Endodontic treatment and fractured instrument retrieval on mandibular second molar pulp necrosis with symptomatic apical periodontitis: a case report

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ABSTRACT

Introduction: Root canal treatment requires proper cleaning, shaping, and obturation. However, complications such as instrument fracture may occur. Preventing instrument fracture is important and should be prioritized over its retrieval. This case report aimed to evaluate endodontic treatment and the retrieval of a fractured instrument in a mandibular second molar with pulp necrosis and symptomatic apical periodontitis. **Case report:** A 52-year-old man was referred by a periodontist to the Dental Conservation Specialist Clinic of Prof. Soedomo RSGM with chief complaints of tooth mobility and swollen gums in the lower-right region. The tooth had no restoration, and palpation was positive. The patient was taking antihypertensive medication. Periapical radiography revealed a radiolucent area extending from the mesial root of tooth 47 to the bifurcation, with associated bone loss. The diagnosis was pulp necrosis with symptomatic apical periodontitis. At the first visit, COVID-19 screening, access opening, canal exploration, working length determination, root canal preparation, irrigation, and calcium hydroxide dressing were performed. At the subsequent visit, radiography revealed a fractured file in the apical third of the mesiobuccal root. Retrieval was performed using an endodontic microscope, Endosuccess retreatment tips (ET20–ET25; ACTEON), ultrasonic instrumentation, irrigation, and a wire loop device (BTR Pen, Cerkamed). Root canal treatment was continued after retrieval. The fractured file was located in the apical third of the mesiobuccal root, which curved distally on the periapical radiograph. Important considerations included visibility, file location, and remaining tooth structure. The endodontic microscope, Endosuccess retreatment tips (ET20–ET25; ACTEON), ultrasonic instrumentation, and wire loop device were used to facilitate maximum visibility and minimize root canal dentin reduction. **Conclusion:** The fractured instrument was successfully retrieved following instrument separation during endodontic treatment.

Keywords

Endodontic treatment, separated instrument, fractured instrument retrieval, pulp necrosis, symptomatic apical periodontitis

Perawatan endodontik dan pengambilan instrumen yang mengalami fraktur pada molar kedua mandibula dengan nekrosis pulpa dan periodontitis apikalis simptomatik: laporan kasus

ABSTRAK

***Pendahuluan**: Perawatan saluran akar harus dilakukan dengan baik mulai dari pembersihan, pembentukan, dan pengisian saluran akar meskipun terkadang terjadi kegagalan dalam perawatan, salah satunya adalah fraktur instrumen. Pencegahan fraktur instrumen endodontik merupakan hal yang sangat penting dan harus diprioritaskan dibandingkan dengan upaya pengambilan instrumen yang mengalami fraktur. Laporan kasus ini bertujuan untuk mengevaluasi perawatan endodontik dan pengambilan file patah pada molar kedua mandibula dengan periodontitis apikalis simptomatik. **Laporan kasus**: Laki-laki berusia 52 tahun datang ke Klinik Spesialis Konservasi Gigi RSGM Prof. Soedomo atas rujukan dari dokter spesialis periodonsia dengan keluhan mobilitas gigi, gusi bengkak, tidak terdapat restorasi, palpasi positif dan sedang mengonsumsi obat hipertensi. Pada radiografi periapikal terdapat area radiolusen pada akar mesial gigi 47 yang meluas hingga bifurkasi dan pengeroposan tulang. Berdasarkan pemeriksaan, diagnosisnya adalah nekrosis pulpa dengan periodontitis apikalis simptomatik. Pada kunjungan pertama, dilakukan skrining COVID-19, pembukaan akses, eksplorasi, penentuan panjang kerja, preparasi saluran akar, irigasi dan dressing kalsium hidroksida. Radiografi pada kunjungan berikutnya menunjukkan file yang mengalami fraktur di sepertiga apikal akar mesiobukal. Pengambilan instrumen yang mengalami fraktur dilakukan dengan menggunakan mikroskop endodontik, tip retreatment Endosuccess ET20–ET25 (ACTEON), instrumen ultrasonik, irigasi, dan alat wire loop (BTR Pen, Cerkamed). File yang mengalami fraktur terletak di sepertiga apikal akar mesiobukal, yang tampak melengkung ke arah distal pada radiografi periapikal. Mikroskop endodontik, tip retreatment Endosuccess ET20–ET25 (ACTEON), instrumen ultrasonik, dan alat wire loop digunakan untuk memfasilitasi visibilitas maksimal dan dan meminimalkan pengurangan dentin saluran akar. **Simpulan:** Pengambilan instrumen yang mengalami fraktur berhasil dilakukan setelah terjadi pemisahan instrumen instrumen selama perawatan endodontik.*

Kata kunci

Perawatan endodontik, instrumen yang mengalami fraktur, pengambilan instrumen yang mengalami fraktur, nekrosis pulpa, periodontitis apikalis simptomatik

INTRODUCTION

Endodontic treatment is generally safe with a high rate of success, even in the most challenging clinical situations. Nonetheless, endodontic management can be complex, presenting varying levels of difficulty and potential risks during the cleaning, shaping, and filling of root canals. Endodontic treatment is performed on teeth affected by necrosis, irreversible pulpitis, or specific conditions in vital teeth necessitating such intervention to preserve the tooth in the oral cavity for as long as possible.[1]

The main goals of root canal treatment are to clean and disinfect the root canal system thoroughly and achieve an effective seal. This process aims to establish or preserve the health of the periapical tissues.[2] Pulp and periodontal tissues are closely related, as both originate from mesodermal tissue during the embryonic stage.[3] When pulp abnormalities occur, bacterial products and inflammatory mediators can escape into the periodontal tissues. Conversely, in periodontal disorders, inflammatory products from periodontal pockets can enter the pulp cavity.[2]

These endo-perio lesions can be managed non-surgically. Endodontic and periodontal treatment aim to eliminate the disease's etiology and preserve the affected teeth.[4,5] Treatment consists of endodontic treatment, initial periodontal treatment, and a maintenance phase. Endodontic treatment involves root canal cleaning and preparation, the application of medicaments, and proper obturation.[2]

Endodontic treatment can result in procedural errors not only among students and beginners but also among skilled and experienced clinicians, even when all possible precautions are taken. Procedural errors in endodontic treatment can be broadly categorized into three types, namely errors related to access opening of the pulp space, canal shaping and cleaning, and obturation. A common procedural error encountered during root canal cleaning and shaping is instrument separation.[6]

A fractured instrument can cause blockage of the root canal system, complicating irrigation, disinfection, cleaning, and shaping procedures, thereby compromising the treatment outcome, particularly in infected teeth. Preventing instrument fracture is of vital importance and should be prioritized over retrieval. Several strategies can be implemented to minimize the risk of instrument separation, including proper glide path creation, which helps reduce the torsional load on NiTi rotary files, thereby reducing the risk of instrument separation.[7]

The use of torque-controlled endodontic motors with an auto-reverse function helps reduce cyclic fatigue and torsional failure of endodontic instruments.[8] Excessive apical force can lock the file tip within the canal, increasing friction and leading to torsional breakage.[9] Instruments should be inspected periodically for signs of fatigue, such as microcracks or unwinding, and replaced immediately if these signs are detected.[10] Operators should also adhere to the manufacturer's recommended number of uses.[11]

Preventing file fracture requires the operator to understand canal morphology before initiating endodontic treatment, including the root canal curvature angle and radius. Other relevant factors include the preparation instruments used, such as stainless steel (SS) hand files or nickel-titanium (NiTi) instruments, fatigue fractures caused by cyclic fatigue, torsional fractures, manufacturing methods, cross-sectional design, retreatment instruments, operator factors, and instrument usage frequency. This knowledge enables adequate root canal cleaning and shaping, which ultimately affects the prognosis of endodontic treatment.[12]

In addition, 2D radiographs often result in misdiagnosis and underestimation of the true curvature of the root canal. 3D imaging, such as magnetic resonance imaging and cone beam computed tomography, has provided dentists with detailed images of the root canal before treatment begins.[13] Eight out of ten dentists have encountered fractured endodontic files at some stage in their clinical practice, particularly when working on

posterior teeth.[14,15] Instrument separation is a prevalent and challenging issue in endodontic treatment, often resulting from improper or excessive use of instruments. This problem is particularly common when working in curved, narrow, or tortuous canals.[16] Clinicians must thoroughly comprehend the characteristics and designs of various tools employed in shaping and cleaning procedures. Among these, rotary instruments stand out due to their significant impact on outcomes.[17]

Instrument fracture is multifactorial and is influenced by various factors. These include the features of the access cavity, root canal geometry, and cross-sectional characteristics, which are affected by the patient's age and endodontic pathology. Additionally, the design and metallurgical properties of nickel-titanium rotary instruments, possible imperfections or manufacturing defects, instrumentation techniques, instrument dynamics within the root canal, and the number of sterilization cycles and uses all play a role.

Furthermore, the complexity of prior clinical situations, prior endodontic procedures, and the experience of the clinician are significant factors.[18] Continuous lubrication with an irrigation solution or lubricant is required for each instrument, which should be checked before use. If a bent instrument is rotated and viewed under reflected light from the lamp, the distortion of the flutes may become more apparent.[19]

Two approaches can be employed for the non-surgical management of a fractured instrument in the root canal system: fragment removal and fragment bypass.[6] When nonsurgical methods fail to retrieve fractured instruments, surgical interventions such as apicoectomy, root amputation, or intentional replantation may be employed. Intentional replantation involves the purposeful extraction and reinsertion of a tooth that has undergone endodontic treatment into its socket to address clinical or radiographic endodontic failures.[20]

Retrieving a fractured instrument from the root canal system is a complex task that demands specialized training, extensive experience, and a thorough understanding of the methods, techniques, and equipment available. The success of the removal process hinges on various factors, such as the instrument's location, visibility, size, length, and type, as well as the curvature and radius of the root canal. Furthermore, the operator's experience and level of fatigue play crucial roles in determining the procedure's outcome. The preparation phase plays a crucial role in the retrieval of separated instruments. Procedure times tend to increase with longer file lengths and greater degrees of canal curvature.[21]

Specialized instruments employed for the retrieval of separated instruments include the Endoextractor, instrument removal device, wire loop technology, and surgical techniques for removing fractured instruments.[16] In this case report, several advanced tools were used to retrieve the fractured file, including an endodontic microscope, Endosuccess retreatment tips (ET20-ET 25; ACTEON), ultrasonic instrumentation, and wire loop device. The use of an operating microscope and advanced illumination techniques greatly enhances the predictability of treatments. These tools enable clinicians to accurately locate all canals, ensuring thorough preparation and optimal obturation.[22] Utilizing indirect ultrasonic techniques results in minimal harm to the underlying root dentin, thereby potentially reducing the necessity for periapical surgery or intentional reimplantation.[23]

The novelty of this case lies in retrieving a fractured file located in the apical third of a severely curved mesiobuccal root using a combination of advanced endodontic techniques, including the use of an endodontic microscope, ultrasonic instrumentation (Endosuccess ET20–ET25; ACTEON), and a wire loop device (BTR Pen, Cerkamed). This approach demonstrates the importance of enhanced visibility and conservative dentin removal in improving the prognosis of complex retreatment cases, especially when managing file separation in posterior teeth with difficult anatomy**.** The aim of this case report is to evaluate endodontic treatment and fractured file retrieval in a mandibular second molar with pulp necrosis with symptomatic apical periodontitis**.**

CASE REPORT

The 52 year old male patient presented to the Dental Conservation Clinic of Prof. Soedomo, Faculty of Dentistry, UGM, following a referral from the periodontics clinic because of mobility of a mandibular right tooth, and a wire had been installed in the periodontia section for further endodontic treatment. The tooth had been mobile for 1 year and had been painful during chewing for 1 month. No abnormalities were identified on extraoral examination.

The gum in the area of the tooth had swollen and the swelling had resolved spontaneously without treatment. The tooth had never been restored. The patient did not want the tooth extracted, and wanted to retain it. The patient had a history of hypertension and heart disease. The patient also reported smoking one pack of cigarettes per day.

On objective examination, tooth 47 had no caries. Splinting was present. Percussion and palpation tests were positive (+), the cold vitality test was negative (-), and tooth mobility was grade 2. Probing depths were approximately 6 mm distally, 7 mm buccally, and 8 mm mesially. Periapical radiographic examination revealed a radiolucent area around the mesial root of tooth 47 that extended to the bifurcation area. There was horizontal and angular bone loss extending to the apex of the mesial root of tooth 47 and the apical third of the distal root. There was no radiolucent area associated with the crown of tooth 47 (Figure 1).

Based on the clinical and radiographic findings, the tooth was diagnosed with pulp necrosis with symptomatic apical periodontitis. The differential diagnosis included a primary periodontal lesion and a combined endodontic-periodontal lesion because of tooth mobility, increased periodontal probing depths, and extensive bone loss. However, the negative cold vitality test, positive percussion and palpation tests, and radiographic findings supported a primary endodontic diagnosis of pulp necrosis with symptomatic apical periodontitis in this case. The prognosis was considered favorable, provided that adequate chemomechanical preparation, removal of the separated instrument, disinfection, and adequate root canal obturation could be achieved, followed by definitive coronal restoration and periodontal maintenance.

The treatment plan consisted of initial scaling and root planing, nonsurgical root canal treatment, retrieval of the separated instrument using an endodontic microscope, ultrasonic tips, and a wire-loop device, followed by calcium hydroxide intracanal medication, root canal obturation, definitive composite restoration, and periodic clinical and radiographic follow-up. The favorable clinical and radiographic outcomes observed during follow-up further supported the selected treatment approach.



A **B**

Figure 1. A. Pre-operative clinical photograph of tooth 47; B. Pre-operative periapical radiograph of tooth 47.

At the first visit, COVID-19 screening, subjective and objective examinations, and intraoral photographs were obtained to confirm the diagnosis and determine the treatment plan. Pulp necrosis with symptomatic apical periodontitis was diagnosed in tooth 47. The patient was informed about the condition of the tooth, clinical findings, treatment plan,

treatment procedures, treatment risks, treatment costs, and treatment duration. After the patient agreed to the treatment plan, the patient signed an informed consent form.

Scaling and root planing were performed, and access to the pulp chamber was achieved using an Endo access bur (Dentsply). The pulp chamber walls were widened using a non-cutting ended fissure bur (Diamendo bur, Dentsply). Exploration, working length measurement, and coronal flaring were performed using SX, S1, and S2 files. The working lengths were confirmed using an electronic apex locator (Morita, Japan). The working length of the distal root canal was 20.5mm, PK of mesiobuccal root canal was 20 mm, and PK of mesiolingual root canal was 20mm were obtained. Root canal preparation was performed using ProTaper Gold (Dentsply) with the crown down technique. During preparation of the mesiobuccal root canal using an F1 size rotary file, the file fractured. The patient was informed of the incident, which was confirmed radiographically (Figure 2).

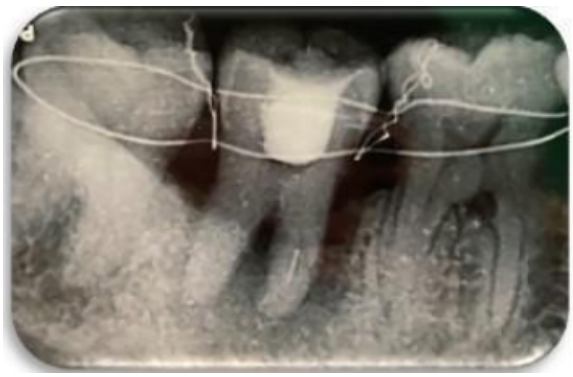


Figure 2. Periapical radiograph of tooth 47 showing an elongated radiopaque image on the mesial half of the root, approximately 4 mm in length, resembling a fractured instrument.

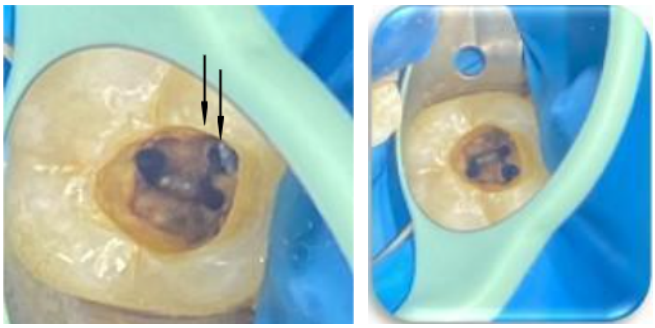
The root canal was irrigated with an irrigant activated using an endodontic irrigation tip (EDDY, VDW). An endodontic microscope was used to assist in retrieving the fractured file. Furthermore, the distal root canal orifice and mesiolingual root canal orifice were sealed using Teflon tape so that the retrieved fragment would not enter other root canals. Retrieval of the fractured file began by widening the mesiobuccal root canal access in the coronal two-thirds using an endosuccess retreatment tip (ET20, ACTEON) to form a staging platform.

Dilation was interspersed with irrigation using 2.5% NaOCl, which was ultrasonically activated. The root canal access was widened until the instrument fragments could be seen using an endodontic microscope, appearing as a shiny gray object within the root canal. The staging platform was prepared to expose 2-3 mm of the coronal portion of the fragment. Removal of the fractured instrument was continued using the ET-25 (ACTEON) tip in a counterclockwise motion to loosen the fragment from the root canal wall.

This procedure was performed repeatedly interspersed with irrigation using activated 2.5% NaOCl and saline solution, but the fragments could not be removed. This was likely due to the length of the fragment, which required a mechanical device to retrieve it. Retrieval was continued using a wire loop device (BTR Pen, Cerkamed) by adjusting the loop according to the diameter of the fragment, then inserted onto the staging platform that had been prepared. Once 2–3 mm of the coronal fragment had been exposed, the loop was tightened around it, and the fragment was withdrawn (Figure 3).

After the fragment was retrieved, root canal preparation was continued on the mesiobuccal root canal using an F1 size rotary file. The root canal was irrigated again using 2.5% NaOCl rinsed with saline, dried with a paper point. Root canal medication using calcium hydroxide paste (Calcigel, Prevest Dentpro) was applied directly into the root canal through a syringe tip. The cavities were closed with sterile cotton pellets and then a

temporary filling (Caviton) was placed, and the patient was instructed to return for a follow-up visit in 2 weeks.



A B

Figure 3. Endodontic microscope view: A. The fractured instrument fragment in the mesiobuccal orifice; B. The fragment was pulled out

At the second visit, subjective and objective examinations were performed. The patient reported no complaints. Percussion and palpation tests were negative, and tooth mobility was grade 0. The temporary restoration was then removed using an ultrasonic scaler. The root canal was cleaned of residual medicament by irrigating with 2.5% NaOCl and rinsed with saline. Root canal obturation was performed using the single cone technique. The fit of the master gutta percha (master apical cone) was checked at the respective working lengths: size F1 into the mesiobuccal, mesiolingual root canal, and size F2 in the distal root canal according to the respective working length.

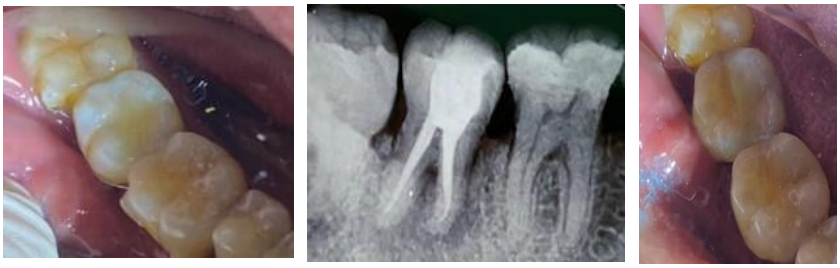
Each root canal was checked for tugback. Gutta percha was previously disinfected by soaking in 2.5% NaOCl solution for 1 minute then rinsed with 70% alcohol and dried. The gutta percha master cone was sealed by bioceramic sealer (ceraseal) at 1/3 of the end and then inserted through the root canal according to working length. The gutta percha was cut 1 mm below the canal orifice using a down pack device (Fast Pack, Eighteenth) and lightly condensed. The remaining sealer in the cavities was cleaned using cotton pellets and base application using RMGIC then the temporary filling (Caviton) was closed in cavities then asked to the patient to come back 2 weeks later (Figure 4).



A B

Figure 4. A. Orifice has been filled by gutap percha point; B. Periapical radiograph of tooth 47, the root canal has been hermetically obturated

At the third visit, subjective and objective examinations were performed. The patient reported no complaints. The tooth was then restored using composite resin. A follow-up examination was conducted 8 months after restoration. The patient remained asymptomatic, and the restoration was intact. Radiographic examination also showed healing of the tooth supporting tissues (Figure 5).



A B C

Figure 5. A. Final restoration with composite resin; B. Periapical radiograph of tooth 47 at control 8 months after RCT; C. Clinical photo at 10 months control.

DISCUSSION

The findings of this case indicate that successful management of a separated instrument in a curved mesiobuccal canal can be achieved when retrieval is carefully planned according to the location and accessibility of the fragment, while preserving the remaining radicular dentin (Figure 2). In this case, the successful retrieval of the separated F1 instrument enabled the continuation of chemomechanical preparation and completion of root canal treatment, followed by the resolution of clinical signs and favorable radiographic healing during follow-up (Figure 3).

These findings are consistent with previous research by Terauchi, who reported successful retrieval of all 128 separated instruments in a clinical series, with 89.8% removed using ultrasonic instruments alone, while greater instrument length and root canal curvature were associated with longer retrieval procedures, supporting the importance of individualized planning in curved canals.[24] Similarly, Hindlekar demonstrated successful retrieval of separated instruments located in the middle and apical thirds of molar canals using ultrasonic instrumentation under magnification, followed by completion of root canal treatment and restoration, further supporting the use of magnification-assisted ultrasonic retrieval as a conservative approach.[25]

The improvement in tooth mobility from grade 2 to grade 0 and the absence of percussion and palpation sensitivity suggest a favorable clinical response after combined periodontal and endodontic treatment. Aminsobhani previously reported successful management of a mandibular molar with a separated instrument accompanied by furcation involvement and periapical and furcation radiolucencies, in which magnification-assisted instrument retrieval followed by adequate endodontic treatment resulted in resolution of the apical and furcal lesions at a 2-year follow-up.[26] These findings suggest that instrument separation does not necessarily require extraction or compromise the treatment outcome when the fragment can be safely accessed and removed using appropriate magnification and retrieval techniques. However, the favorable outcome should be interpreted within the context of this individual case, as the predictability of separated instrument retrieval depends on anatomical complexity, fragment location, remaining dentin thickness, and the clinician's technical expertise.

Instrument fragments separated in the middle to apical thirds of the root canals of molars can be successfully retrieved using ultrasonic tips under magnification, with primary consideration given to minimizing radicular dentin loss and preserving the structural integrity of the tooth.[24] Three cases of separated NiTi instruments have been reported in which the fragments were successfully retrieved using a customized syringe-and-loop technique under a dental operating microscope, suggesting that loop-based retrieval techniques may serve as a conservative alternative when adequate access to the separated fragment is achievable.[27]

The use of the Masserann technique for the retrieval of separated instruments has been reported, emphasizing that the selection of the retrieval method should consider the location and characteristics of the fragment, root canal anatomy, and the risk of excessive dentin removal during the procedure.[28] Guided endodontics has been described as a more controlled approach for the retrieval of separated instruments from root canals by integrating CBCT, intraoral scanning, digital drilling-path planning, and 3D-printed guides, thereby enabling more precise access to the fragment while minimizing the sacrifice of dental tissue.[29]

The selection of the retrieval approach for the separated instrument in this case was based on the fact that the fragment remained clinically visible and accessible (Figure 3). Similarly, previous research by Rathod et al. reported successful retrieval of a separated instrument in the mesiolingual canal of a mandibular first molar when the fragment was directly visualized under a dental operating microscope, allowing a staging platform to be created and the fragment to be loosened using ultrasonic instrumentation while minimizing unnecessary dentin removal.[30] The success of fragment retrieval is primarily influenced by fragment visibility, fragment length in relation to the degree of root canal curvature, and the technique employed (Figure 4). Therefore, the use of an operating microscope in combination with ultrasonic tips and a wire loop was considered a conservative approach to facilitate completion of root canal preparation while minimizing excessive removal of radicular dentin.[20]

From the patient's perspective, treatment success was demonstrated by achieving the goal of preserving a tooth that had previously been at risk of extraction (Figure 1), in accordance with the patient's desire to retain the tooth. This outcome was further supported by the resolution of clinical symptoms, improvement in tooth mobility, and radiographic findings indicating healing of the supporting tissues during the follow-up period (Figure 5). A similar outcome was reported in a case involving the successful management of an endo-periodontal lesion with an initially unfavorable prognosis through a conservative endodontic-periodontal approach, with regression of periodontal pockets and clinical improvement after 18 months of follow-up.[31]

Likewise, previous reports have described the resolution of endo-periodontal lesions following endodontic treatment, including the disappearance of tooth mobility and restoration of periodontal health, with favorable findings maintained over a 4-year follow-up period. These findings suggest that, in teeth with a compromised prognosis, successful treatment should be assessed not solely by tooth retention, but also through a combination of patient-centered outcomes and objective clinical and radiographic parameters, including symptom resolution, reduction or absence of mobility, periodontal stability, and evidence of supporting tissue healing.[32] However, these findings should be interpreted with caution, as this report describes a single case with a limited follow-up period.

Therefore, the successful retrieval of the separated instrument and subsequent periapical healing observed in this case cannot be generalized to all cases of instrument separation, particularly those involving more complex root canal anatomy or fragments that cannot be directly visualized and accessed. The limitation of this case report is that it represents a single clinical observation, and the findings may not be generalizable to all clinical scenarios involving instrument separation in curved root canals.

CONCLUSION

Retrieval of a fractured instrument was successfully performed following instrument separation during endodontic treatment. Despite the condition of pulp necrosis with symptomatic apical periodontitis, the treatment results showed that the supporting tissues healed favorably following instrument retrieval and endodontic treatment. The implication

of this report is to highlight the value of incorporating advanced magnification and retrieval devices into endodontic practice to enhance treatment outcomes in challenging cases involving separated instruments.

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