



Comprehensive Management of Iatrogenic Errors in a Mandibular Molar: A Case Report

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Abstract

Endodontic procedural errors such as ledge formation, perforations, and instrument separation complicate root canal therapy and may adversely affect long-term prognosis. This case report describes the comprehensive management of a mandibular molar that presented with a ledge in mesial canal, furcation perforation, and fractured instrument fragment in distal canal. Through systematic management, including ledge bypass, ultrasonic-assisted instrument retrieval, and mineral trioxide aggregate (MTA) repair of the perforation, full canal preparation and obturation were achieved. Follow-up radiographs demonstrated progressive periradicular healing, highlighting that modern endodontic techniques and biomaterials can salvage teeth with multiple complications.

Keywords: Ledge formation, perforation repair, instrument retrieval, MTA, endodontic mishaps

Introduction

Root canal therapy is a predictable treatment modality with high success rates when infection is eliminated and a proper seal is established. However, procedural mishaps such as ledge formation, root perforations, and instrument separation can complicate treatment and compromise outcomes [1].

Endodontic mishaps or procedural accidents are unfortunate occurrences that can occur during treatment. Among the complications most commonly observed during root canal instrumentation is a deviation from the original canal curvature without communication with the periodontal ligament, resulting in a procedural error termed as ledge formation or ledging.[2] The presence of a ledge might exclude the possibility of achieving an adequately shaped canal preparation that reaches the ideal working length, and this can result in incomplete instrumentation and disinfection of the root canal system as well as incomplete obturation of the canal.[3]

Another most common accidental error is instrument separation. Its incidence ranges from 2% to 6% of the cases. A variety of techniques and systems have been developed to remove a separated instrument. Successful removal depends on: the level of separation (coronal, middle or apical third); location in relation to the root canal curvature; the type of separated instrument; its length; the degree of canal curvature and the tooth type.[4]

Perforation in the floor of the pulp chamber of multirrooted teeth causes an inflammatory response in the periodontium, which can lead to irreversible loss of periodontal attachment in the area. The prognosis is related more with the size, contamination location of the lesion.[5] The main principle of conservative furcal perforation treatment is to seal the defect with filling material as soon as possible.[6]

These complications may prevent adequate cleaning and shaping, impair disinfection, and increase the risk of persistent periradicular pathology .[7] Advances in

magnification, ultrasonic instruments, and biocompatible repair materials such as MTA have enabled clinicians to overcome these challenges. This case report documents the successful management of a mandibular molar involving a ledge, furcation perforation, and separated instrument, followed by radiographic evidence of periradicular healing.

Case Report

A 26-year-old patient reported with pain and discomfort in the mandibular left first molar. The tooth had been previously accessed and exhibited tenderness on percussion. Radiographic examination revealed incomplete endodontic treatment with a fractured instrument fragment in the distal root canal and a periapical radiolucency associated with both roots. A furcation perforation was also suspected radiographically. [Fig.1]

Rubber dam isolation was performed, and the access cavity was refined under magnification. The fractured instrument in the distal root and a canal ledge in the mesiobuccal canal were identified. A glide path was negotiated using pre-curved stainless steel hand files (#8, #10, #15) with watch-winding and balanced force techniques in the mesial canals. Patency to full working length was re-established in the mesial canals and the ledge was managed. [Fig.2] The fractured instrument was simultaneously bypassed with the help of stainless-steel hand files (#8, #10, #15) and working length was determined in the distal canal.

The bleeding control was then achieved from the perforation site in the furcation area. After blocking the orifices of the canals with the help of Teflon tape, perforation site was sealed with mineral trioxide aggregate (MTA). A moist cotton pellet was placed to facilitate MTA setting. [Fig.3]

The fractured instrument removal was attempted in the next appointment. The fragment was exposed using ultrasonic tips under the dental operating microscope. Controlled ultrasonic vibration successfully dislodged and copious saline irrigation following it, helped retrieve the fragment without excessive dentin removal. [Fig.4,5]

The cleaning and shaping of the root canals were completed using rotary nickel-titanium instruments with copious irrigation of sodium hypochlorite and EDTA. Master cone radiograph was taken. [Fig.6]

Obturation was performed using the cold lateral compaction technique with a bioceramic sealer. The access cavity was restored with resin-modified glass ionomer followed by composite resin to ensure a durable coronal seal. [Fig.7]

At three months, the patient was asymptomatic with no tenderness to percussion. Radiographs demonstrated initial signs of periradicular healing.

Progressive reduction in periapical radiolucency was evident, with bone trabeculation re-establishing in the furcation and periapical regions. [Fig.8]

Discussion

Endodontic mishaps, or procedural accidents, are unfortunate events that may occur during treatment. While some result from inattention to detail, others are inherently unpredictable.[8] A lack of understanding of the principles behind cleaning and shaping can increase the risk of complications such as blockages, ledge formation, apical transportation, and perforations. These issues are often linked to the application of inappropriate cleaning and shaping techniques.

Ledging of curved canals is a common instrumentation error that typically occurs on the outer aspect of the curvature. It is often caused by excessive cutting and careless manipulation during root canal instrumentation. The formation of a ledge, along with canal blockage due to packed dentin chips or tissue debris, can hinder instrument access to the apex, leading to inadequate cleaning, incomplete instrumentation, and insufficient obturation.[9]

Ledges may result from several errors during endodontic treatment, [10] including:

1. Inadequate extension of the access cavity, limiting access to the apical portion of the root canal.
2. Loss of instrument control when treatment is attempted through a proximal surface cavity or restoration.
3. Incorrect assessment of the root canal direction.
4. Erroneous determination of root canal length.
5. Forcing instruments into the canal rather than using controlled movements.
6. Failing to follow the sequential use of instruments.

7. Overuse of a reaming action, such as rotating the file at the working length.
8. Inadvertent packing of debris in the apical portion, resulting in an apical blockage.
9. Inadequate irrigation and/or lubrication during instrumentation
10. Attempting to prepare calcified root canals

The most effective strategy for managing ledges is prevention. Careful and attentive instrumentation significantly reduces the risk of ledge formation. When a ledge does occur, it can often be bypassed by selecting the shortest file capable of reaching the desired working length. Gentle advancement of the file using a combination of slight rotational and “picking” motions can help guide the instrument past the ledge and allow it to reach the full working length of the canal. [11]

The root canal system's anatomical diversity is one of the most common reasons for tool fracture. [12] Furthermore, these mishaps are linked to a lack of professional knowledge of the technique, excessive instrument use, insufficient use, and the amount of sterilization undergone by the instrument. Torsional stress has been found in 55.7% of the cracked files studied by Sattapan et al., while cyclic fatigue was found in 44.3%. [13]

Instrument separation before complete instrumentation, particularly in teeth with pre-existing periapical pathology, often compromises the prognosis of endodontic treatment. In such situations, either retrieval or bypass of the fractured instrument becomes essential for achieving long-term success of therapy [14].

The likelihood of nonsurgical removal of a separated instrument is influenced by several factors, including the fragment's diameter, length, and position within the canal. In addition, dentin thickness, the presence of external root concavities, and overall canal anatomy play a significant role in determining retrieval feasibility. Fragments located in straight portions of the canal are generally more accessible for removal [15].

In the present case, the fractured segment was located in the distal canal, which exhibited minimal curvature and provided a favourable trajectory for retrieval. Various instrument retrieval systems and techniques

have been described in the literature; however, none can guarantee universal success or be considered a definitive gold standard [16].

The application of ultrasonics in endodontics was first introduced by Richman in 1957. Early ultrasonic devices operated at frequencies of 25–40 kHz; however, later handpieces were developed to function at lower frequencies (1–8 kHz), producing reduced shear stresses and thereby minimizing alterations to the canal surface.

In this report, ultrasonic techniques were successfully employed to retrieve the fragment without surgical intervention, thereby minimizing patient discomfort and preventing unnecessary dentin removal. The advantages of ultrasonics—such as conservative dentin cutting and tip designs that allow access even to the apical third—make it a valuable method for instrument retrieval in challenging cases.

Perforations are defined as pathological or iatrogenic communications between the root canal system and the surrounding periodontal tissues, which can significantly compromise the long-term prognosis of root canal therapy [17]. When the perforation is small, easily accessible, uninfected, and associated with a healthy periodontium, a non-surgical repair approach is preferred. However, in cases where non-surgical retreatment is unsuccessful or when simultaneous management of the periodontium is required, surgical intervention becomes necessary.

In the present case, the perforation was identified in the furcation area of a mandibular molar. It may have occurred during access cavity preparation, either while locating the canal orifices or during modification of the cavity. A sudden appearance of bleeding from the canal is often the earliest sign of such an occurrence. To prevent these mishaps, access cavity preparation should be carried out with a thorough understanding of the tooth anatomy and, wherever possible, under magnification aids such as dental operating microscopes to ensure accurate location of the canal orifices. [18].

Mineral trioxide aggregate (MTA) is a bioactive material composed of fine hydrophilic particles such as tricalcium silicate, tricalcium aluminate, and tricalcium oxide, with small amounts of additional mineral oxides. Bismuth oxide is incorporated to impart radiopacity. MTA exhibits a high pH of 12.5,

low solubility, and good compressive strength, although its mechanical properties make it less ideal for use in functional load-bearing areas. [19].

The successful resolution of periradicular pathology in this case emphasizes that careful planning and use of modern endodontic techniques can restore health even in severely compromised teeth.

Conclusion

This case illustrates that comprehensive management of complex endodontic mishaps—including ledge bypass, ultrasonic-assisted instrument retrieval, and MTA perforation repair—can lead to successful treatment outcomes with radiographic evidence of osseous healing. Clinicians should employ magnification, ultrasonics, and biocompatible materials to optimize the prognosis of such challenging cases.

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Figures

Fig 1. Preoperative radiograph showing perforation in furcation area, instrument fragment in distal canal and radiolucency in periapical area and furcation



Fig 2. Ledger is negotiated in mesiobuccal canal



Fig 3. Perforation repair done using MTA



Fig 4. Instrument retrieved from the distal canal



Fig 5. Retrieved instrument



Fig 6. Master cone radiograph



Fig 7. Post obturation Radiograph



Fig 8. Follow-up radiograph of 3 months

