



Non-Surgical Management of a Mandibular First Molar with Strip Perforation, Separated File, and Canal Ledge: A Case Report

Amir Hosein Mehdizadeh ^{a*} , Fatemeh Soltani ^a , Motahareh Yusefi ^a , Razieh Sadeghi ^a ,
Arash Shahravan ^a

^a Endodontology Research Center, Kerman University of Medical Sciences, Kerman, Iran

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*Corresponding author: Amir Hosein Mehdizadeh, Unit 4, Saba Building, No. 14, 4th Alley, End of North Chamran St., Shahrek Ghods St., Qom, Iran; Postal Code: 3716113143.

E-mail: am.mehdizadeh@gmail.com

Abstract

Root canal mishaps such as perforations, separated instruments, and canal ledges remain significant challenges in endodontic retreatment. This case report describes the successful non-surgical management of a mandibular first molar presenting with a strip perforation in the mesiobuccal canal, a separated file in the mesiolingual canal, and a ledge in the distal canal. The tooth was generally asymptomatic with only mild sensitivity to percussion, without any pockets of endodontic origin. Radiographic examination revealed periapical and furcation radiolucencies. The tooth had a previous endodontic treatment with an infected root canal system and chronic apical periodontitis. Notably, the tooth was left undressed for approximately three months following the initial mishap, negatively influencing prognosis. Nonetheless, considering the patient's preference and the favorable periodontal and restorative conditions, non-surgical retreatment was initiated. Treatment included thorough chemomechanical preparation, bypassing the separated file and ledge, and sealing the perforation with calcium-enriched mixture cement. The tooth was subsequently restored with bonded composite resin. At 12-month follow-up, radiographic signs of healing were evident, and at 18 months, the tooth remained asymptomatic with no clinical or radiographic signs of apical or furcation pathology.

Keywords: Endodontic Ledge; Fractured Instrument; Retreatment; Root Perforation

Introduction

Endodontic therapy aims to eliminate pulpal and periapical infection, with reported success rates exceeding 90% in primary treatments [1] and approximately 78% in retreatments [2]. The lower success rate in retreatment is often attributed to complications such as persistent lesions, canal obstructions, perforations, and retained instruments. However, addressing the etiology of failure can improve retreatment outcomes to levels comparable with primary treatment [3].

Non-surgical retreatment is the first-line approach for managing failed root canal therapy, offering a conservative alternative to surgical intervention. Accurate diagnosis remains the cornerstone of successful endodontic therapy [4]. Visual inspection under magnification may detect missed canals, cracks, perforations, and caries [5]. Clinical tests and periodontal probing

aid in evaluating periradicular pathology. Radiography, particularly parallel or modified parallel techniques, is crucial for assessing periapical status [6], with cone-beam computed tomography (CBCT) offering enhanced diagnostic value when conventional imaging is insufficient [7].

A comprehensive treatment plan should be tailored after identifying factors contributing to failure. Canal obstructions, including ledges and separated instruments, impede effective debridement of apical areas. Ledges may be bypassed using pre-curved stainless-steel K-files [6], while management of separated instruments depends on location, length, and the treatment phase at which the separation occurred. In the presence of necrotic pulp tissue, prognosis is more favorable when fractures occur apically during later treatment stages [8] and when bypassing is successful without excessive removal of the root structure. Instrument fracture has no significant impact on prognosis [9].



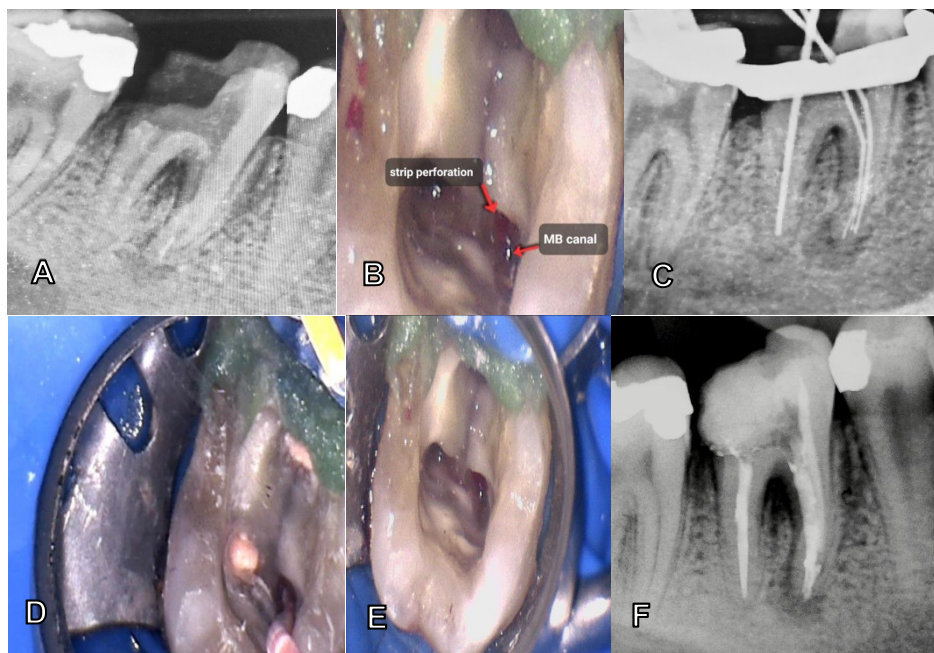


Figure 1. A) Preoperative radiograph shows lost tooth structure, and radiolucency in the furcation area and apical area of the mesial root, there is a separated file fragment in the apical third of the ML canal; B) Visual inspection of the strip perforation in the ML canal; C) Negotiation of all three canals to working length; D) Placement of a gutta-percha point in the MB canal to prevent obstruction. Note the dark curved space between the gutta-percha point and the canal wall (white arrow); E) Sealing the perforation by placing CEM in the space between the MB canal wall and gutta-percha; F) Final radiograph of the first session. ML and D canals were obturated, but gutta-percha was temporarily placed in the ML canal, and the perforation area was sealed by CEM cement

Perforations, defined as pathological communications between the root canal system and the periodontal tissues, negatively impact prognosis, especially when located coronally near the crestal bone, which causes periodontal involvement and pocket formation [10]. Apical perforations are associated with better outcomes. Prompt sealing is critical, and most importantly, time is a key factor, as delayed repair may result in chronic inflammation [11]. Bioceramic materials such as mineral trioxide aggregate (MTA) and calcium-enriched mixture (CEM) cement demonstrate favorable outcomes due to their biocompatibility, bioactivity, alkaline pH, sealability, and calcium ion release [12-15]. Although some studies suggest that larger perforations worsen prognosis [16], others report no correlation [17].

This report presents the non-surgical retreatment of a molar with a strip perforation, a separated file, and a canal ledge associated with periapical and furcation radiolucencies.

Case Presentation

The case of a tooth #30 of a 25-year-old male with no specific medical disorder is presented. His chief complaint was the loss of a substantial portion of the tooth structure, accompanied by mild pain, and he sought restorative treatment. The tooth was initially treated by a dental student at Kerman University in June 2022.

Following treatment mishaps, calcium hydroxide was placed as an intracanal medicament; however, the patient failed to return for approximately three months. Upon referral to the endodontic department in October 2022, clinical examination revealed mild percussion sensitivity and periradicular tenderness, with no periodontal pocketing.

Preoperative radiographs revealed extensive coronal structure loss, periapical and furcation radiolucencies, and a separated instrument in the ML canal (Fig. 1A). According to Abbot's classification, the pulpal diagnosis was previous endodontic treatment with an infected root canal system, and the periapical diagnosis was chronic apical periodontitis. The restorability of the tooth was proven, and the periodontal prognosis was deemed favorable. After informed consent, the patient opted for tooth preservation over extraction and implant placement [18].

An inferior alveolar nerve block was administered using 2% lidocaine with 1:100,000 epinephrine. The tooth was isolated with a rubber dam, and the caries were removed. Under a 3D dental microscope (VOMS-102D, Sometech, Seoul, Korea), a strip perforation in the MB canal was visualized (Fig. 1B). A pre-curved K-file (Mani, Tochigi, Japan) was used to bypass the perforation. The separated file in the apical third of the ML canal was successfully bypassed with C-pilot files (#6, #8, #10) under copious irrigation with 2.5% sodium hypochlorite.



Figure 2. Second appointment of root canal treatment: A) Absolute isolation using rubber dam; B) Pulp chamber space after filling MB canal, note the fully set CEM (white arrow) next to the gutta-percha (red arrow); C) Deep margin elevation of the distal wall using composite resin; D) Composite restoration to improve the coronal seal; E) Final radiograph of second appointment

A ledge in the distal canal, undetected on initial radiographs, was identified tactilely and bypassed. All canals were instrumented up to the size F2 blue alloy rotary files (Eighteenth Medical, ChangZhou, China) using an anticurvature technique (Fig. 1C). Irrigation was performed with 2.5% NaOCl [19], followed by 17% EDTA, and finally sterile saline. Ultrasonic activation (UltraX; Eighteenth Medical, ChangZhou, China) enhanced irrigant efficacy.

Obturation of the ML and D canals was completed using the continuous wave technique with AH-26 sealer (Dentsply, Konstanz, Germany) and thermoplasticized gutta-percha. To manage the MB perforation, a gutta-percha cone was temporarily placed in the main canal to maintain patency (Fig. 1D), and CEM cement was delivered *via* an MTA carrier and condensed at the perforation site (Fig. 1E). A moist cotton pellet was placed on CEM cement to provide moisture for the coronal part of the bioceramic to set completely, then Cavisol (Golchai, Tehran, Iran) was used for temporary sealing (Fig. 1F), and the next session was scheduled one week later to reduce the patient's symptoms and to ensure complete setting of the CEM.

At the subsequent appointment, CEM setting was confirmed (Fig. 2A-C), and the MB canal was obturated using

the lateral condensation technique with 2% gutta-percha points. Then, since an appropriate coronal seal improves the prognosis of root canal treatment [20] the tooth was restored using bonded composite resin. After selective etching, a fifth-generation bonding agent (Amber; FGM Dental, Joinville, SC, Brazil) was applied and cured. The restoration was completed using the snowplow technique with DenFil Flow (Vericom, Seoul, Korea) and Tokuyama Estelite Posterior composite (Tokuyama Dental, Tokyo, Japan), layered incrementally. Each layer was cured for 20 sec.

Post-curing was performed from occlusal, buccal, and lingual aspects for 40 sec each (Fig. 2D & E). The patient was prescribed 400 mg ibuprofen as needed. The patient was informed to contact the dentist if he had any symptoms or swelling.

Follow-up at 6-month recall, the tooth was asymptomatic, and radiographs showed evidence of bone regeneration in the furcation and periapical regions (Fig. 3A & B). At the 18-month follow-up, clinical and radiographic assessments confirmed the absence of signs or symptoms. Periapical and bitewing radiographs demonstrated normal periodontal ligament space, intact lamina dura, and normal trabecular bone (Fig. 3C-F). The patient was advised to restore the tooth with a crown to enhance the long-term prognosis.

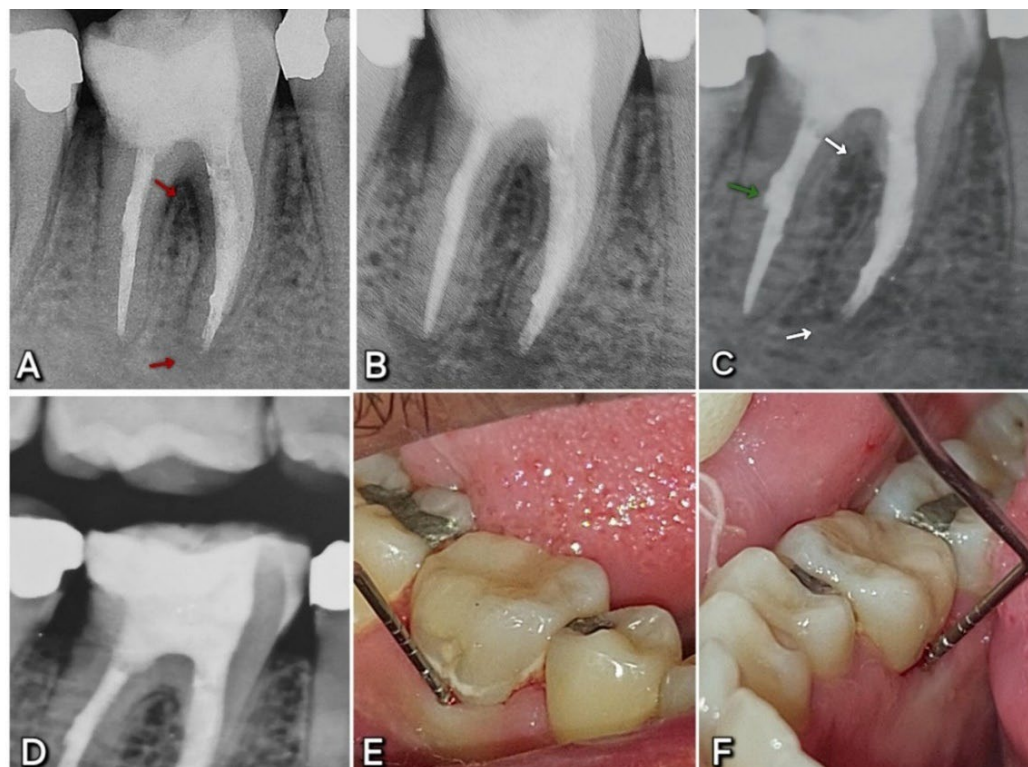


Figure 3. Follow-ups: A) Post-treatment radiograph, note the radiolucency of the furcation area and mesial root (red arrows); B) Follow-up after 6 months, all symptoms have resolved and evidence of bone formation is visible in furcation area; C) Follow-up after 18 months, no evidence of radiolucency of the furcation area and apical region is seen on the periapical radiograph (white arrows), note the bypassed ledge on distal root (green arrow); D) Bite-wing radiograph at 18-month follow-up, note the normal pattern of bone trabeculation, lamina dura and PDL in the furcation area; E and F) No pockets of endodontic origin were observed on probing of the tooth at the follow-up session

Discussion

The mandibular first molar is the most complex tooth in terms of its morphology [21]. Distal walls are mostly the thinnest walls in the mesial canals of mandibular molars and have less than 1 mm thickness in apical levels in many cases. Thus, the possibility of perforation in the distal walls is higher than in the other walls [22].

This case demonstrates successful management of a lower molar with severe structural compromise, intracanal mishaps, and peri-radicular pathosis. Similar cases have been reported in the literature. For instance, Mirikar *et al.* [23] described the successful management of a mandibular first molar with iatrogenic perforation, a separated instrument, and chronic apical periodontitis by sealing the perforation area with MTA and managing the separated instrument.

Strip perforation is a severe procedural complication during root canal therapy, often associated with a poor prognosis. Retreatment of strip perforations poses considerable challenges due to their irregular location, thin root dentin walls, and limited accessibility [24]. Also, relocating the root canal close to the perforation site is quite challenging, even with the aid of a dental

operating microscope [25]. Apart from microbial debridement of the root canal system, the success of root canal therapy is based on achieving a seal. As a biocompatible hard tissue-inducing material, CEM cement may effectively be used for the repair of procedural perforations [26].

Consistent with prior studies, favorable outcomes were achieved when etiological factors were addressed. The bioceramic CEM cement contributed to the predictable sealing of the strip perforation. CEM showed significantly less microleakage than MTA, and bacterial leakage similar to Biodentine [15]. Utneja *et al.* [27] demonstrated that CEM has similar clinical applications to MTA and has acceptable clinical results in treatments such as perforation repair or vital pulp therapies [28, 29]. Both CEM and MTA resulted in the formation of hard tissues, i.e., cementogenesis and osteogenesis [15, 30].

One of the obstacles to root canal treatment success is the failure to completely clean the root canal system. Canal blockages, such as ledge formation and separated instruments, hinder disinfecting the root canal system. There are three solutions when dealing with a separated instrument: retrieval, bypassing, and

leaving the fragment in situ. The latter approach is only considered when the canal has been adequately disinfected and no signs of active infection are present. Attempts to remove fractured instruments can lead to ledge formation, over enlargement, and transportation of prepared root canal, or can lead to perforation. If the separation occurs beyond the curvature or the fragment is located in the apical third, the successful retrieval without procedural accidents is deemed impossible [31]. Therefore, bypassing is typically attempted as the initial strategy.

The success of bypassing largely depends on the available space surrounding the fractured segment. A pre-curved size #8 or #10 K-file, used with minimal apical pressure and proper tactile control, can be effective in negotiating a path around the separated fragment and re-establishing canal patency [32]. In the study by Parveen *et al.*, a separate instrument was managed using a conservative bypass technique. A #8 K-file was initially used to negotiate around the fractured fragment and establish a glide path through gentle watch-winding and in-and-out motions, accompanied by copious irrigation. Subsequently, a #10 file and progressively larger sizes were employed as needed to further shape the canal. The authors concluded that bypassing is a conservative and effective approach for the management of separated instruments within the root canal system [33].

Of note, the extended delay between perforation and definitive treatment posed a potential risk; however, it was mitigated by careful retreatment planning and use of magnification. In the management of broken instruments in the apical area, the lack of visibility and access makes their predictable removal virtually impossible [34]. There was no choice but to bypass the file by tactile sense. Early referral to a specialist is critical in complex cases to prevent deterioration of prognosis. Overall, this report highlights the potential for successful non-surgical retreatment of teeth previously deemed untreatable through meticulous technique and with appropriate materials.

Conclusion

The reported case highlights that even teeth with complex endodontic mishaps can be saved with precise diagnosis, advanced techniques, and careful follow-up, avoiding the need for extraction and implant placement. Preserving natural teeth should remain a priority when feasible, as it offers biological, functional, and economic advantages over implant-supported prostheses.

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Conflict of interest

None.

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Authors' contributions

Methodology: AM, Formal analysis and investigation: AM, Writing review and editing: AS/FS/MY/RS, Supervision: AS. All authors read and approved the final manuscript.

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