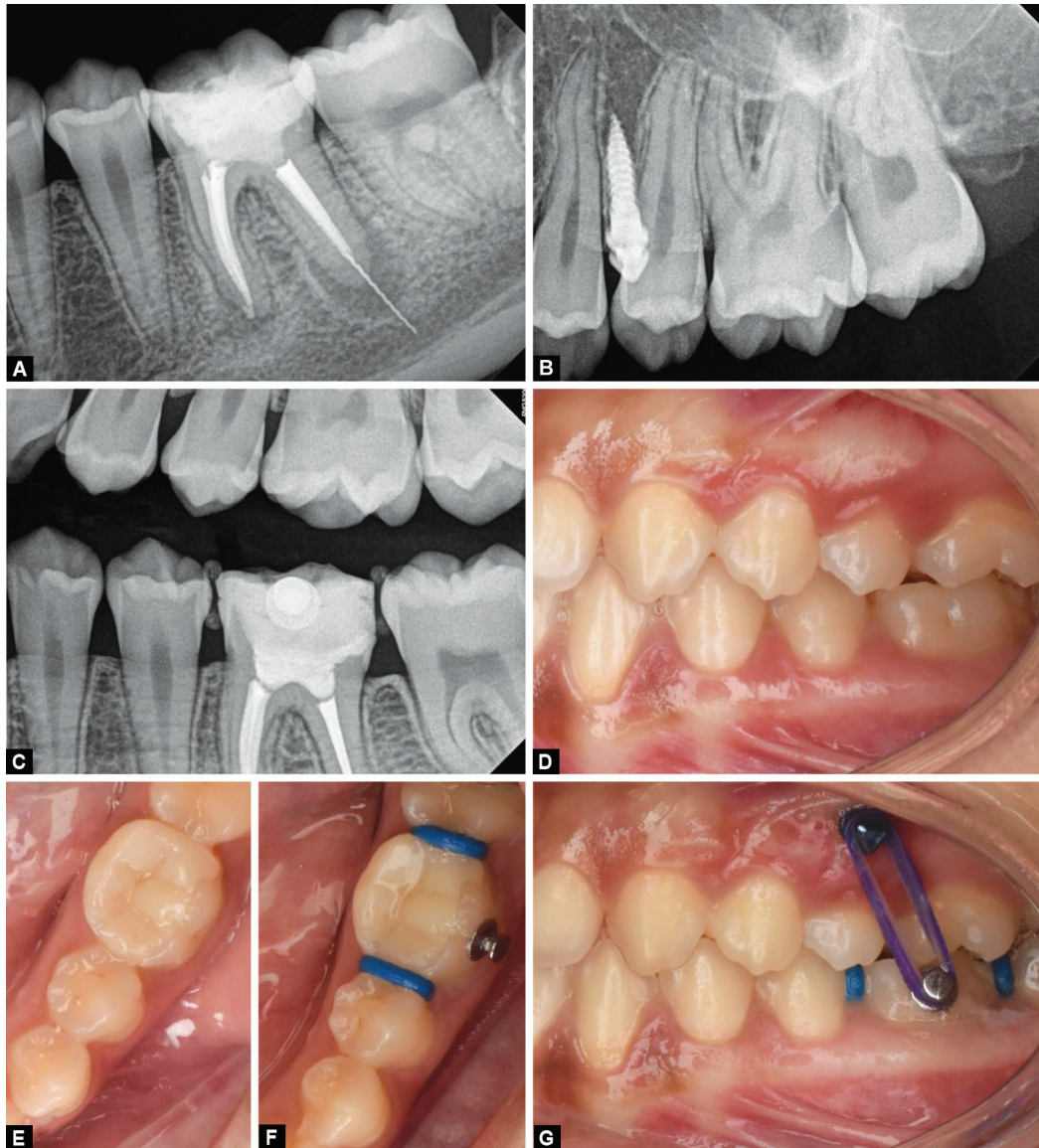
O-ring separators were placed mesial and distal to #36 to accelerate the luxation process. A lingual button was cemented buccal of tooth #36 (Figs 3C and F). Vertical elastics from the miniscrew to the lingual button (1/4 inch medium 6.4 mm) were given to the patient to be worn 24 hours a day (except when eating) until the day of her intentional replantation (Fig. 3G).

Two weeks later, the patient presented to the clinic to perform the surgical treatment. Medical history was reviewed, and informed consent was obtained for the surgical intervention. Vital signs were taken, and they were within the normal limits. Chlorhexidine mouth rinse was given to the patient before starting the treatment (0.2% CHX, Avalon Pharma, Sulimaniyah, Riyadh). All the procedures were done under the use of the dental operating microscope. About 20% benzocaine topical anesthetic was used prior to injecting two cartridges of 2% lidocaine with 1:100,000 epinephrin were administered as IAN block and buccal infiltration. The miniscrew, lingual button, and O-ring elastics were removed prior to the start of the surgical procedure.

Atraumatic extraction was carried out using forceps. The file was attached to the root upon tooth removal (Fig. 4A). A preapical radiograph of the socket was taken to confirm the complete removal of the extruded file (Fig. 4C). The tooth was held with wet gauze from the crown and continuously irrigated with Hanks' Balanced Salt Solution (HBSS) (Gibco™, Life Technologies Corporation, New York, USA) during the whole procedure. The extraoral time was calculated using a stopwatch, and it was within 10 minutes. About 3 mm of each root was resected with long fissure carbide bur in a high-speed handpiece. Methylene blue staining was used for roots inspection under DOM (25x magnification). No apical cracks were noticed. Root-end preparation was done with a straight diamond-coated ultrasonic tip CT4 (SybronEndo, Orange, CA, USA), to a depth of 3 mm. Then, prepared root-ends were dried with paper points and retrofilling was done using Endosequence BC root repair material (Brasseler, Boulevard, Savannah, GA, USA). A radiograph was taken to evaluate the quality of the root-end filling after replanting the tooth back to its original socket, asking the patient to bite on a gauze for 10 minutes. The mobility of the tooth was checked, and it was within the physiological limits (Figs 4D and F). An ice pack was provided to be applied extraorally for 10 minutes and to rest for 10 minutes for the following 12 hours. Postoperative instructions were given to the patient and the patient was advised to continue on soft diet for the next few days and to avoid any sticky food. The patient was instructed to take 400 mg ibuprofen Q6h prn pain. It was explained to the patient that it is expected to have some swelling and soreness in the area, and it should subside within 5 days and the preoperative neurological symptoms should start to improve gradually by time.

The patient came after 2 weeks for a follow-up. She reported improvement in the sharp shooting pain. The gingiva in the miniscrew place healed with mild inflammation. Oral hygiene instructions were reinforced, and the patient was scheduled back for a follow-up in 3 months.

At 3 months follow-up visit, the patient presented with no symptoms and with complete resolution of the neuropathic pain. Intraoral clinical examination showed healthy gingiva around the replanted tooth, normal mobility, and normal response to percussion and palpation tests. Radiographic evaluation showed complete resolution of the periradicular radiolucency with the re-establishment of normal PDL space and lamina dura (Fig. 5A). Additionally, CBCT showed complete re-establishment of the buccal plate and healing of the area of low density (Figs 5D to F).



Figs 3A to G: (A) PA radiograph after nonsurgical root canal retreatment; (B) PA radiograph after miniscrew insertion between #24 and #25; (C) Bitewing radiograph after lingual button placement buccal to tooth #36; (D and E) Preoperative lateral and occlusal photos before miniscrew insertion; (F) Occlusal photo after lingual button cementation and placement of separators; (G) Lateral photo after miniscrew insertion and elastic placement

The patient has been asymptomatic since her last follow-up visit 2 weeks after completing the procedure, and she was advised to place a full cuspal coverage restoration.

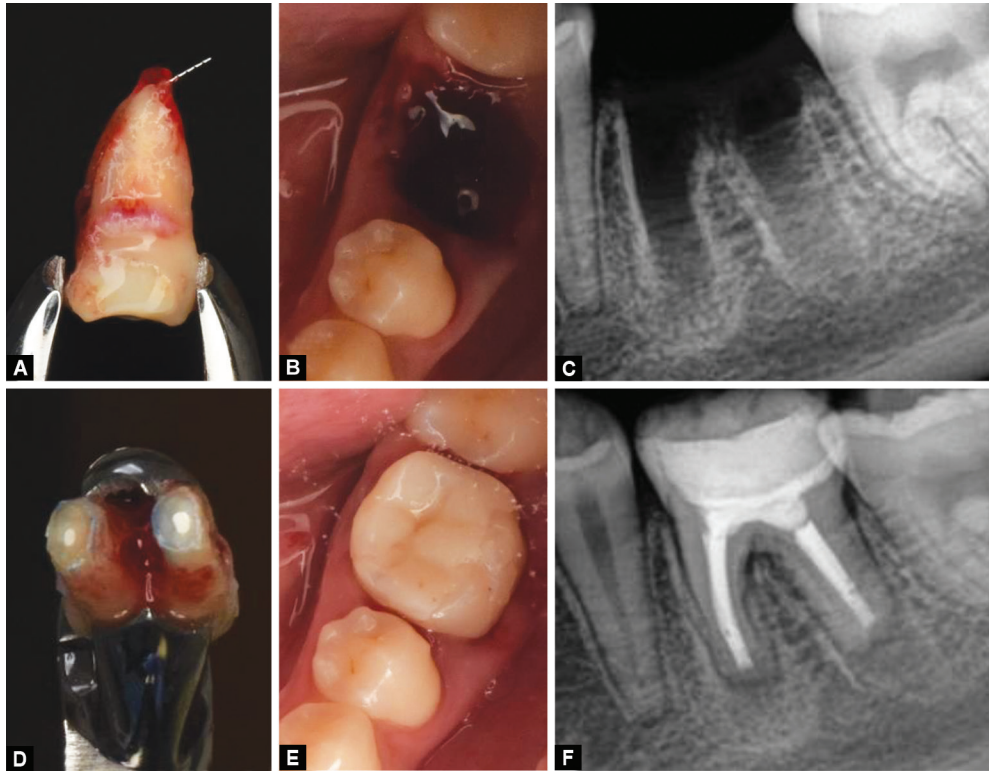
The patient and her parents were very satisfied for a couple of reasons. First, the patients' pain and symptoms were completely resolved. Additionally, the patient was able to maintain her natural tooth at this young age which is crucial as replacing the tooth with dental implant is not controversial at this age. Finally, the associated financial cost of placing a dental implant was avoided by providing the mentioned treatment.

DISCUSSION

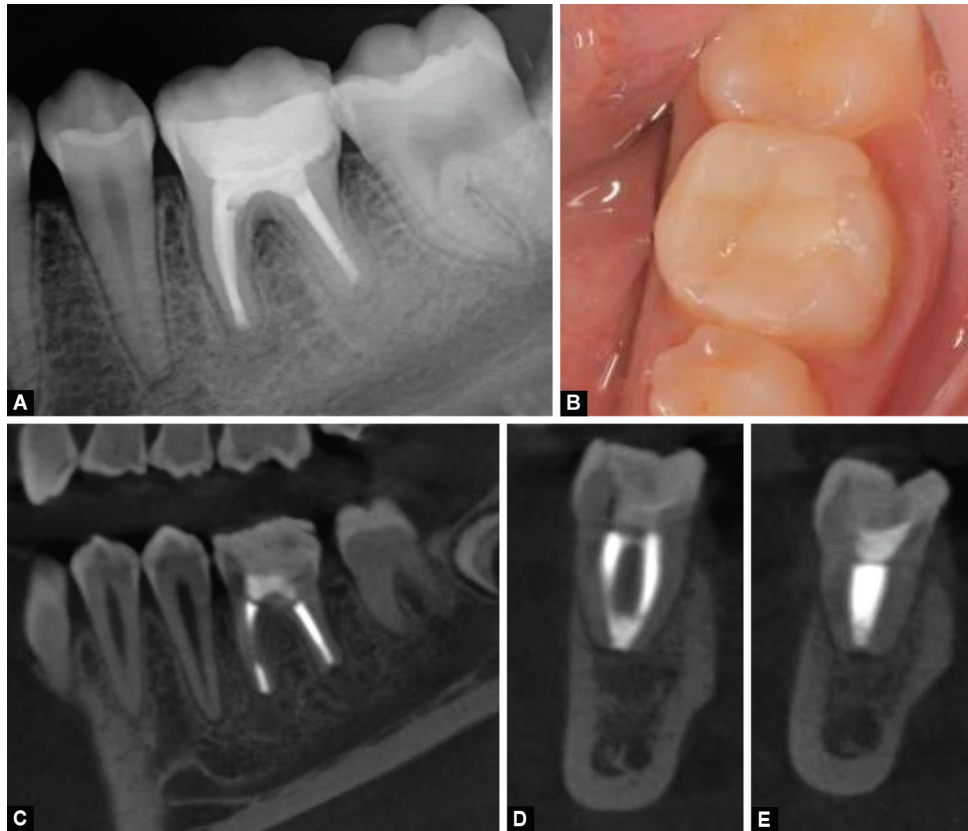
The indications of IR were expanded from evaluating the root surface to include the treatment of canal obstructions, non-healing cyst or large apical lesions, complex root canal morphology,

the correction of perforations, and the removal of extruded materials.^{23,28}

To reduce the risk of root fracture and damage during extraction, orthodontic extrusion is recommended. Choi et al. have reported a 98% success rate in cases with orthodontic extrusion prior to IR, and they have reported no cases with external resorption.²⁵ Temporary anchorage devices (TADs) are fabricated from a pure titanium or titanium alloy with a length of 8–20 mm and a diameter of 1–2 mm.²⁷ They are usually stable during orthodontic treatment and incur minimum anchorage loss.²⁹ The success rate varies from 60 to 100%, with an average of 86%.^{27,29} Several advantages are associated with TADs: The TAD device prevents the movement of surrounding teeth, allows for a more controlled action and reaction, and has fewer restrictions when it comes to placement when compared with a normal implant.³⁰ Advantages over the conventional method of sectional fixed orthodontics include



Figs 4A to F: (A) Atraumatic extraction of #36, extruded separated instrument was attached to the tooth; (B) Occlusal photo of the socket; (C) Preapical radiograph of the socket confirming the complete file retrieval; (D) Root-end filling with BC putty, Postoperative; (E) Occlusal photo; (F) PA radiograph after tooth replantation



Figs 5A to E: Three months follow-up clinical and radiographic assessment of tooth #36. (A) PA radiograph shows complete healing of periapical lesion; (B) Occlusal clinical photo shows normal gingiva around the transplanted tooth; (C) Coronal view showed bone deposition and healing of the area of low density; (D) Corrected sagittal view of mesial root; (E) Distal root showed bone healing with establishment of normal PDL space

better oral hygiene, fewer appliances, and reduced patient discomfort.³¹

Chemical and thermal endodontics-related IAN injuries showed no recovery from the neurosensory disturbances even after removing the cause in the reported cases.⁶ In cases of mechanical nerve damage, such as this case, animal in vivo, and human observational studies showed regeneration and healing of the injured IAN happened within 6 months.^{32,33}

Case selection is a critical step in the decision-making process for this procedure. There are several factors that need to be considered when selecting a case for IR. The overall health and strength of the tooth should be able to withstand the extraction procedure without significant damages. This means that the tooth should not have any significant decay or damage. Furthermore, the root form should be carefully studied before attempting the procedure. Severely curved or dilacerated roots are not suitable candidates for such a procedure. The success rate of IR decreases when the tooth is out of the socket for longer time. Ideally, the tooth should be replanted within 30 minutes of being extracted. In the current report, the time was kept within the recommended range.

CONCLUSION

Within the limitation of the current investigations, we are demonstrating for the first time the possibility of utilizing the miniscrew to help in increasing the PDL volume as well as reducing the chances of tooth fracture by luxating the tooth which in turn will increase the success and survival rate of IR procedure.

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