https://doi.org/10.5272/jimab.2025313.6433

Journal of IMAB
ISSN: 1312-773X
https://www.journal-imab-bg.org

Journal of IMAB. 2025 Jul-Sep;31(3)

Original article

USE OF A STATIC ENDODONTIC GUIDE FOR SEPARATED ENDODONTIC INSTRUMENT REMOVAL

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ABSTRACT:

Purpose: The study aimed to compare the volumetric changes in the root canal after separated endodontic instrument removal with two techniques.

Material and methods: 20 intact, human premolars were divided into two groups according to the technique used for access to the head of the separated instrument – with a static endodontic guide or with ultrasonic U-files. For the next stages of the removal, an ultrasonic technique with magnification is applied. A comparative analysis of volumetric changes was performed on CBCT images. The data was processed with IBM SPSS and Minitab. The Shapiro-Wilk test and t-test were conducted.

Results: The use of a static endodontic guide resulted in the removal of two times less dentin, with a statistical significance of the difference p=0.017.

Conclusions: The use of a static endodontic guide is an alternative technique for accessing the separated endodontic instrument, which proved to be minimally invasive and can limit the application of ultrasound in "dry conditions".

Key words: separated endodontic instrument, removal, static guide,

INTRODUCTION:

The ultrasonic technique for removing separated endodontic instruments is the most widely used and studied, and has a high success rate [1, 2]. However, to ensure good visibility under a dental operating microscope, the ultrasonic tip must operate in "dry conditions" [3] – without irrigation solution for an indefinite period of time. This can lead to tissue heating and microcrack formation with all the associated complications. If proven to be minimally invasive, static endodontic guides could reduce the total time of ultrasound application in the root canal in "dry conditions".

MATERIALS AND METHODS:

20 intact, human premolars extracted for orthodontic or periodontal indications were included in the study. After removal of organic debris, the teeth were stored in 0.5% aqueous thymol solution at 4°C for up to 2 weeks. An endodontic access is prepared using rotary diamond burs and a turbine. Root canals are prepared to full working length using the standard technique up to K-file #20. The irrigation protocol included sequential use of 2.5% NaOCL and 17% EDTA. A final wash is performed with saline, and the canals are dried with paper points. The working part of K-file No. 25 is filed transversely in half of its thickness at a distance of 4 mm from the tip with a diamond bur and a turbine. The silicone stop is adjusted so that the file enters the middle third of the root canal. This is followed by rotating the file in the corresponding position until it is separated. The teeth thus prepared are fixed in two Frasaco models with liquid silicone. The alveoli of the distal teeth were used, and 10 single-rooted premolars were included in each model. For the purposes

of the study, the following two groups are distinguished:

Group using a static endodontic guide n=10;

Group without use of static endodontic guide n=10.

Preoperative CBCT scanning of the models from both groups was performed with Planmeca Romexis® (Romexis 5.0.0, Helsinki, Finland). The positions of the separated instruments in the middle third of the root canal are confirmed.

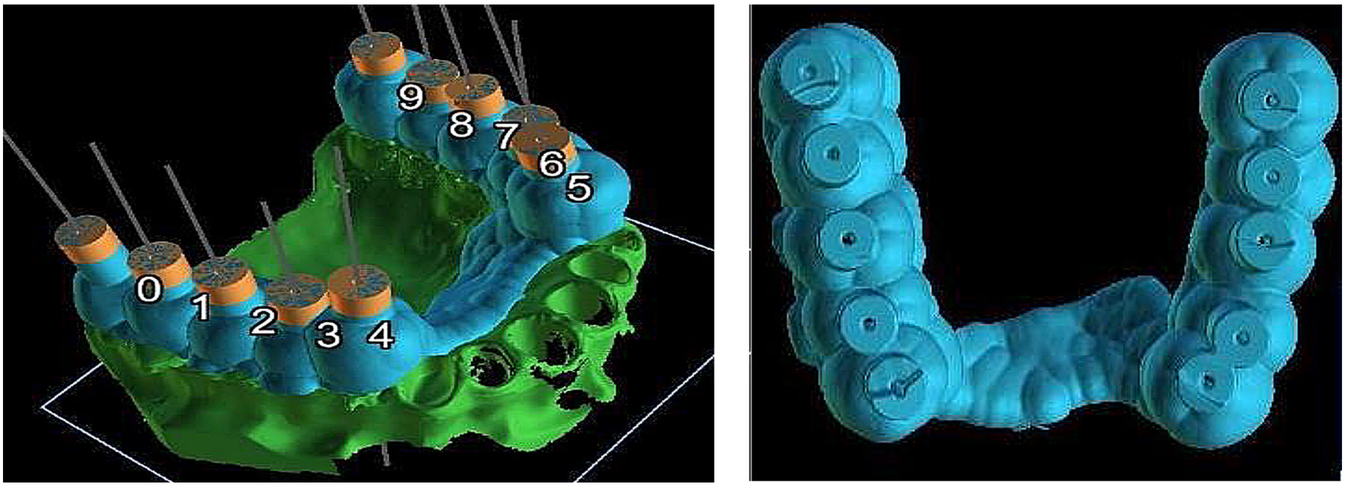
Additional laboratory stages in the guided group:

1. Laboratory scan of the model with Trios 3 color Pod (3Shape, Denmark).

2. Digital endodontic guide planning and modeling with BlueSky Plan® (BlueSky Bio).

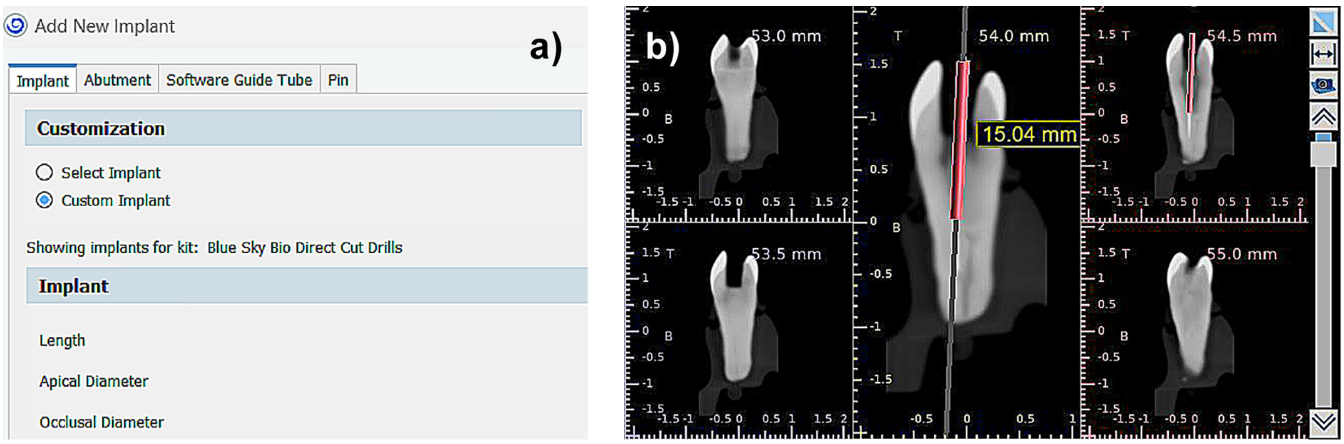
Static guided endodontics combines the information obtained from the CBCT image and the digital optical impression. This allows planning a minimally invasive digital path for the instruments to or beyond an obstruction in the root canal system.

Fig. 1. Planning of static endodontic guide with BlueSky Plan.



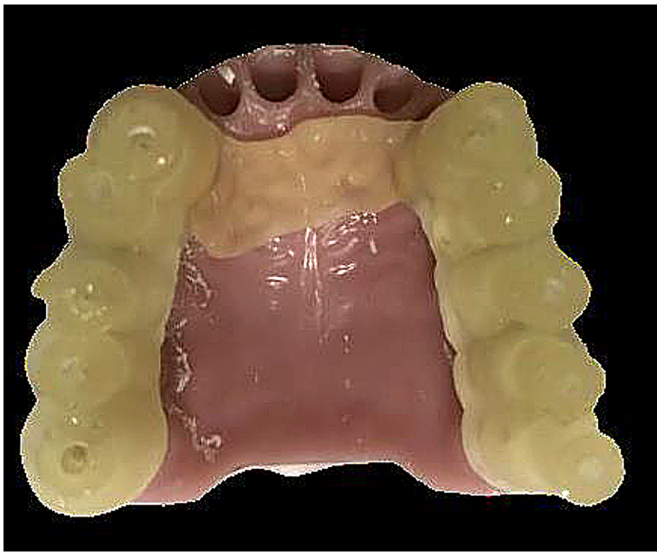
The instrument used to provide access to the segment was Munce Discovery Burs® #2 (CJM Engineering, Santa Barbara, CA, USA), 31 mm in length and 1 mm in diameter. The parameters of the latter are modeled in the program as a custom implant. Individual values for penetration length and equal values for apical and occlusal diameters are entered for each individual guide. A characteristic feature is that the inner diameter of the sleeve must be 0.2 mm larger than the instrument that will create access to the face of the segment.

Fig. 2. a) Customization of guide values by custom implant setting; b) Digitally planned file path with individual parameters centered on the separated instrument.



3. Computer-aided 3D printing and adjustment of an endodontic guide.

Fig. 3. Endodontic guide adjusted on a model of the group using a static endodontic guide.



Access to the head of the separated endodontic instrument.

1. Group using a static endodontic guide - Straight-line direct access is achieved using Munce Discovery Burs® (CJM Engineering, Santa Barbara, CA, USA) - a #2 Munce bur at 10,000 rpm to the preset depth of penetration corresponding to the level of the head of the segment. A minimally invasive, centered, horizontal platform is created.

2. Group without the use of a static endodontic guide – Access is made with a U-file #25 (Mani) and an ultrasonic endodontic tip E1/120° (Nsk-Satelec Type), with visibility provided by a dental operating microscope.

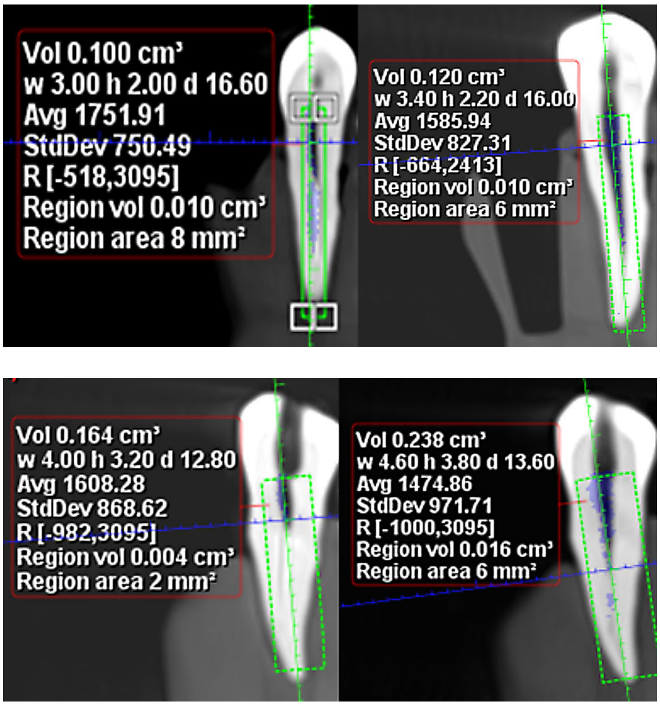
Removing the segment.

The segment removal step is performed at X10 magnification by a dental operating microscope, with a Woodpecker DTE D5 Scaler ultrasound device (Guilin Woodpecker Medical Instrument Company), in E mode, in power settings 1-3, using a #20 U-file and ultrasound tip E1. The work is carried out in a dry operating field, providing the necessary visibility. When moving the segment, a 17% EDTA solution is introduced into the cavum pulpae and the root canal, facilitating the final evacuation of the separated instrument.

Postoperative CBCT volumetric analysis.

The volume of the three-dimensional images (Planmeca Romexis) was assessed by manual segmentation relative to the axial plane with a set slice thickness of 0.2 mm. Delineation of canal boundaries before and after segment removal is done on each slice using the Free Region Grow Tool. The program software automatically calculates the target volume and presents it in cubic centimeters.

Fig. 4. Preoperative and postoperative CBCT volumetric evaluation: a) Group using a static endodontic guide; b) Group without the use of a static endodontic guide.



Statistical methods.

The statistical programs IBM SPSS version 27 (2020) and Minitab version 24.1.1 (2023) were used for statistical data processing. Target values include canal volume with and without a separated endodontic instrument, measured in cm3 and as a percentage of the total root volume. The Shapiro-Wilk test was performed to assess normal distribution, with a p-value>0.05 for all values. Results are analyzed as means, standard deviations (SDs), and 95% confidence interval (95% CI) of the difference. A paired samples t-test was performed to monitor the group's volume value change. An independent samples t-test was used for statistical comparison between groups. Statistical significance was reported at an acceptable type I error level of 5%, where a significant difference within or between groups was accepted at p<0.05. For greater reliability, 95% confidence intervals of the differences between the two study groups are assessed.

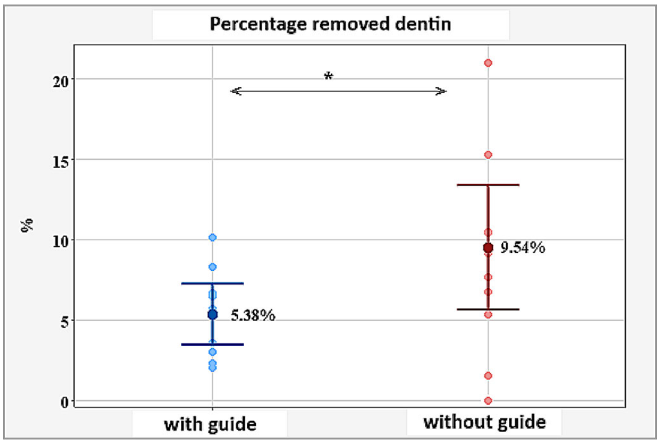
RESULTS:

Before segment removal, the two groups did not show a statistically significant difference (p=0.824) in the mean canal volume values, which were as follows - for the group with the use of a guide 0.91±0.01 cm3, for the group without the use of a guide 0.95±0.04 cm3, which is evidence of the uniform distribution of the samples. After segment removal, canal volume increased statistically significantly (p=0.023) more in the non-guide group (0.19±0.06 cm3) compared to the guide group (0.13±0.02 cm3). The average value of the dentin volume removed in the group without the use of a guide was 0.09±0.06 cm3. In the group with a guide, the value was 0.04±0.02 cm3. The results showed that the use of a static endodontic guide resulted in the removal of two times less dentin, with a statistical significance of the difference p=0.017.

In addition, when comparing the volume of the root canal after segment removal relative to the total root volume in both studied groups, the results are 17.45±3.53% in the guide group and 19.87±6.39% in the non-guide group. The difference is 2.42% and does not reach statistical significance, p=0.309. This result shows that both approaches are minimally invasive, but an advantage can be reported when using a static endodontic guide.

Regarding the percentage of dentin removed, the mean value recorded in the non-guide group was 9.54±5.40%, compared to 5.38±2.65% for the guide group. It can be summarized that the group without the use of a guide recorded a statistically significantly higher percentage (4.16%, p=0.042) of removed dentin compared to the group with the use of a guide.

Fig. 5. Mean and individual values of the percentage of dentin removed in the groups with and without the use of a guide (*p<0.05).



DISCUSSION:

For the first time, Buchgreitz J, et al. [4] demonstrated the principles of static guided endodontics, which were adopted from implantology. This discovery is of interest to many researchers and clinicians, who are constantly expanding the indications for use of static endodontic guides (SEG), including: guided minimally invasive endodontic access [5, 6, 7], cases with obliterated root canals [8, 9, 10, 11, 12, 13, 14, 15, 16], removal of a fiber post [17], access through MTA barrier [18] and others. In 2022, Bordone A, et al. [19] presented a clinical case of guided access to the head of a separated endodontic instrument. They concluded that the technique prevents excessive loss of hard dental tissues and facilitates the procedure by shortening the time of the clinical visit. Ali A, et al. [18] studied the changes in fracture resistance of 30 mandibular premolars after preparation of access through an MTA barrier with and without a SEG and reported significantly preserved fracture resistance in the group using SEG, due to less dentin removal. In this regard, when access to the segment is achieved through root canal filling materials, the use of SEG can ensure safe and rapid removal with minimal loss of hard dental tissues.

To date, the ultrasonic technique is the most widely studied and has the best success rate in removing separated endodontic instruments [1, 2], but to ensure better visibility under a dental operating microscope, the ultrasonic tip works in dry conditions for an unregulated time period, without irrigation solution. This can lead to overheating and microcracks. A need arises to reduce the total ultrasonic exposure time in a single root canal in dry conditions. Therefore, the use of a static endodontic guide is a good alternative to limit the use of ultrasound during the access stage. The results registered from the volumetric CBCT analysis demonstrate that the use of SEG leads to the removal of two times less dentin. In addition, SEG can serve to safely straighten the canal curvature and subsequently ensure visibility of the head of the segment under a microscope. The created access is centered, individualized and straight-lined. Otherwise, the principle of working on the inner wall of the curvature with the ultrasonic tip sometimes carries the risk of strip perforation, displacing the canal in a medial direction. The risk of iatrogenic errors, such as perforation, overexpansion, transportation, etc., is reduced. The disadvantages of the technique are related to the need for training, additional equipment (intraoral scanner), time for designing and printing the guides, possible errors in the laboratory stages and the possibility of displacement of the guide in a partially edentulous jaw.

CONCLUSIONS

The use of static endodontic guides has been statistically significantly proven to be a minimally invasive method for creating access to the head of the separated endodontic instrument, which clearly increases the safety of manipulation.

Acknowledgements:

This study was financed by the Medical University – Plovdiv /DPDP-03/2022/

REFERENCES:

1. Ramos DQ, Figueroa FS, Ramírez LAP, Venegas DC. Fractured instrument removal strategies in endodontic practice: a review of the literature. *Revista OACTIVA UC Cuenca*. 2022 May–Aug;7(2):71–80. [Crossref]
2. Shaik I, Qadri F, Deshmukh R, Clement C, Patel A, Khan M. Comparing techniques for removal of separated endodontic instruments: systematic review and meta-analysis. *Int J Health Sci*. 2022 Jun;6(S1):13792-13805. [Crossref]
3. Terauchi Y, Renton TF. Managing iatrogenic events. In: Berman LH, Hargreaves KM. *Cohen's Pathways of the Pulp*. 12th ed. St. Louis: Elsevier; Oct 1, 2020. Section III, 20:p.762. [Internet]
4. Buchgreitz J, Buchgreitz M, Mortensen D, Bjørndal L. Guided access cavity preparation using cone-beam computed tomography and optical surface scans – an ex vivo study. *Int Endod J*. 2016 Aug;49(8):790-5. [PubMed]
5. Connert T, Krug R, Eggmann F, Emsermann I, ElAyouti A, Weiger R, et al. Guided endodontics versus conventional access cavity preparation: A comparative study on substance loss using 3 dimensional–printed teeth. *J Endod*. 2019 Mar;45(3):327–331. [PubMed]
6. Loureiro MAZ, Elias MRA, Capeletti LR, Silva JA, Siqueira PC, Chaves GS, et al. Guided endodontics: Volume of dental tissue removed by guided access cavity preparation: An ex vivo study. *J Endod*. 2020 Dec;46(12):1907-12. [PubMed]
7. Zehnder MS, Connert T, Weiger R, Krastl G, Kühl S. Guided endodontics: accuracy of a novel method for guided access cavity preparation and root canal location. *Int Endod J*. 2016 Oct;49(10):966-972. [PubMed]
8. Ali A, Ishaq A, Jain P, Ali S. Management of pulp canal obliteration using static-guided endodontic technique: Case series. *Saudi Endod J*. 2022 Jan-Apr;12(1):120-128. [Crossref]
9. Barbosa Freire B, Vianna S, Nascimento EHL, Freire M, Chilvarquer I. Guided endodontic access in a calcified central incisor: a conservative alternative for endodontic therapy. *Iran Endod J*. 2021 Jan;16(1):56-59. [PubMed]
10. Buchgreitz J, Buchgreitz M, Bjørndal L. Guided root canal preparation using cone beam computed tomography and optical surface scans – an observational study of pulp space obliteration and drill path depth in 50 patients. *Int Endod J*. 2019 May;52(5):559–568. [PubMed]
11. Fonseca Tavares WL, Diniz Viana AC, de Carvalho Machado V, Feitosa Henriques LC, Ribeiro Sobrinho AP. Guided endodontic access of calcified anterior teeth. *J Endod*. 2018 Jul;44(7):1195–1199. [PubMed]
12. Lara-Mendes STO, Barbosa CFM, Machado VC, Santa-Rosa CC. A new approach for minimally invasive access to severely calcified anterior teeth using the guided endodontics technique. *J Endod*. 2018 Oct;44(10):1578–1582. [PubMed]
13. Llaquet Pujol M, Vidal C, Mercadé M, Muñoz M, Ortolani-Seltenerich S. Guided endodontics for managing severely calcified canals. *J Endod*. 2021 Feb;47(2):315-321. [PubMed]
14. Loureiro MAZ, Silva JA, Chaves GS, Capeletti LR, Estrela C, Decurcio DA. Guided endodontics: The impact of new technologies on complex case solution. *Aust Endod J*. 2021 Sep;47(3):664–671. [PubMed]
15. Tavares WLF, Machado V de C, Fonseca FO, Vasconcellos BC, Guimarães LC, Viana ACD, et al. Guided endodontics in complex scenarios of calcified molars. *Iran Endod J*. 2020 Jan–Mar;15(1):50–56. [PubMed]
16. Torres A, Lerut K, Lambrechts P, Jacobs R. Guided endodontics: Use of a sleeveless guide system on an upper premolar with pulp canal obliteration and apical periodontitis. *J Endod*. 2021 Jan;47(1):133–139. [PubMed]
17. Perez C, Finelle G, Couvrechel C. Optimisation of a guided endodontics protocol for removal of fibre reinforced posts. *Aust Endod J*. 2020 Jan;46(1):107–114. [PubMed]
18. Ali A, Arslan H. Effectiveness of the static guided endodontic technique for accessing the root canal through MTA and its effect on fracture strength. *Clin Oral Investig*. 2021 Apr;25(4):1989-1995. [PubMed]
19. Bordone A, Ciaschetti M, Perez C, Couvrechel C. Guided endodontics in the management of intracanal separated instruments: a case report. *J Contemp Dent Pract*. 2022 Aug;23(8):853–856. [PubMed]

Please cite this article as: Dimitrova S, Dimitrova V, Zlatev S, Kanazirska P. Use of a static endodontic guide for separated endodontic instrument removal. *J of IMAB*. 2025 Jul-Sep;31(3):6433-6437.
[Crossref - https://doi.org/10.5272/jimab.2025313.6433]

Received: 05/02/2025; Published online: 05/09/2025

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