

	<div>ORIGINAL RESEARCH PAPER</div>	<div>Dental Science</div>
	<div>ENDODONTIC MANAGEMENT OF SEPARATED INSTRUMENT: A CASE SERIES OF INSTRUMENT RETRIEVAL</div>	<div>KEY WORDS: Endodontic complications, Instrument separation, Retrieval techniques, Bypass techniques, Root canal treatment.</div>
<div>Dr. Kartika Goswami</div>	<div>Post Graduate, Conservative Dentistry and Endodontics, Kalka Dental College, Meerut, UP</div>	
<div>Dr. Panna Mangat</div>	<div>Prof & HOD Conservative Dentistry and Endodontics, Kalka Dental College, Meerut, UP</div>	
<div>Dr. Mandeep Solanki</div>	<div>Post Graduate, Conservative Dentistry and Endodontics, Kalka Dental College, Meerut, UP</div>	
<div>Dr. Neha Rajput</div>	<div>Post Graduate, Conservative Dentistry and Endodontics, Kalka Dental College, Meerut, UP</div>	
<div>ABSTRACT</div>	<div>Background: Instrument separation during endodontic treatment is a common complication that can hinder the cleaning and shaping of root canals, potentially affecting the treatment outcome. Properly managing separated instruments is crucial to ensure the long-term success of the endodontic procedure. Methods: This case series presents various clinical scenarios involving separated instruments in molar canals. Techniques employed included retrieval using ultrasonic tips and bypassing using K-files, depending on the instrument's location, size, and the canal's anatomy. Each case was evaluated based on the feasibility of instrument retrieval and the potential risks associated with each approach. Results: In cases where retrieval was feasible, ultrasonic tips under magnification successfully removed the separated instruments, allowing for complete canal cleaning and obturation. For cases where retrieval posed high risks, bypassing techniques were used to navigate around the separated instruments, enabling continued canal preparation. Both approaches resulted in well-obtured canals, confirmed by post-operative radiographs, and the patients reported no symptoms during follow-up. Conclusion: This case series demonstrates that both retrieval and bypassing techniques can effectively manage separated instruments in endodontic treatment. The choice of method should be guided by the specific clinical scenario, instrument position, and potential risks. Advanced endodontic tools and meticulous technique are essential for successful outcomes. Future research should focus on long-term success rates and the development of new technologies to further improve the management of separated instruments.</div>	
<div>INTRODUCTION</div>	<div>Endodontic instrument separation is one of the most difficult challenges in endodontic therapy and results in adverse consequences if not addressed properly. When instruments are separated, they can hinder access to the canal, during cleaning and shaping of canals which are significant in avoiding reinfection and attaining effective treatment outcomes.¹ The extent of instrument separation varies between 0.4% to 5%, depending on several factors, such as the type of instruments utilized, the difficulty of the apical third orifices, and the expertise of the practitioner.² The management of separated instruments involves either removal, passage around, or, at times, the instrument can be left within the canal and the canal is sealed because if removed it will cause undue risk to the tooth structure because of extra cutting.³</div> <div>Complete removal of separated instruments is more recommended because the canal can then be well cleaned and shaped to minimize the load of the microbes hence improving its chances of a positive outcome.⁴ Retrieval methods include the use of ultrasonic tips, micro-trephine burs and other endodontic instruments meant to engage and remove fractured instrument from the canal.⁵ However, retrieval depends on the location of the separated instrument inside the canal, the extent of the curvature of the canal and size of the fragment.⁶ It is more dangerous where the instrument is embedded in canal, as this exposes the possibility of perforation or further breaking of the instruments during the process.⁷</div> <div>Bypassing can be done by placing smaller instrument to form a glide path around the fragment so that cleaning, shaping and obturation of the canal can continue.⁸ This approach is helpful, especially when direct removal could damage the walls of the canal or when the instrument is stuck in the apical third in a curved or narrowed part of the canal.⁹ Bypassing is usually time-consuming as the surgeon has to carefully create a smooth path around the obstruction to avoid pushing or piercing through the canal.¹⁰</div> <div>The clinical outcomes of managing separated instruments are dependent strongly on the success of the chosen technique. Research conducted on the outcome of cases that underwent successful retrieval shows that the cases have a higher overall success compared with cases where the instrument is bypassed over or left inside.¹¹ However, bypass can still be effective to provide a satisfactory result if the remaining canal space can be adequately cleaned and sealed.¹² The survival of teeth with separated instruments also depends on the presence of pre-operative periapical lesions, with success rates being significantly lower for teeth with pre-existing apical lesions.¹³</div> <div>In the case of bypassing, the quality of the subsequent obturation should be excellent to offset the possibility of the separated instrument acting as a potential source of infection if it is not thoroughly sealed off.¹⁴ Procedures like Lateral condensation or warm vertical compaction of gutta-percha for obtaining a compact and tight surface can be used frequently.¹⁵ Nonetheless, in post-endodontic restoration, the significance cannot be downplayed since it helps to address the issue of coronal leakage, and therefore the failure of the endodontic treatment.¹⁶</div> <div>This case series intends to describe and discuss different clinical situations associated with the treatment planning of separated instruments in endodontic therapy. The cases will show the need for flexibility and versatility in endodontics and also stress on the importance of utilizing more sophisticated equipment and accurate approaches towards handling the instrument separation. These cases underscore the importance of assessing each clinical case to decide on the best course of action to maintain the tooth and achieve the</div>	

66

www.worldwidejournals.com

best outcomes for the patient.¹⁷

Case Series

Case 1:

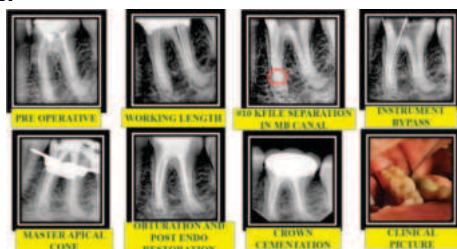


Figure 1: Photographic Representation Of Case 1

A patient had intermittent pain in lower molar (36); while attempting to bypass a ledge during Re-RCT a #10 K-file got separated. The radiograph showed separation at the junction of middle and apical third in the MB canal. The recovery of the instrument was very difficult due to the depth at which instrument got separated. Several attempts were made to create a glide path but failed so ultrasonic tips under the operating microscope were used to vibrate the instrument and cut the surrounding dentin which lead to instrument retrieval during irrigation. Subsequently, the canals were prepared and then obturated with gutta-percha. The tooth was restored. Thus, this case shows that it is useful to try for direct retrieval when a separated instrument cannot be bypassed and presents more risk of another instrument separation.

Case 2:

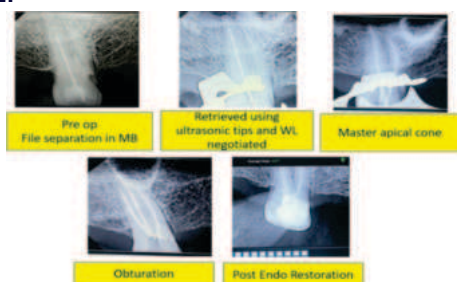


Figure 2: Photographic Representation Of Case 2

A patient came with complaint of pain in a previously initiated pulpectomy in maxillary molar (17) with a separated file in the mesiobuccal (MB) canal based on radiographic findings. The ultrasonic tips under the operation microscope helped in removal, the WL was reallocated for appropriate cleaning and instrumentation. Following which master apical cone were selected, and the obturation was done to achieve a fluid-tight seal. The radiographs taken after procedure and on follow ups revealed no sign of apical pathology and the patient had no complaint of pain. This case highlights the usefulness of ultrasonic tips in cases of separated files and stresses correct management and re-negotiation of the working length for successful root endodontic treatment, thereby presenting a realistic scenario of advanced techniques like use of ultrasonic tips for complex endodontic procedures.

Case 3:



Figure 3: Photographic Representation Of Case 3

This case involved a patient who had complaint regarding mandibular molar (38) because of a fractured rotary instrument in the mesio-buccal (MB) canal. It proved challenging to retrieve the 3 mm fragment due to its location and the curvature of the canal. Initial efforts were made to bypass the instrument and these proved to be futile hence it was bypassed with K-files and then retrieved using H-files in braiding technique to continue with the cleaning and shaping. It was therefore easy to determine the working length and prepare the canal in the acquired working length. Appropriate master apical cones were selected based on the anatomy of the canals after the reshaping. The canals were then sealed using gutta-percha, the material offered enough calibration which was evidenced by post-operative radiographic images. The patient had no complaints when followed up, so having taken the treatment into consideration one could conclude that it was effective. This case demonstrates the typical process of employing bypass techniques in endodontic treatment of fractured instruments as an intervention when direct removal of an instrument is impossible in order to effectively align and clean the root canal and retain the tooth.

Case 4:



Figure 4: Photographic Representation Of Case 4

The present case showcases a separated instrument in a molar with varied anatomy in the P2 canal. The approach for bypass was made by creating a head space with a greater number K-file #30 after which #8 K-file was used to negotiate the working length and once confirmed with apex locator the file sequence was followed till #15 k- file, then while further shaping canals by using rotary files the separated instrument got engaged in the rotary file which when used anticlockwise retrieved the instrument out of the canal. Master apical cones were then selected to better fit the changed canal anatomy to greatly limit the access of microbes in the canals. The restoration post endodontic treatment was done which aimed at reinforcement of the structure of the tooth. The post-operative radiographs were taken to confirm that the canals were filled properly and the patient had no pain or tenderness on follow-ups. This case demonstrates that the instrument bypass can adequately manage the separated files and maintain treatment effectiveness while maintaining the integrity of the teeth.

Case 5:

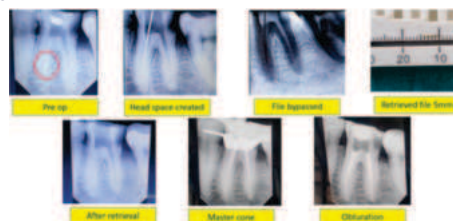


Figure 5: Photographic Representation Of Case 5

A patient had a 5 mm separated rotary instrument in the MB canal of mandibular molar (36) that was seen during radiographic examination. To treat this case, head space was created around the fragment using larger number K-file (#25) after which rotary files were used in counterclockwise motion to dis-engage the fragment then glide path was worked

around the separated file using smaller number K-files in sequence till #20. This approach was helpful in the removal of the fragment which came out during irrigation without extra cutting of canal walls. After retrieval, the working length was confirmed and master cones were selected and seated in the canal. Then canals were obturated and post treatment radiographs were taken which computes to no further evidence of infection in the apical area. As shown in this case, it is helpful to gain a head space for bypassing and negotiating the working length beyond the extent of the instrument separation till apex of root with an aim of delivering a successful procedure while maintaining the structural integrity of the tooth.

Case 6:



Figure 6: Photographic Representation Of Case 6

In this previously initiated case, the patient came with complication in a maxillary molar (16). The instrument separation was seen in the MB canal and in this case, perforation in the furcation area was also present which was observed during clinical and radiographical examination. The difficult situation was managed by cautiously removing the obstructing instrument by using ultrasonic tips to vibrate the instrument which would dis-engage it and cut as minimal dentin as possible to create space around the separated instrument without further hampering the structural integrity of the tooth as the tooth was already in compromised state. Copious irrigation was done during which the instrument came out of the canal. Thereafter, working length assessment was done. On the completion of the retrieval process, the canals were cleaned and shaped and the most appropriate master apical cones were selected and obturation was done. After obturation the perforation in the furcal area was sealed using MTA on which GIC was placed and then standardised bonding and restorative procedure with composite was followed creating a satisfactory and tight compaction which could be observed in the post-operative radiograph. The enhanced the retention of the tooth and its ability to function. Subsequent radiographic examination revealed adequate obturation of the canal with no apparent pathology indicating favorable prognosis. This particular case also demonstrates that even when dealing with a convoluted scenario in endodontics it is possible to manage the situation, maintain the health of the tooth, and avoid having to extract it.

DISCUSSION

This case series describe the difficulties and management approaches of separated instruments in molar canals while stressing the importance of advanced endodontic procedures when attempting to resolve the problem. All the cases successfully illustrated the application of either retrieval or bypassing methods depending on the particular situation, like the location and size of the separated instrument. In cases where retrieval was possible, ultrasonic tips applied under visual control assisted in the exact extraction of the instrument, which contributed to the thorough shaping of the canal space as well as the application of filling material.^{8,9} However, when retrieval entailed considerable risk of complication, bypass had been used, which meant that a glide path was made around the fragment to allow canal preparation to continue.¹⁰ This method helped preserve the canal structure and offered a good seal during the obturation process.

These cases demonstrate the versatility needed in

endodontic treatment and the importance for the clinician to know several approaches to addressing a separated instrument. A thorough and detailed treatment planning is of great importance even so certain required changes can be made during the procedure. Further research should investigate the overall survival rates of teeth that received endodontically treated teeth with bypassed instruments as opposed to those where the instrument was removed, as well as possible effects on periapical healing.^{11,12} However, it can be observed that the case management of these challenging cases might get easier with the utilization of better instruments and imaging technologies in endodontics.

One of the sources of bias in this study is the relatively small sample size which may not capture many clinical conditions in general practice. Further, in the study, the follow-up period was short, so the impact on different long-term outcomes could not be adequately evaluated. Subsequent studies should involve more centres and longer duration of follow up to give more details on the outcome of different management approaches to separated instruments.¹⁸

CONCLUSION

This case series exemplifies the difficulties and issues that are inherent when dealing with separated instruments in endodontics. Hence there is a need to engage in specifically targeted practices, including retrieval and bypassing techniques, in addressing instrument separation. The use of the ultrasonic tips under the operating microscope was successful when the fragment was retrievable, and the canal was fully cleaned and shaped, which is essential in endodontics. In those cases where access to the canal presented a certain amount of danger, getting around the separated instrument by establishing a glide path was indeed a feasible option that kept both canal preparation and obturation going without further damage to the tooth.

The study reveals the importance of clinicians being resourceful and well-trained in various management techniques, especially concerning separated instruments and the use of advanced technologies in countering these difficulties. Further studies must target the evaluation of the effectiveness of various management approaches in the long-term periods and the role of the micro-instruments left aside in the periapical healing process. However, increased knowledge in the field of endodontic instruments, diagnostic methods and therapeutic strategies may also improve outcomes and safety for the management of separated instruments or parts. However, more extensive large-scale studies with longer follow-up periods are required to set specific recommendations and fine-tune therapy regimens for separated instruments in endodontic management.

REFERENCES

- (1) Anand, A. V.; A. S.; N. J. P.; C. C.; Shetty, A.; Adsare, S. Prevalence of Separated Instruments in Routine Endodontic Practice and its Overall Impact on the Procedure: A Questionnaire Study. *RGUHS Journal of Dental Sciences* 2023, 15 (2). https://doi.org/10.26463/rjds.15_2_4.
- (2) Madarati, A. A.; Hunter, M. J.; Dummer, P. M. H. Management of Intracanal Separated Instruments. *Journal of Endodontics* 2013, 39 (5), 569–581. <https://doi.org/10.1016/j.joen.2012.12.033>.
- (3) Ungerechts, C.; Bårdsen, A.; Fristad, I. Instrument fracture in root canals □ where, why, when and what? A study from a student clinic. *International Endodontic Journal* 2013, 47 (2), 183–190. <https://doi.org/10.1111/iej.12131>.
- (4) Triantafyllia, V.; El, C. M.; Kleoniki, L. Separated instrument in endodontics: Frequency, treatment and prognosis. *Balkan Journal of Dental Medicine* 2018, 22 (3), 123–132. <https://doi.org/10.2478/bjdm-2018-0022>.
- (5) Shen, Y.; Peng, B.; Cheung, G. S.-P. Factors associated with the removal of fractured NiTi instruments from root canal systems. *Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontology* 2004, 98 (5), 605–610. <https://doi.org/10.1016/j.jtripleo.2004.04.011>.
- (6) Souter, N.; Messer, H. Complications Associated with Fractured File Removal Using an Ultrasonic Technique. *Journal of Endodontics* 2005, 31 (6), 450–452. <https://doi.org/10.1097/01.don.0000148148.98255.15>.
- (7) Lakshmaiah, D.; Kumar, J. R.; Sakthi, N.; Karunakaran, J.; Vishwanath, S. The Management of Fractured Dental Instruments: A Case Series. *Cureus* 2023. <https://doi.org/10.7759/cureus.49132>.
- (8) Ruddie, C. Nonsurgical Retreatment. *Journal of Endodontics* 2004, 30 (12), 827–845. <https://doi.org/10.1097/01.don.0000145033.15701.2d>.
- (9) Suter, B.; Lussi, A.; Sequeira, P. Probability of removing fractured instruments from root canals. *International Endodontic Journal* 2005, 38 (2), 112–123.

- <https://doi.org/10.1111/j.1365-2591.2004.00916.x>.
- (10) Nevares, G.; Cunha, R. S.; Zuolo, M. L.; Da Silveira Bueno, C. E. Success Rates for Removing or Bypassing Fractured Instruments: A Prospective Clinical Study. *Journal of Endodontics* 2012, 38 (4), 442-444. <https://doi.org/10.1016/j.joen.2011.12.009>.
 - (11) Malentacca, A.; Zaccheo, F.; Rupe, C.; Lajolo, C. Endodontic Clinical Outcome after Separated Instrument Removal Using a Spinal Needle Technique: A Retrospective Study of Thirty Years of Clinical Experience. *Journal of Endodontics* 2023, 49 (8), 980-989. <https://doi.org/10.1016/j.joen.2023.06.007>.
 - (12) Spili, P.; Parashos, P.; Messer, H. H. The Impact of Instrument Fracture on Outcome of Endodontic Treatment. *Journal of Endodontics* 2005, 31 (12), 845-850. <https://doi.org/10.1097/01.don.0000164127.62864.7c>.
 - (13) Crump, M. C.; Natkin, E. Relationship of Broken Root Canal Instruments to Endodontic Case Prognosis: A Clinical Investigation. *The Journal of the American Dental Association* 1970, 80 (6), 1341-1347. <https://doi.org/10.14219/jada.archive.1970.0259>.
 - (14) Parveen, S.; Hossain, M.; Uddin, Md. F. Management of broken instrument by file bypass technique. *Bangabandhu Sheikh Mujib Medical University Journal* 2017, 10 (1), 41. <https://doi.org/10.3329/bsmmuj.v10i1.31305>.
 - (15) Schilder, H. Filling Root Canals in Three Dimensions. *Journal of Endodontics* 2006, 32 (4), 281-290. <https://doi.org/10.1016/j.joen.2006.02.007>.
 - (16) Ray, H. A.; Trope, M. Periapical status of endodontically treated teeth in relation to the technical quality of the root filling and the coronal restoration. *International Endodontic Journal* 1995, 28 (1), 12-18. <https://doi.org/10.1111/j.1365-2591.1995.tb00150.x>.
 - (17) Hülsmann, M.; Schinkel, I. Influence of several factors on the success or failure of removal of fractured instruments from the root canal. *Dental Traumatology* 1999, 15 (6), 252-258. <https://doi.org/10.1111/j.1600-9657.1999.tb00783.x>.
 - (18) Terauchi, Y.; Sexton, C.; Bakland, L. K.; Bogen, G. Factors Affecting the Removal Time of Separated Instruments. *Journal of Endodontics* 2021, 47 (8), 1245-1252. <https://doi.org/10.1016/j.joen.2021.05.003>.