https://doi.org/10.33472/AFJBS.6.9.2024.3035-3044

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

Evaluation of Dentine Structure Loss after Separated File Retrieval using Novel Instrument. An ex vivo study.

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Introduction

Endodontic procedures are integral to restoring the health and function of teeth afflicted by deep-rooted dental infections or extensive decay. However, these treatments are not without challenges, and one of the most significant complications faced by dental professionals is the separation of instruments within the root canal system. Beyond the primary objective of removing the fragment, the preservation of the tooth's structural integrity emerges as a crucial factor for ensuring positive long-term outcomes.

The amount of remaining dentin surrounding the separated instrument has been identified as a key determinant influencing the overall prognosis of the treated tooth. The removal process, if not carefully executed, may compromise the tooth's strength and potentially lead to complications such as tooth fractures or perforations, necessitating further complex interventions.(1)

In the pursuit of more effective and minimally invasive instrument retrieval techniques, the Block Technique for Removal (BTR) pen has emerged as a promising solution. This

microsurgical instrument harnesses the power of ultrasonic energy to delicately dislodge and retrieve separated instruments while minimizing damage to the surrounding dentin. Its introduction into endodontic practices presents a significant advancement in achieving successful treatment outcomes, reducing patient discomfort, and enhancing the overall longevity of the treated tooth.(1)

In this article, we delve into the critical importance of preserving tooth integrity during endodontic procedures, with a specific focus on the potential impact of the BTR pen on separated instrument management. By discovering the benefits of this innovative tool, we direct to shed light on its role in revolutionizing endodontic practices and elevating the standard of patient care. Additionally, we discuss the implications of this technology on long-term treatment outcomes, with an emphasis on concerns such as tooth fracture and perforation.

As the field of endodontics continues to progress, understanding the potential effectiveness of the BTR pen becomes vital in optimizing the success of endodontic treatments while preserving the natural dentition of patients.

Methods and Methodology:

Ethical Considerations:
The Saveetha Institute of Medical and Technical Sciences in Chennai, India's Institutional Review Board granted approval for the project.

Sample Selection:
Extracted single-rooted lower premolars were selected as the sample teeth for this study due to their common occurrence and standardized anatomy. All teeth included in the study had their canal prepared to a standardized size #20 with a 0.06 taper.

Preoperative Assessment:
Preoperative CBCT (Cone Beam Computed Tomography) scans were taken to assess the initial status of the fractured Protaper Gold F3 files within the root canal and the surrounding structures. The fractured Protaper Gold F3 files, which were 4mm in length, were dislodged within the canal at the middle third. (Figure 1)

Figure 1: Preoperative CBCT with a two-dimensional radiograph.

Patent information:
Endodontic file retrieval loop with double-pronged hooked tip application number 202241049387 published on 09/09/2022 by the Indian patent office under Saveetha Institute of Medical and Technical Sciences.

Fractured File Retrieval Techniques:
Two techniques were employed for file retrieval:

Loop Technique: A nitinol loop attached to a BTR pen of gauge 25 was utilized for one group of cases.

Modified Novel Technique: A novel instrument was used for the other group.

Staging was done for both groups using a modified Gates Glidden number 3. Ultrasonic endodontic tip ET 25 was used to trough around the fractured instrument to facilitate instrument access. The procedures were performed by a single operator following standardized protocols. (Figure 2-5)

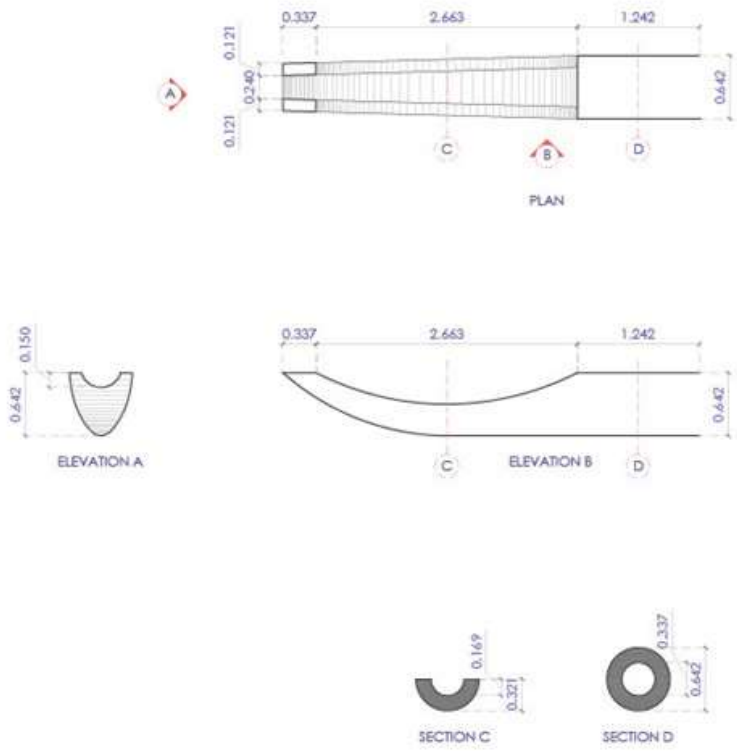

Figure 2: Diagram of Novel Endodontic file retrieval loop with a double pronged hooked tip.

Figure 3: Side profile view of prototype of novel instrument.

Figure 4: Long axial view of prototype of novel instrument.

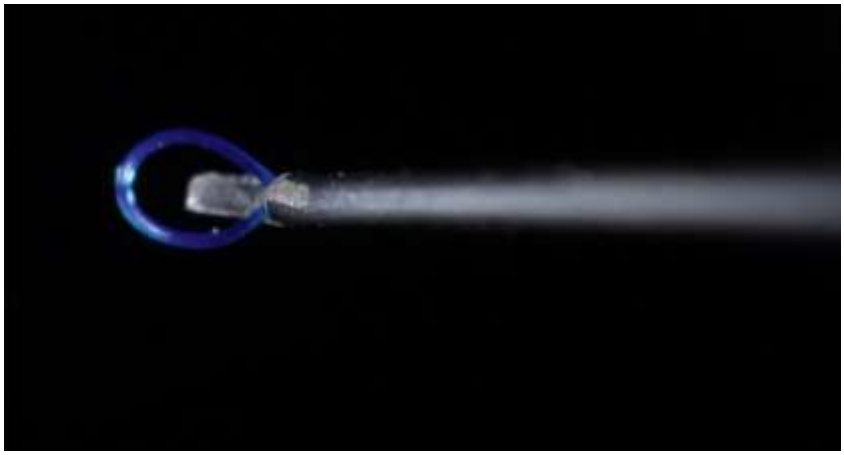

Figure 5: Topside view of prototype of novel instrument.

Postoperative Assessment:
Following successful retrieval of the fractured files, postoperative CBCT scans were taken to evaluate the efficacy of both techniques in terms of file removal and preservation of surrounding dentin. (Fig 6)

Figure 6: View of novel instrument prototype with retrieved fractured segment.

Data Analysis:
The CBCT images were analyzed using CS 3D software (Carestream) to measure the remaining dentin thickness in each group. Measurements were taken at standardized points along the length of the root canal, ensuring consistency and accuracy. Statistical analysis was conducted to compare the remaining dentin thickness between the BTR pen with the nitinol loop group and the Novel Instrument group.(Fig 7)

Figure 7: Postoperative Cone Beam Computed Tomography (CBCT)

Ethical Considerations:
The Saveetha Institute of Medical and Technical Sciences in Chennai, India's Institutional Review Board granted approval for the project.

Results:

Conventional Endodontic Retrieval Loop vs. Modified Endodontic Retrieval File:

Dentin Removal at Coronal 1/3rd:
- Conventional Endodontic Retrieval Loop: 0.74mm +/- 0.23
- Modified Endodontic Retrieval File: 0.76mm +/- 0.17
- Significance: p = 0.52

Dentin Removal at Middle 1/3rd:
- Conventional Endodontic Retrieval Loop: 0.69mm +/- 0.16
- Modified Endodontic Retrieval File: 0.55mm +/- 0.13
- Significance: p = 0.19

The results indicate that there was no statistically significant difference in dentin removal between the two techniques at the coronal 1/3rd (p = 0.52). However, at the middle 1/3rd, the Modified Endodontic Retrieval File resulted in a lower dentin removal compared to the Conventional Endodontic Retrieval Loop, although the difference was not statistically significant (p = 0.19). (Table 1)

N=10	Conventional Endodontic Retrieval Loop (n=5)	Modified Endodontic Retrieval File (n=5)	Sig.
Dentin removal at coronal 1/3rd	0.74mm +/- 0.23	0.76mm +/- 0.17	0.52
Dentin removal of a middle 1/3rd	0.69mm +/- 0.16	0.55mm +/- 0.13	0.19

Table 1: Remaining dentinal thickness post-removal of a 4mm fractured instrument at the middle third using the BTR pen and a Novel Instrument via CBCT analysis.

Discussion:

The long-term efficacy of endodontic therapy may also depend on the difficult issue of managing a shattered instrument. The canal curvature is a critical component that impacts the management of separated instrument retrieval (1,2). Retrieving instruments that were detached before the canal curvature has been stated to be 100% efficient (3), however those that were at or beyond the curve had success rates of 60percent and 31percent, correspondingly (4). Moreover, removal rates have been reported to be 100%, 83%, and 43%, respectively, from canals with minor curvature (<5°), moderate curvature (5 to 20°), as well as severe curvature (>20°) (5). Mandibular molars have been observed to have a worse success rate in removing fractured instruments than maxillary molars because of factors such as smaller dimensions, uneven root canals, and limited accessibility (5). A recent review found a positive correlation between the length of the broken instrument and the preparation & retrieval times with regard to canal curvature and file size (2). These factors led to the separation of a 4-mm section in the middle third of the mandibular first molars' moderately curved mesiobuccal canals in the current study. When retrieving files, it is crucial to utilize a dental operating microscope to prevent damaging dentine removal and additional root deterioration. Consequently, every procedure used in this investigation was carried out at a 25X magnification under a microscope. In an effort to preserve the tooth structure during retrieval attempts, this offered the best circumstances (6).

Since it is regarded as the gold standard retrieval approach, Ruddle's (7) methodology for removing intracanal fragments that have broken was chosen (8,9,10,11, 12). Terauchi et al. (8) created a new system that consists of a trephine bur, ultrasonic tips, and a loop device. If the fractured fragment does not exit even after 0.7mm of coronal exposure, it is allegedly able to be grasped in the loop device and removed without the need for additional canal enlargement (8). The Endo Rescue kit's tube mechanics control how the file interacts with a hole in the tube; as the fragment is engaged, the tube wedges and secures it in place.

The presented study aimed to evaluate the dentin structure loss after the retrieval of separated files using a Novel Instrument, with a specific focus on the preservation of tooth integrity. The investigation employed a comprehensive methodology, encompassing ethical considerations,

sample selection, preoperative assessment, fractured file retrieval techniques, postoperative assessment, data analysis, and statistical evaluation. Sample selection involved the use of extracted single-rooted lower premolars, chosen for their standardized anatomy, and prepared to size #20 with a 0.06 taper. (13-16)

Preoperative assessment was conducted via CBCT scans to evaluate the status of the fractured Protaper Gold F3 files within the root canal. Fractured files, 4mm in length, were identified within the canal at the middle third.

Two retrieval techniques were employed: the Loop Technique, utilizing a nitinol loop attached to a BTR pen of gauge 25, and the Modified Novel Technique, involving a novel instrument. Both techniques were staged using a modified Gates Glidden number 3, with ultrasonic endodontic tip ET 25 used to facilitate access around the fractured instrument. The procedures were executed by a single operator following standardized protocols. (17-20)

Postoperative assessment involved CBCT scans to evaluate the efficacy of both techniques in terms of file removal and dentin preservation. CBCT images were analyzed using CS 3D software to measure the remaining dentin thickness at standardized points along the root canal length, ensuring consistency and accuracy. Statistical analysis was performed to compare dentin removal between the two groups.

The results indicated no statistically significant difference in dentin removal at the coronal 1/3rd between the Conventional Endodontic Retrieval Loop and the Modified Endodontic Retrieval File. However, in the middle 1/3rd, the Modified Endodontic Retrieval File resulted in lower dentin removal compared to the Conventional Endodontic Retrieval Loop, although the difference was not significant. (21-24)

This study provides valuable insights into the efficacy of the Novel Instrument in preserving dentin structure during separated file retrieval, contributing to the advancement of endodontic practices and patient care.

Souter et al. (13) recommended spreading out the removal of the fractured fragments over 45 to 60 minutes to prevent operator fatigue, secondary fracture, or excessive dentine removal that could cause fracture or perforation. The results of this investigation demonstrated that the retrieval times of the R and T groups did not differ significantly. This was consistent with the findings of Kumar et al. (2014) and Pruthi et al. (9). However, it disagreed with Terauchi et al. (10), who claimed that TFRK took a lot less time than Ruddle's method. Given that mandibular incisors were the only teeth utilized in the study, this could be explained by the varied types of teeth employed. Retrieving instruments from posterior teeth may be more difficult than from anterior teeth because of their more intricate canal anatomy (2).

In this study, the null hypothesis is accepted, as there was no significant difference among both groups regarding the amount of remaining dentin after file retrieval.

Conclusion:

The findings suggest that the Novel Instrument, represented by the Modified Endodontic Retrieval File, tended to exhibit a lower requirement for dentin removal compared to the BTR pen. While both techniques demonstrated effective removal of the fractured instrument, the Novel Instrument preserved a greater amount of dentin, particularly at the middle 1/3rd of the root canal. This suggests that the modified instrument allows for a more conservative approach while still achieving successful file removal. To validate these results and investigate additional factors influencing dentin preservation during file retrieval processes, bigger sample sizes may be required for future research.

References

1. Terauchi, Y., Sexton, C., Bakland, L. K., & Bogen, G. (2021). Factors Affecting the Removal Time of Separated Instruments. Journal of endodontics, 47(8), 1245–1252. https://doi.org/10.1016/j.joen.2021.05.003
2. Terauchi Y, Ali WT, Abielhassan MM. Present status and future directions: removal of fractured instruments. IntEndod J. 2022;55(Suppl 3):685–709.
3. Hülsmann M, Schinkel I. Influence of several factors on the success or failure of removal of fractured instruments from the root canal. Endod Dent Traumatol. 1999;15(6):252–8.
4. Suter B, Lussi A, Sequeira P. Probability of removing fractured instruments from root canals. IntEndod J. 2005;38(2):112–23.
5. Shen Y, Peng B, Cheung GS. Factors associated with the removal of fractured NiTi instruments from root canal systems. Oral Surg Oral Med Oral Pathol Oral RadiolEndod. 2004;98(5):605–10.
6. Alomairy KH. Evaluating two techniques on removal of fractured rotary nickel-titanium endodontic instruments from root canals: an in vitro study. J Endod. 2009;35(4):559–62.
7. Ruddle CJ. Nonsurgical retreatment. J Endod. 2004;30(12):827–45.
8. Terauchi Y, O'Leary L, Suda H. Removal of separated files from root canals with a new file-removal system: case reports. J Endod. 2006;32(8):789–97.
9. Pruthi PJ, Nawal RR, Talwar S, Verma M. Comparative evaluation of the effectiveness of ultrasonic tips versus the Terauchi file retrieval kit for the removal of separated endodontic instruments. Restor Dent Endod. 2020;45(2):e14.
10. Terauchi Y, O'Leary L, Kikuchi I, Asanagi M, Yoshioka T, Kobayashi C, et al. Evaluation of the efficiency of a new file removal system in comparison with two conventional systems. J Endod. 2007;33(5):585–8.
11. Gerek M, Başer ED, Kayahan MB, Sunay H, Kaptan RF, Bayırlı G. Comparison of the force required to fracture roots vertically after ultrasonic and Masserann removal of broken instruments. IntEndod J. 2012;45(5):429–34.
12. Yang Q, Shen Y, Huang D, Zhou X, Gao Y, Haapasalo M. Evaluation of two trephine techniques for removal of fractured rotary nickel-titanium instruments from root canals. J Endod. 2017;43(1):116–20.
13. Abijeth B, Ezhilarasan D. Syringic acid induces apoptosis in human oral squamous carcinoma cells through mitochondrial pathway. J Oral Maxillofac Pathol. 2020;24(1):40-45. doi:10.4103/jomfp.JOMFP_178_19

14. S, R., J, J., & T, L. (2022). A Review on plant mediated selenium nanoparticles and its applications: Selenium nanoparticles . Journal of Population Therapeutics and Clinical Pharmacology, 28(2). https://doi.org/10.47750/jptcp.2022.870
15. Nasim, I., Rajeshkumar, S., & Vishnupriya, V. (2021). Green synthesis of reduced graphene oxide nanoparticles, its characterization and antimicrobial. Properties against common oral pathogens. Int J Dentistry Oral Sci, 8(2), 1670-1675.
16. Nasim I, Rajesh Kumar S, Vishnupriya V, Jabin Z. Cytotoxicity and anti-microbial analysis of silver and graphene oxide bio nanoparticles. Bioinformation. 2020;16(11):831-836. Published 2020 Nov 30. doi:10.6026/97320630016831
17. Kamath, A. K., Nasim, I., Muralidharan, N. P., & Kothuri, R. N. (2022). Anti-microbial efficacy of Vanilla planifolia leaf extract against common oral micro-biomes: A comparative study of two different antibiotic sensitivity tests. Journal of oral and maxillofacial pathology : JOMFP, 26(3), 330–334. https://doi.org/10.4103/jomfp.jomfp_293_21
18. Nasim, I., Jabin, Z., Kumar, S. R., & Vishnupriya, V. (2022). Green synthesis of calcium hydroxide-coated silver nanoparticles using Andrographis paniculata and Ocimum sanctum Linn. leaf extracts: An antimicrobial and cytotoxic activity. Journal of conservative dentistry : JCD, 25(4), 369–374. https://doi.org/10.4103/jcd.jcd_411_21
19. Kamath, K. A., Nasim, I., & Rajeshkumar, S. (2020). Evaluation of the re-mineralization capacity of a gold nanoparticle-based dental varnish: An in vitro study. Journal of conservative dentistry : JCD, 23(4), 390–394. https://doi.org/10.4103/JCD.JCD_315_20
20. Siddique, R., Nivedhitha, M. S., Ranjan, M., Jacob, B., & Solete, P. (2020). Comparison of antibacterial effectiveness of three rotary file system with different geometry in infected root canals before and after instrumentation-a double-blinded randomized controlled clinical trial. BDJ open, 6, 8. https://doi.org/10.1038/s41405-020-0035-7
21. Janani K, Teja KV, Ajitha P, Sandhya R. Evaluation of tissue inflammatory response of four intracanal medicament - An animal study. J Conserv Dent. 2020;23(3):216-220. doi:10.4103/JCD.JCD_243_20
22. Aparna J, Maiti S, Jessy P. Polyether ether ketone - As an alternative biomaterial for Metal Richmond crown-3-dimensional finite element analysis. J Conserv Dent. 2021;24(6):553-557. doi:10.4103/jcd.jcd_638_20
23. Souter NJ, Messer HH. Complications associated with fractured file removal using an ultrasonic technique. J Endod. 2005;31(6):450–2.
24. Kumar BS, Krishnamoorthy S, Shanmugam S, PradeepKumar AR. The time taken for retrieval of separated instrument and the change in root canal volume after two different techniques using CBCT: an in-vitro study. Indian J Dent Res. 2021;32(4):489–94.