Scholars Journal of Dental Sciences
Abbreviated Key Title: Sch J Dent Sci
ISSN 2394-4951 (Print) | ISSN 2394-496X (Online)
Journal homepage: https://saspublishers.com

OPEN ACCESS

Apical Extrusion Potential of Two Nickel-Titanium Retreatment Systems

Emilia Karova[1], Sherihan Zongova-Adem[2*]

[1]Associate Professor, Department of Conservative Dentistry, Faculty of Dental Medicine, Medical University, Sofia, Bulgaria
[2]Doctor of Dental Medicine, Center of Integrated Dental Medicine, Faculty of Dental Medicine, Medical University, Sofia, Bulgaria

DOI: 10.36347/sjds.2022.v09i05.002 | **Received:** 17.05.2022 | **Accepted:** 12.06.2022 | **Published:** 17.06.2022

***Corresponding author**: Dr. Sherihan Zongova-Adem
Doctor of Dental Medicine, Center of Integrated Dental Medicine, Faculty of Dental Medicine, Medical University, Sofia, Bulgaria

Abstract **Original Research Article**

The aim of the study was to quantify the amount of apically extruded debris during root canal filling removal with D-Race and Mtwo retreatment systems. Twenty-four extracted single-rooted mandibular incisors with straight oval-shaped root canals were instrumented with XP-Endo Shaper files and filled with gutta-percha and AH Plus sealer using vertical compaction technique. All filled samples were temporarily sealed with Citodur Hard and stored in distilled water for 30 days. The specimens were randomly divided into two groups, according to the nickel-titanium system used for root canal filling removal (n=12). The retreatment procedure was performed with Mtwo Retreatment and D-Race Retreatment. The extruded debris during retreatment procedures, was collected in preweighted Eppendorf tubes. The actual weight of extruded debris was calculated by subtracting the initial weight from the final weight of the Eppendorf tubes. Statistical analysis was performed using IBM SPSS Statistics 23.0 software. The level of significance was set at $P<0.05$. The investigation results did not find statistically significant differences between the experimental groups. It could be concluded that retreatment with both Mtwo and D-Race cause apical extrusion of debris material with no statistically significant difference between the amounts produced by the two tested systems.

Keywords: Apical extrusion, endodontic retreatment, debris extrusion, Mtwo Retreatment, D-Race Retreatment.

INTRODUCTION

Nonsurgical endodontic retreatment procedure is a first-choice procedure for eliminating the microbial infection in case of a failed primary endodontic treatment (Topçuoğlu HS *et al.*, 2014). The main goal of the orthograde retreatment is to regain healthy periapical tissues. A properly performed retreatment procedure requires complete root canal filling removal and thorough shaping, disinfection and obturation of the root canal space (Kaşıkçı Bilgi I *et al.*, 2017; Karova E *et al.*, 2021). Although the tooth survival rate after a nonsurgical endodontic retreatment is reported to be 95.3%, in 1.4% to 16% of the cases flare-ups can occur (Ng Y-L *et al.*, 2010; Siqueira JF *et al.*, 2002; Seltzer S *et al.*, 1985). Flare-up is an inter-appointment endodontic complication characterized by appearance of pain, swelling or both. Microorganisms are the main factors causing flare-ups as they can provoke an acute periapical inflammation when extruded into the periapical space during endodontic procedures (Siqueira JF Jr., 2003). It has been stated that all root canal preparation techniques cause extrusion of a certain amount of debris and irrigants through the apical foramen (Tanalp J *et al.*, 2014; Altundasar E *et al.*, 2011). Current studies assessing the amount of extruded debris during secondary root canal treatment reveal that apical extrusion occurs in all cases despite the retreatment techniques and tools used (Çanakçi BC *et al.*, 2016; Keskin C *et al.*, 2018). However, according to Huang *et al.* (Huang X *et al.*, 2007), the most effective retreatment technique with the least amount of debris extrusion should be preferred.

Hand files, various engine-driven nickel-titanium (NiTi) instruments, specially designed for the retreatment procedures, sonic and ultrasonic devices, instruments producing heat, solvents, lasers and combinations between them are described to be part of the current retreatment protocols (Cordeiro KF *et al.*, 2018; Duncan HF *et al.*, 2011). Mtwo Retreatment (VDW, Munich, Germany) and D-Race (FKG, La Chaux de Fonds, Switzerland) are NiTi rotary systems specially designed for orthograde endodontic retreatment. Mtwo Retreatment system consists of two instruments – R1(# 25.05) and R2 (# 15.05) - with an S-shaped cross-section, two cutting edges and active tips. The R1 file removes the filling material from the coronal two thirds of the root canal, while the R2 file is used in the apical area and reaches the working length.

D-Race retreatment system includes two files – DR1 (# 30.10), and DR2 (#25.04), both with altering cutting edges and a triangular cross-section. The active tip of the first instrument enables its penetration into the filling material in the coronal part of the root canal, while the second file is expected to clean the root canal at full working length.

Few studies in the current literature evaluate the quantity of extruded debris during retreatment procedures using the aforementioned retreatment systems (Çanakçi BC *et al.*, 2016; Lu Y *et al.*, 2013; Topçuoğlu HS *et al.*, 2020). Therefore, the purpose of this study was to quantify the amount of apically extruded debris during root canal filling removal with D-Race and Mtwo retreatment systems. The null hypothesis tested was that no significant difference between the evaluated groups will be found.

MATERIALS AND METHODS

Sample collection and preparation

Twenty-four freshly extracted mandibular incisors stored for one hour in 0,1% thymol solution, with a straight root (curvature <5º) according to Shneider (Shneider SW, 1971), completely formed apex without any signs of external or internal resorption were included in the test sample. The external surfaces of all teeth were ultrasonically cleaned from plaque and calculus and polished with polishing discs, brushes and polishing paste. Each tooth was radiographed in both *buccolingual and mesiodistal* direction to confirm the presence of a single oval-shaped root canal (*buccolingual to mesiodistal ratio 2:1*).

Coronal parts of the teeth were removed with high-speed diamond burs under water cooling to achieve a final length of 16mm for each root. The apical patency of each canal was established with an ISO 10 K-file (Dentsply Sirona, Ballaigues, Switzerland). The file was introduced into the root canal until the tip was slightly visible at the apical foramen and the working length (WL) was determined 1mm shorter of this initial length. A glide path was created with an ISO 10 and ISO 15 K-files (Dentsply Sirona, Ballaigues, Switzerland). The instrumentation of each root canal was made with XP-Endo Shaper files (FKG Dentaire SA, La Chaux-de-Fonds, Switzerland) up to size 30/.04, following the instructions of the manufacturer (800 rpm, 1 Ncm torque) in the presence of a chelating agent (Glyde, Dentsply Sirona Endodontics, Ballaigues, Switzerland). Each NiTi instrument was used in a slow pecking motion until it reached 0.5 mm of the premeasured working length. One file was used for instrumentation of 3 root canals. Copious irrigation with 2% NaOCl was made throughout all shaping procedures. As the mechanical instrumentation was completed, a final irrigation with 2% NaOCl and 17% EDTA for 1 min was performed for each root.

Root canal filling

All canals were filled with gutta-percha (GP) and AH Plus sealer (Dentsply Sirona Endodontics, Ballaigues, Switzerland) using vertical compaction technique and ElemetsTM Free Cordless Obturation System (SybronEndo/Kerr Endodontics, Orange, CA) (Schilder H *et al.*, 1974). A Buchanan heat plugger was adjusted to fit in the root canal 5-mm shorter than the full WL. A master gutta-percha cone ISO size 30/.04, coated with AH Plus sealer, was seated with tug back at full WL and the coronal excess seared off at the orifice level. The plugger was activated and then inserted steady into the canal at the adjusted depth and was kept steady for 5-10 seconds. After cooling, it was activated again for one second and removed from the canal together with the excess gutta-percha. The gutta-percha in the root canal was then down packed by using a Buchanan hand plugger. The remaining portion of the canal was filled with warm gutta-percha (backfill). At the end of the filling procedure all samples were temporarily sealed with Citodur Hard (DoriDent, Wien, Austria) and stored in distilled water for 30 days to allow the sealer to fully set (Ørstavik D *et al.*, 2001). The obturation quality was evaluated with a Cone beam computed tomography (CBCT).

Debris collection

The method of collecting debris was the one previously described by Myers and Montgomery (Myers GL *et al.*, 1991). Each tooth was placed up to the level of the cementoenamel junction in a hole, made in a rubber stopper. A 27 gauge needle was inserted alongside the stopper to equalize the air pressure inside and outside the tubes. The stoppers with the teeth were then attached to Eppendorf tubes. The tubes were then pre-weighted three times in an analytical microbalance with an accuracy of 10-3 and mean values were recorded. The samples were randomly divided into two groups (n=12), according to the rotary NiTi system used for the root filling removal:

- Group 1 – MTwo Retreatment Files (VDW, Munich, Germany) used with an X-Smart Plus endomotor (Dentsply Sirona Endodontics, Ballaigues, Switzerland) in a crown-down manner with brushing movements against the canal walls at 280 rpm and 1.2 Ncm torque.
- Group 2 – D-Race Retreatment Files (FKG Dentaire, La Chaux-de-Fonds, Switzerland) driven by X-Smart Plus endomotor set to 1000 rpm and 1.5 Ncm torque for DR1 (30/.10) files and 600 rpm and 1 Ncm torque for DR2.

Each file was used for the preparation of only three canals and was subsequently discarded. The flutes of the files were cleaned each time the instrument was removed from the root canal. The instrumentation was carried out in the presence of distilled water as an irrigant. The retreatment procedure was considered complete when full WL was reached, the canal walls were free of debris and no filling material was observed

covering the file. The apical portion of each root was then washed with distilled water to remove adhered debris. The Eppendorf tubes were kept in an incubator for five days at 70 ºC to allow the liquid to evaporate. The dry mass of debris in each tube was then weighted three times with the same analytical balance and mean values were recorded. The final weight of the extruded debris was calculated by subtracting the first measurements from those done after the retreatment procedure.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics 23.0 software (International Business Machines Corporation, New York, NY, USA). The data were normally distributed according to Kolmogorov-Smirnov test. The analysis of the amount of the formed debris was done by the Independent Sample T-test. The level of significance was set at $P<0.05$.

RESULTS

The mean values of apically extruded debris after the retreatment with Mtwo and D-Race retreatment systems are shown in Table 1. Both rotary systems cause apical extrusion of debris but no significant differences between the experimental groups were registered (p=0.475).

Table 1: Amount of apically extruded debris after root canal filling removal with Mtwo and D-Race NiTi retreatment systems

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
D-Race	12	.00097222	.001048889	.000302788	.00030579	.00163865	.000000	.003667
Mtwo-R	12	.00072222	.000565567	.000163265	.00036288	.00108157	.000000	.001667
Total	24	.00084722	.000833937	.000170227	.00049508	.00119936	.000000	.003667
Independent Samples T-test (t_{22} = 0.727, p=0.475)								

Std. Deviation: standard deviation; Std. Error: standard error; Min: Minimum; Max: Maximum

DISCUSSION

Gutta-percha is the most frequently used root canal filling material and is described as a biocompatible and well tolerated by human tissues material. However, when extruded apically during canal obturation, it is associated with delayed healing of the periapex and may cause foreign body reaction if contaminated with microorganisms (Nair PNR, 2006). Apically extruded debris produced during retreatment procedures may also lead to posttreatment complications and persistent inflammation (Topçuoğlu HS *et al.*, 2014). Nevertheless, the number of studies, evaluating the amount of debris extruded during endodontic retreatment is limited.

No statistically significant difference between the examined groups was found in the current study, so the null hypothesis was accepted. Similar are the findings of other investigators (Alfenas C *et al.*, 2017).

Opposite to the results of the present study, Çanakçi *et al.* (Çanakçi BC *et al.*, 2016) recorded significantly more debris in the samples instrumented with the Mtwo Retreatment system than in the D-Race Retreatment files group. They assume that the file tip design is responsible for the results, as the Mtwo retreatment instruments have an active tip.

The number or variables concerning the sample collection and preparation were minimized. The ability of sodium hypochlorite (NaOCl) to form crystals on the debris may adversely affect the final results of the study, so distilled water was used as a single irrigant during retreatment procedures. The same was the protocol applied in other experimental works (Bürklein S *et al.*, 2012). In our study, the NiTi files were at full WL, following the manufacturers' recommendations, unlike the work of other researchers. They commented that apical extrusion is minimized if endodontic files 1 to 2 mm shorter than the working length are used (Somma F *et al.*, 2008). To compare the amount of extruded debris while using the two retreatment systems, the instrumentation was accomplished without any additional preparation of the apical third of the root canal, as supplementary techniques may cause bigger amount of extruded debris (Çiçek E *et al.*, 2016). No solvents were used thus avoiding formation of a thin layer of softened gutta-percha covering the canal dentinal walls (Gkampesi S *et al.*, 2016).

All samples were instrumented in a downward position in correlation with Kaşıkçı Bilgi *et al.* (Kaşıkçı Bilgi I *et al.*, 2017) who concluded that gravitation force had no effect on the amount of the extruded debris.

During primary or secondary endodontic treatment the tooth apex is surrounded by periradicular or granulation tissue which offers resistance to the apical extrusion of debris and irrigants (Lu Y *et al.*, 2013). This made some of the investigators use floral foam or agar gel as a barrier to simulate the backup pressure of the periapex (Altundasar E *et al.*, 2011). Agar gel model shows density and resistance similar to periapical tissues, but it is difficult to provide an appropriate imitation of a periapical lesion (Keskin C *et al.*, 2018). Floral foam, on the other hand, can absorb irrigants and debris while used as a barrier (Delai D *et*

al., 2018). All these limitations made us leave the samples without any surrounding apical barrier.

Comparative studies of NiTi files designed for orthograde retreatment and hand files reveal that rotary instrumentation causes less apical extrusion of debris than manual preparation of root canals (Topçuoğlu HS *et al.*, 2014). Furthermore, the investigation of Gupta R. *et al.* (Gupta R *et al.*, 2019) found that Mtwo Retreatment system produces less amount of extruded debris compared to other retreatment NiTi systems. In the investigation of Uzunoglu and Turker (Uzunoglu E *et al.*, 2016). D-Race Retreatment files were compared to other retreatment systems and Reciproc. The amount of apical extrusion of debris was found to be significantly less in the samples prepared with the D-Race system than in the other retreatment files tested. Both Mtwo Retreatment and D-Race work in a crown-down manner and use continuous rotation which directs the debris towards the orifice (Bürklein S *et al.*, 2012).

The design of the files can also influence the amount of extruded debris. The smaller number of cutting edges that come into contact with the dentinal wall enables the removal of debris out of the canal. Mtwo Retreatment files has an S-shaped cross-section with 2 cutting edges, while D-Race retreatment files are with a triangular cross section (Caviedes-Bucheli J *et al.*, 2016).

All studies using human teeth as experimental models have their limitations, such as the current experiment. It was previously stated that dentin microhardness values influence the amount of extruded debris, and register worse results in teeth with lower hardness (Tanalp J *et al.*, 2006). In addition, some authors criticize the debris collection methodology because of some other deficiencies that may affect the results of the study (Tanalp J *et al.*, 2014).

CONCLUSION

Retreatment with both Mtwo and D-Race was accompanied by apical extrusion of debris material. There was no statistically significant difference between the amounts produced by the two tested systems.

REFERENCES

- Topçuoğlu, H. S., Aktı, A., Tuncay, Ö., Dinçer, A. N., Düzgün, S., & Topçuoğlu, G. (2014). Evaluation of debris extruded apically during the removal of root canal filling material using ProTaper, D-RaCe, and R-Endo rotary nickel-titanium retreatment instruments and hand files. *Journal of endodontics*, *40*(12), 2066-2069.
- Kaşıkçı Bilgi, I., Köseler, İ. R. E. M., Güneri, P. E. L. İ. N., Hülsmann, M., & Çalışkan, M. K. (2017). Efficiency and apical extrusion of debris: a comparative ex vivo study of four retreatment techniques in severely curved root canals. *International Endodontic Journal*, *50*(9), 910-918.
- Karova, E., Dogandzhiyska, V., Tsenova-Ilieva, I., Raykovska, M., & Zongova-Adem, S. (2021). Nickel -Titanium rotary instruments in retreatment cases. *Medinform*, 8(1), 1306-1311.
- Ng, Y. L., Mann, V., & Gulabivala, K. (2010). Tooth survival following non-surgical root canal treatment: a systematic review of the literature. *International endodontic journal*, *43*(3), 171-189.
- Siqueira Jr, J. F., Rôças, I. N., Favieri, A., Machado, A. G., Gahyva, S. M., Oliveira, J. C., & Abad, E. C. (2002). Incidence of postoperative pain after intracanal procedures based on an antimicrobial strategy. *Journal of endodontics*, *28*(6), 457-460.
- Seltzer, S., & Naidorf, I. J. (1985). Flare-ups in endodontics: I. Etiological factors. *Journal of endodontics*, *11*(11), 472-478.
- Siqueira Jr, J. F. (2003). Microbial causes of endodontic flare-ups. *International endodontic journal*, *36*(7), 453-463.
- Tanalp, J., & Güngör, T. (2014). Apical extrusion of debris: a literature review of an inherent occurrence during root canal treatment. *International endodontic journal*, *47*(3), 211-221.
- Altundasar, E., Nagas, E., Uyanik, O., & Serper, A. (2011). Debris and irrigant extrusion potential of 2 rotary systems and irrigation needles. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, *112*(4), e31-e35.
- Çanakçi, B. C., Ustun, Y., Er, O., & Sen, O. G. (2016). Evaluation of apically extruded debris from curved root canal filling removal using 5 nickel-titanium systems. *Journal of Endodontics*, *42*(7), 1101-1104.
- Keskin, C., & Sarıyılmaz, E. (2018). Apically extruded debris and irrigants during root canal filling material removal using Reciproc Blue, WaveOne Gold, R-Endo and ProTaper Next systems. *Journal of dental research, dental clinics, dental prospects*, *12*(4), 272-276.
- Huang, X., Ling, J., Wei, X., & Gu, L. (2007). Quantitative evaluation of debris extruded apically by using ProTaper Universal Tulsa rotary system in endodontic retreatment. *Journal of endodontics*, *33*(9), 1102-1105.
- Cordeiro, K. F., Silva Filho, D. F., & IDJ, C. F. (2018). Current Protocols for Endodontic Retreatment: A Review. *J Odontol*, *2*(3), 111-16.
- Duncan, H. F., & Chong, B. S. (2008). Removal of root filling materials. *Endodontic Topics*, *19*(1), 33-57.
- Lu, Y., Wang, R., Zhang, L., Li, H. L., Zheng, Q. H., Zhou, X. D., & Huang, D. M. (2013). Apically extruded debris and irrigant with two N i-T i systems and hand files when removing root fillings:

a laboratory study. *International endodontic journal*, *46*(12), 1125-1130.

- Topçuoğlu, H. S., Demirbuga, S., & Topçuoğlu, G. (2020). Evaluation of apically extruded debris during the removal of canal filling material using three different Ni-Ti systems and hand files in teeth with simulated apical root resorption. *International Endodontic Journal*, *53*(3), 403-409.
- Schneider, S. W. (1971). A comparison of canal preparations in straight and curved root canals. *Oral surgery, Oral medicine, Oral pathology*, *32*(2), 271-275.
- Schilder, H., Goodman, A., & Aldrich, W. (1974). The thermomechanical properties of gutta-percha: III. Determination of phase transition temperatures for gutta-percha. *Oral Surgery, Oral Medicine, Oral Pathology*, *38*(1), 109-114.
- Ørstavik, D., Nordahl, I., & Tibballs, J. E. (2001). Dimensional change following setting of root canal sealer materials. *Dental materials*, *17*(6), 512-519.
- Myers, G. L., & Montgomery, S. (1991). A comparison of weights of debris extruded apically by conventional filing and Canal Master techniques. *Journal of endodontics*, *17*(6), 275-279.
- Nair, P. N. R. (2006). On the causes of persistent apical periodontitis: a review. *International endodontic journal*, *39*(4), 249-281.
- Alfenas, C. F., de Azevedo Jacinto, I. D. F., de Azevedo Carvalhal, J. C., Faria, M. T. M., Lins, F. F., de Souza Gonçalves, L., & Neves, M. A. S. (2017). Comparação de quatro técnicas de retratamento através da quantidade de detritos apicalmente extrusados: um estudo ex vivo. *Revista Brasileira de Odontologia*, *74*(4), 309-313.
- Bürklein, S., & Schäfer, E. (2012). Apically extruded debris with reciprocating single-file and full-sequence rotary instrumentation systems. *Journal of endodontics*, *38*(6), 850-852.
- Somma, F., Cammarota, G., Plotino, G., Grande, N. M., & Pameijer, C. H. (2008). The effectiveness of manual and mechanical instrumentation for the retreatment of three different root canal filling materials. *Journal of Endodontics*, *34*(4), 466-469.
- Çiçek, E., Koçak, M. M., Koçak, S., & Sağlam, B. C. (2016). Comparison of the amount of apical debris extrusion associated with different retreatment systems and supplementary file application during retreatment process. *Journal of conservative dentistry: JCD*, *19*(4), 351-354.
- Gkampesi, S., Mylona, Z., Zarra, T., & Lambrianidis, T. (2016). Assessment of apical extrusion of debris during endodontic retreatment with 3 rotary nickel-titanium retreatment systems and hand files. *Balkan Journal of Dental Medicine*, *20*(1), 22-28.
- Delai, D., Boijink, D., Hoppe, C. B., & Kopper, P. M. P. (2018). Apically extruded debris in filling removal of curved canals using 3 NiTi systems and hand files. *Brazilian Dental Journal*, *29*, 54-59.
- Gupta, R., Tomer, A. K., & Bhatheja, A. Quantitative Analysis of Apical Extrusion of Debris by Different Retreatment File Systems. *IOSR Journal of Dental and Medical Sciences*, 18(1), 72-75.
- Uzunoglu, E., & Turker, S. A. (2016). Impact of different file systems on the amount of apically extruded debris during endodontic retreatment. *European journal of dentistry*, *10*(02), 210-214.
- Caviedes-Bucheli, J., Castellanos, F., Vasquez, N., Ulate, E., & Munoz, H. R. (2016). The influence of two reciprocating single-file and two rotary-file systems on the apical extrusion of debris and its biological relationship with symptomatic apical periodontitis. A systematic review and meta-analysis. *International Endodontic Journal*, *49*(3), 255-270.
- Tanalp, J., Kaptan, F., Sert, S., Kayahan, B., & Bayirl, G. (2006). Quantitative evaluation of the amount of apically extruded debris using 3 different rotary instrumentation systems. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, *101*(2), 250-257.