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Surgical removal of a fractured endodontic instrument beyond periapex of maxillary lateral incisor using a dental operating microscope: A case report

Siddhesh Mokal, Suresh Shenvi
KLE Academy of Higher Education and Research (KLE University), Belgaum, Karnataka, India
sureshshenvi123@gmail.com

Abstract

The introduction of rotary nickel-titanium (NiTi) instruments revolutionized endodontics, enhancing root canal treatment through greater flexibility and procedural efficiency. However, NiTi instruments carry a higher risk of fracture compared to stainless steel files. Instrument separation within the canal can complicate endodontic therapy and may adversely affect prognosis if untreated spaces remain. This case report describes the surgical retrieval of a fractured endodontic instrument extending beyond the apical foramen in a 52-year-old female patient. Under magnification and using precise techniques, the instrument was successfully removed, followed by a one-year follow-up that revealed complete healing. Advanced technologies like operating microscopes, CBCT, and regenerative materials such as platelet-rich fibrin (PRF) significantly improve outcomes by enhancing precision and supporting healing. Despite the potential challenges posed by instrument fractures, successful outcomes can be achieved with meticulous diagnosis, planning, and the use of modern techniques. This case highlights the importance of integrating advanced tools in endodontic practice to optimize treatment results.

Keywords: apical surgery, CBCT, endodontic instrument fracture, nickel-titanium instruments, platelet-rich fibrin, root canal therapy, surgical instrument retrieval

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Хирургическое удаление сломанного эндодонтического инструмента за пределами периапикального отверстия верхнего латерального резца с использованием стоматологического операционного микроскопа: клинический случай

С. Мокал, С. Шенви
KLE Academy of Higher Education and Research (KLE University), Белгаум, Карнатака, Индия
sureshshenvi123@gmail.com

Аннотация

Введение вращающихся никель-титановых (NiTi) инструментов произвело революцию в эндодонтии, улучшив лечение корневых каналов благодаря большей гибкости и эффективности процедур. Однако инструменты NiTi имеют более высокий риск поломки по сравнению с инструментами из нержавеющей стали. Сломанные инструменты в канале могут усложнить эндодонтическое лечение и негативно сказаться на прогнозе, если останутся необработанные участки. В данном клиническом случае описывается хирургическое извлечение фрагмента эндодонтического инструмента, выступающего за пределы апикального отверстия, у 52-летней пациентки. С использованием увеличения и точных техник инструмент был успешно удален, что подтвердилось полным заживлением при наблюдении через год. Современные технологии, такие как операционные микроскопы, КЛКТ и регенеративные материалы, такие как богатая тромбоцитами фибриновая матрица (PRF), значительно улучшают результаты, повышая точность и поддерживая заживление. Несмотря на сложности, вызванные поломками инструментов, возможно достижение успешных результатов при тщательной диагностике, планировании и использовании современных методов. Этот случай подчёркивает важность интеграции передовых технологий в эндодонтическую практику для оптимизации результатов лечения.

Ключевые слова: апикальная хирургия, КЛКТ, поломка эндодонтического инструмента, никель-титановые инструменты, богатая тромбоцитами фибриновая матрица, лечение корневых каналов, хирургическое извлечение инструмента

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INTRODUCTION

The introduction of rotary nickel-titanium (NiTi) instruments in endodontics marked a significant advancement in root canal treatment by enhancing the efficiency of cleaning and shaping procedures [1]. Because of their superelastic characteristics, these incredibly flexible tools are renowned for their ability to minimize procedural errors like ledging and canal transportation while encouraging more centered and rounder canal preparations. However, despite their advantages, rotary NiTi instruments are associated with a higher risk of fracture than traditional stainless steel (SS) files. Instrument fracture within the root canal system presents a major challenge in endodontic therapy, often complicating the treatment outcome. Several studies have investigated the factors leading to instrument failure after clinical use, and various strategies have been suggested to decrease the instrument breakage risk [2; 3].

Between 0.5% and 5% of root canal procedures result in broken instrument, according to reports. It can be detrimental to the prognosis of treatment if a fractured tool prevents the canal from being effectively cleaned beyond the obstruction [4; 5]. In many cases, this can lead to the failure of root canal therapy, causing significant anxiety for patients. Consequently, the optimal management of fractured root canal instruments involves their removal [6].

Various methods and tools have been created to facilitate the recovery of separated instruments. Even with sophisticated methods, there are situations in which it is not possible to recover the separated file. When non-surgical removal techniques have failed, leaving the fragment in the canal may be considered in certain situations [7]. It is important to note that aggressive removal efforts may lead to excessive reduction of the dentinal walls, potentially resulting in canal wall perforation, which can further compromise the tooth's prognosis [8].

While it is uncommon for endodontic instruments to fracture beyond the apical foramen, when this occurs, the retained fragment, often harboring bacteria and dentine debris, acts as a foreign object and may trigger inflammation [8]. The fractured section is frequently perceived by patients as a "broken needle", which causes psychological discomfort. Therefore, surgical intervention is frequently necessary to remove the fragment, especially when it is located beyond the apical foramen. Before doing surgery, it is imperative to have a complete awareness of the exact location, size, and connection of the broken instrument to the surrounding anatomical structures and the root apex [9].

The purpose of this study is to describe a surgically performed removal of a separated endodontic instrument that extended partially beyond the apical foramen.

CASE REPORT

The major complaint of a 52-year-old female patient who had been suffering from minor pain and periodic discomfort in the upper left facial region for six months was sent to the Department of Conservative Dentistry and Endodontics. The patient had no relevant medical history. However, her history of dental depicted that root canal treatment had been performed on the left upper lateral incisor one year ago, with temporary relief achieved through anti-inflammatory medication.

A separate endodontic instrument was found in the maxillary left lateral incisor after clinical and radiographic evaluation. It was found in the apical third of the root and extended into the periapical area beyond the apical foramen and there was a widening of periodontal ligament (Fig. 1, *A*). The fixed location of the instrument was confirmed by the intraoral periapical radiograph. With the patient's informed consent, the choice to remove the instrument surgically was made.

Using 2% lignocaine and 1:80,000 adrenaline (Lignox, Indoco Remedies, India) delivered via an infraorbital block and a nasopalatine block, the surgery was performed under local anesthetic. A finely constructed crevicular incision was created, stretching from the distal portion of the left maxillary canine to the mesial aspect of the right maxillary central incisor. To enhance access, a releasing incision was carefully extended into the vestibule. The entire procedure was performed under the magnification of a dental operating microscope, ensuring precision and control throughout (Zeiss OPMI Pico).

At the root's apex, a 5 mm bony window was made through the buccal cortex (Fig. 1, *B*). Using mosquito forceps, the detached tool was carefully visualized and extracted. A radiograph taken after surgery verified that the fractured segment had been fully removed. To prevent instrument displacement, a 3 mm portion of the root end (Fig. 1, *C*), along with the endodontic instrument, was excised as a single unit, confirmed by a periapical radiograph (Fig. 1, *D*). Using a hot burnisher, the guttapercha at the apical end was burnished. After healing and irrigating the surgery site with regular saline, 3-0 silk sutures were used to close it (Fig. 1, *E*). Following surgery, the patient was given prescriptions for 0.12%

chlorhexidine gluconate mouthwash three times a day for seven days, 500 mg of amoxicillin every eight hours for five days, and 600 mg of ibuprofen every eight hours for three days. Seven days later, the patient was supposed to have her sutures removed. When the patient was seen again a month later, the periapical bone was gradually regenerating, and there were no symptoms. A permanent prosthesis was then fabricated. A one-year recall revealed complete radiographic healing, and the patient was asymptomatic (Fig. 1, *F*).

DISCUSSION

Periradicular disease is primarily caused by the presence of microorganisms in parts of the root canal system that are either not treated enough or are not treated at all, rather than endodontic procedural errors being the direct cause of treatment failure. These mistakes sometimes result in issues like ledge formation or instrument fractures and are caused by things like inadequate understanding of root canal anatomy or inappropriate use of mechanical instrumentation procedures [10].

Instrument separation typically occurs due to improper handling, overuse, or excessive pressure applied to endodontic files, particularly in challenging cases involving curved or calcified canals. The clinical significance of instrument separation has been extensively studied. Crump and Natkin's investigation into cases of teeth with separated instruments revealed no statistically significant difference in failure rates between teeth with or without separated instruments. However, contrasting findings from Frostell and Strindberg reported a 14% higher failure rate in cases where instrument separation occurred, emphasizing the impact this complication can have on treatment outcomes [11; 12].

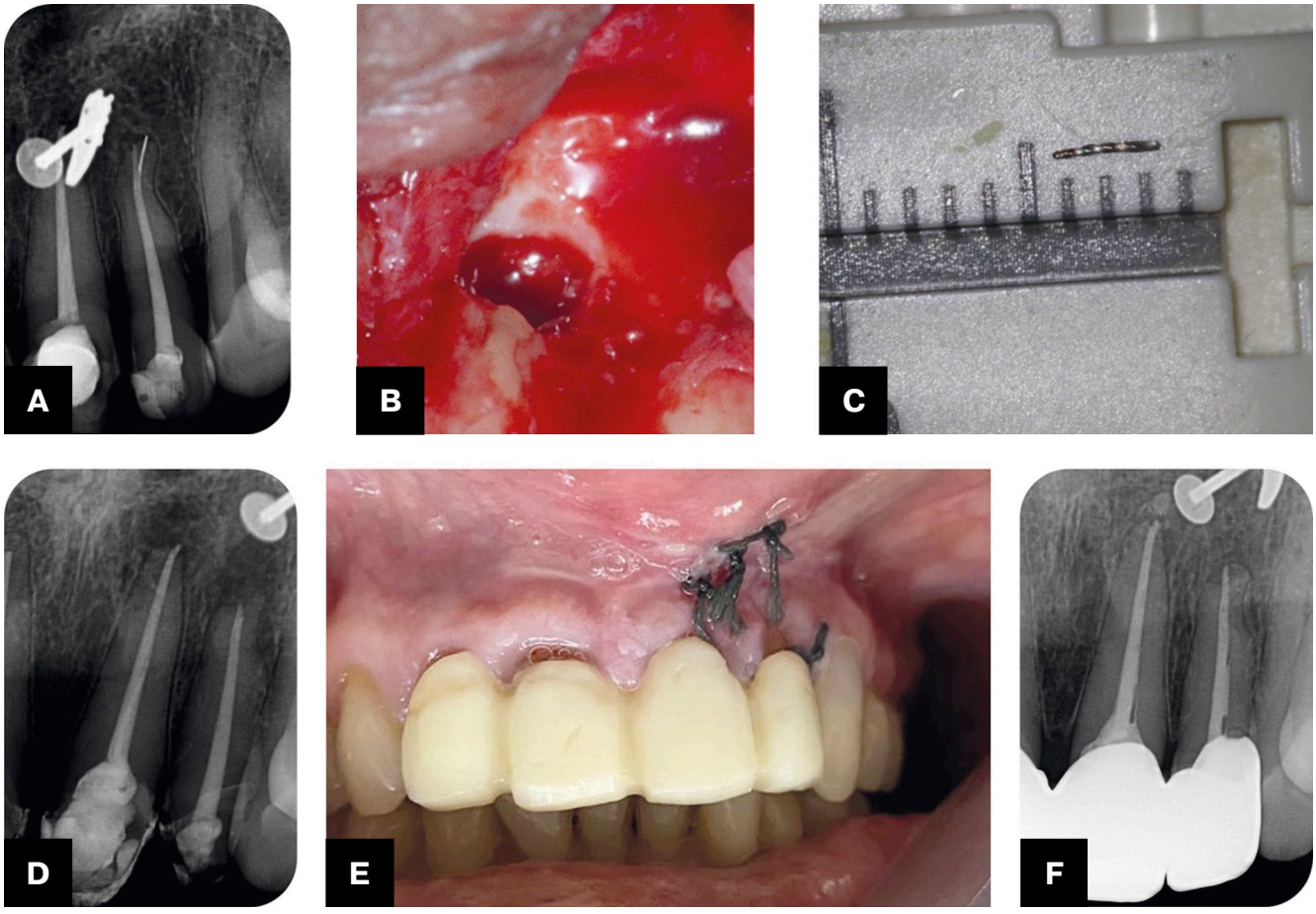

Fig. 1. Case report of the surgical retrieval of a fractured endodontic instrument extending beyond the apical foramen in a 52-year-old female patient: *A* – radiograph showing separated endodontic instrument beyond periapex; *B* – bony window created under Dental operating microscope; *C* – retrieved broken endodontic instrument from root apex; *D* – immediate postoperative radiograph; *E* – immediate clinical picture showing flap closure and suturing; *F* – 1-year follow-up radiograph

Рис. 1. Клинический случай хирургического удаления отделенного эндодонтического инструмента, выступающего за пределы апикального отверстия, у 52-летней пациентки: *A* – рентгенограмма, показывающая фрагмент эндодонтического инструмента за пределами верхушки корня; *B* – костное окно, созданное под стоматологическим микроскопом; *C* – извлеченный сломанный эндодонтический инструмент из верхушки корня; *D* – рентгенограмма, сделанная сразу после операции; *E* – клиническое изображение, демонстрирующее ушивание и закрытие лоскута; *F* – рентгенограмма через 1 год после операции, демонстрирующая успешное заживление и отсутствие патологических изменений

Instrument fractures during endodontic procedures often cause considerable anxiety for both clinicians and patients. Consequently, every effort should be made to manage the tooth non-surgically whenever possible. Torabinejad and Lemon proposed that prognosis is more favourable when a larger instrument separates during the later stages of canal instrumentation, particularly near the working length. Conversely, cases where a smaller instrument separates early in the procedure – especially short of the apex or beyond the apical foramen – pose a greater challenge, as the prognosis is influenced by the volume of infected canal space that remains untreated beyond the separated instrument. In the current case, the instrument fragment extended beyond the apical foramen, and the patient exhibited symptoms, necessitating its removal [13; 14].

Several methods are available for retrieving separated instruments, including forceps, file braiding techniques, chemical solvents, hypodermic surgical needles, Masserann kits, ultrasonics, and loop techniques. In cases where complex root canal anatomy or poor visibility complicates the retrieval, bypassing the fragment is also a viable alternative [15; 16].

A complete medical history, a careful clinical examination, and high-quality periapical radiographs are essential for the proper pre-operative diagnosis of teeth that are scheduled for apical surgery in any surgical procedure. In the present case report, radiovisiography (RVG) was utilized to precisely locate the fractured instrument segment, ensuring detailed visualization and aiding in treatment planning [17].

The operating microscope was a crucial tool for the techniques employed in this study. In our case report, Its use allowed for enhanced visualization, facilitating a more accurate location of the fragment and enabling a less invasive treatment approach. This precision contributes to improved outcomes and minimized tissue damage during the procedure [18].

In situations when endodontic difficulties arise, several extra modalities might be of great benefit. Accurate visualization of anatomical structures is made possible by cone beam computed tomography (CBCT), which makes precise surgical procedure planning easier. The accuracy of surgery can be improved by creating virtual surgical templates that can be manufactured using 3D printers due to developments in digital impressions and 3D imaging technology. Reports on guided procedures in contemporary endodontic periapical surgery and pulpal calcification therapy demonstrate the advantages of incorporating these cutting-edge technologies into clinical practice [19].

In cases involving large lesions, protein-rich fibrin (PRF) can be utilized effectively. PRF's fibrin network promotes angiogenesis and cellular migration, which in turn aids in tissue regeneration. Furthermore, PRF has several growth factors that are released gradually, including insulin-like growth factor (IGF), transforming growth factor (TGF), and platelet-derived growth factor (PDGF). Because the leukocytes and cytokines in PRF help control any infectious or inflammatory processes related to bone graft materials, this prolonged release promotes an ongoing healing process [20].

CONCLUSION

Periradicular disease is mainly caused by microbial infections in untreated or inadequately treated areas of the root canal. While instrument separation can cause anxiety, it doesn't always lead to failure if managed well. Prognosis depends on factors like instrument size, location, and untreated canal space. Advanced techniques, such as operating microscopes, CBCT, and PRF, improve outcomes by enhancing precision, minimizing tissue damage, and aiding healing. Careful diagnosis, effective planning, and modern tools are key to success in complex cases.

REFERENCES

1. Terauchi Y., Ali W.T., Abielhassan M.M. Present status and future directions: Removal of fractured instruments. *Int Endod J*. 2022;55(Suppl. 3):685–709. https://doi.org/10.1111/iej.13743
2. McGuigan M.B., Louca C., Duncan H.F. Clinical decision-making after endodontic instrument fracture. *Br Dent J*. 2013;214(8):395–400. https://doi.org/10.1038/sj.bdj.2013.379
3. Johnson W.T. The impact of instrument fracture on outcome of endodontic treatment. *Yearbook of Dentistry*. 2007;2007:238–239. https://doi.org/10.1016/S0084-3717(08)70487-2
4. Gandevivala A., Parekh B., Poplai G., Sayed A. Surgical removal of fractured endodontic instrument in the periapex of mandibular first molar. *J Int Oral Health*. 2014;6(4):85–88.
5. Sjogren U., Hagglund B., Sundqvist G., Wing K. Factors affecting the long-term results of endodontic treatment. *J Endod*. 1990;16(10):498–504. https://doi.org/10.1016/S0099-2399(07)80180-4
6. Machtou P., Reit C. Non-surgical retreatment. In: Bergenholtz G., Hørsted-Bindslev P., Reit C. (eds). *Textbook of Endodontology*. Oxford: Blackwell Munksgaard Ltd; 2003, pp. 300–310.
7. Madarati A.A., Hunter M.J., Dummer P.M. Management of intracanal separated instruments. *J Endod*. 2013;39(5):569–581. https://doi.org/10.1016/j.joen.2012.12.033
8. Terauchi Y., Sexton C., Bakland L.K., Bogen G. Factors affecting the removal time of separated instruments. *J Endod*. 2021;47(8):1245–1252. https://doi.org/10.1016/j.joen.2021.05.003
9. Wang H., Ni L., Yu C., Shi L., Qin R. Utilizing spiral computerized tomography during the removal of a fractured endodontic instrument lying beyond the apical foramen. *Int Endod J*. 2010;43(12):1143–1151. https://doi.org/10.1111/j.1365-2591.2010.01780.x

10. Lin L.M., Rosenberg P.A., Lin J. Do procedural errors cause endodontic treatment failure? *J Am Dent Assoc*. 2005;136(2):187–193. https://doi.org/10.14219/jada.archive.2005.0140
11. Crump M.C., Natkin E. Relationship of broken root canal instruments to endodontic case prognosis: a clinical investigation. *J Am Dent Assoc*. 1970;80(6):1341–1347. https://doi.org/10.14219/jada.archive.1970.0259
12. Strindberg L.Z. The dependence of the results of pulp therapy on certain factors: An analytic study based on radiographic and clinical follow-up examination. *Acta Odontol Scand* 1956;14(Suppl. 21):1–175.
13. Torabinejad M., Lemon R.R. Procedural accidents. In: Walton R., Torabinejad M. (eds). *Principles and practice of endodontics*. 3rd ed. Philadelphia: Saunders; 2002, pp. 310–330.
14. Lakshmaiah D., Raj Kumar J., Sakthi N., Karunakaran J., Vishwanath S. The management of fractured dental instruments: A case series. *Cureus*. 2023;15(11):e49132. https://doi.org/10.7759/cureus.49132
15. Gencoglu N., Helvacioglu D. Comparison of the different techniques to remove fractured endodontic instruments from root canal systems. *Eur J Dent*. 2009;3(2):90–95.
16. Reit C., Petersson K., Molven O. Diagnosis of pulpal and periapical disease In: Bergenholtz G., Hørsted-Bindslev P., Reit C. (eds). *Textbook of Endodontology*. Oxford: Blackwell Munksgaard Ltd; 2003, pp. 9–18.
17. Suter B., Lussi A., Sequeira P. Probability of removing fractured instruments from root canals. *Int Endod J*. 2005;38(2):112–123. https://doi.org/10.1111/j.1365-2591.2004.00916.x
18. Strbac G.D., Schnappauf A., Giannis K., Moritz A., Ulm C. Guided modern endodontic surgery: A novel approach for guided osteotomy and root resection. *J Endod*. 2017;43(3):496–501. https://doi.org/10.1016/j.joen.2016.11.001
19. Kökdere N.N., Baykul T., Findik Y. The use of platelet-rich fibrin (PRF) and PRF-mixed particulated autogenous bone graft in the treatment of bone defects: An experimental and histomorphometrical study. *Dent Res J*. 2015;12(5):418–424. https://doi.org/10.4103/1735-3327.166188
20. Naik B., Karunakar P., Jayadev M., Marshal V.R. Role of Platelet rich fibrin in wound healing: A critical review. *J Conserv Dent*. 2013;16(4):284–293. https://doi.org/10.4103/0972-0707.114344

INFORMATION ABOUT THE AUTHORS

Siddhesh Mokal – Postgraduate Student, Department of Conservative Dentistry and Endodontics, KLE VK Institute of Dental Sciences, KLE Academy of Higher Education and Research (KLE University); 590010, India, Karnataka, Belgaum, Nehru Nagar; https://orcid.org/0009-0006-3976-9281

Suresh Shenvi – Reader, Department of Conservative Dentistry and Endodontics, KLE VK Institute of Dental Sciences, KLE Academy of Higher Education and Research (KLE University); 590010, India, Karnataka, Belgaum, Nehru Nagar; https://orcid.org/0000-0003-4466-774X

ИНФОРМАЦИЯ ОБ АВТОРАХ

Сиддхеш Мокал – аспирант, кафедра терапевтической стоматологии и эндодонтии, Институт стоматологических наук KLE VK, Академия высшего образования и исследований KLE (Университет KLE), 590010, Индия, Карнатака, Белгаум, Неру Нагар; https://orcid.org/0009-0006-3976-9281

Суреш Шенви – доцент, кафедра терапевтической стоматологии и эндодонтии, Институт стоматологических наук KLE VK, Академия высшего образования и исследований KLE (Университет KLE); 590010, Индия, Карнатака, Белгаум, Неру Нагар; https://orcid.org/0000-0003-4466-774X

AUTHOR'S CONTRIBUTION

Siddhesh Mokal – conceptualization, methodology, formal analysis, writing – original draft preparation. Dr. Mokal was responsible for study design, and drafting the manuscript.

Suresh Shenvi – investigation, resources, writing—review and editing and supervision. Dr. Shenvi contributed to revising the manuscript for critical intellectual content.

ВКЛАД АВТОРОВ

С. Мокал – концепция, методология, формальный анализ, написание – подготовка оригинального черновика. С. Мокал отвечал за разработку исследования и подготовку рукописи.

С. Шенви – проведение исследования, обеспечение ресурсами, написание – рецензирование и редактирование, а также руководство. С. Шенви участвовал в редактировании рукописи, внося существенные интеллектуальные дополнения.