https://doi.org/10.33472/AFJBS.6.9.2024.2993-3005

African Journal of Biological Sciences

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

Research Paper Open Access

Assessing the Efficiency of Retreatment Files in Single-Rooted Premolars with Various Obturation Techniques: A Comparative in- vitro Study

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Volume 6, Issue 9, May 2024

Received: 19 March 2024

Accepted: 12April 2024

Published: 22 May 2024
doi:10.33472/AFJBS.6.9.2024.2993-3005

Abstract

Objective: This in vitro study aimed to assess the efficiency of retreatment files in root canals prepared using three different obturation techniques and quantify remaining debris in extracted mandibular premolars.

Methods: Fifty-four single-rooted premolars were decoronated, prepared, and obturated using lateral condensation (CLC), single cone (MTSC), and downpack backfill (DBF) techniques. Each group was subdivided based on the retreatment file system (Protaper Universal, Coltene Micromega Hyflex Remover, Neoendo). Retreatment times were recorded, and debris was quantified at coronal, middle, and apical thirds post-sectioning using ImageJ software. Statistical analyses were conducted using SPSS.

Results: Coltene Micromega Hyflex Remover demonstrated notable efficiency in Gutta Percha negotiation, resulting in reduced retreatment times compared to other systems. However, complete Gutta Percha retrieval was not guaranteed. Debris scores varied across the root thirds and obturation techniques.

Conclusion: The study highlights the efficacy of Coltene heat-treated single-file systems in reducing retreatment times but acknowledges the limitations, emphasizing the need for personalized approaches considering obturation specifics. While retreatment files are valuable, a comprehensive strategy integrating solvents, H-files, or ultrasonics may enhance cleaning and disinfection, improving endodontic retreatment success. This research contributes to optimizing retreatment protocols and underscores the need for adaptability in endodontic practice, suggesting further exploration, particularly in advanced imaging techniques, to refine retreatment efficacy.

Introduction

Endodontic retreatment is critical in the care of previously treated teeth when infection persists or recurs, necessitating further intervention [1]. It is a complicated process aimed at fully cleaning and disinfecting the root canal system while efficiently eliminating existing obturation materials [2]. The success of retreatment is dependent on numerous aspects, including the sort of obturation process used, the choice of retreatment files, and the capacity to reduce debris extrusion [3].

In contemporary endodontic practice, three primary techniques are commonly utilized for root canal obturation: lateral condensation, single cone, and downpack backfill [4]. These procedures take different approaches to filling the root canal area and create various issues during retreatment. The efficacy of retreatment in teeth obturated with these procedures is being studied, with the goal of improving clinical protocols for the best patient results [5].

The use of rotary file systems built expressly for retreatment improves its efficiency even further. There are several file systems available, each with unique properties that may influence the simplicity and efficacy of junk removal [6]. Endodontists who want to obtain predictable and effective retreatment results must understand the comparative performance of these file systems in the context of various obturation procedures [6,7].

This in vitro study was designed to address these critical aspects of endodontic retreatment. It aimed to assess the efficiency of retreatment files in teeth obturated using the lateral condensation, single cone, and downpack backfill techniques [8,9]. By analysing the time necessary for retreatment and measuring the residual debris in excised mandibular premolars, this study aims to give significant insights into the problems and possibilities related with endodontic retreatment in various clinical circumstances [10]. The findings of this study can help refine clinical protocols and improve retreatment results, thereby helping both practitioners and patients in the area of endodontics.

The aim of this in vitro study is to evaluate the efficiency of retreatment files in root canals obturated using three distinct techniques (lateral condensation, single cone, and downpack

backfill) by assessing the time required for retreatment and quantifying the amount of remaining debris in single-rooted extracted mandibular premolars.

Materials and Methods

Study Design

This in vitro study aimed to evaluate the efficiency of retreatment files in teeth obturated using three different techniques: lateral condensation, single cone, and downpack backfill. The primary outcomes measured were the time taken for retreatment using three distinct rotary file systems and the amount of debris remaining in single-rooted extracted mandibular premolars.

Sample Selection

A total of 54 single-rooted mandibular premolars, extracted for non-restorative reasons, were collected for this study. Teeth with previous endodontic treatment or structural defects were excluded.

Sample Preparation

All the selected teeth were decoronated to have a fixed length of 16mm, access opening was modified using an Endo-Z bur (Dentsply, Maillefer). Working length and glidepath was established with 10 and 15k-files followed by shaping of the root canal with Protaper Gold Rotary files (Dentsply Maillefer, Ballaigues, Switzerland). The canal was prepared up to size F2 and was used as per manufacturer instructions. Copious irrigation was done using 3% sodium hypochlorite, 17% EDTA and Saline along with sonic activation using EndoActivator (Dentsply Maillefer). The teeth were then divided into 3 groups of 18 samples each.

Obturation Techniques

The teeth were obturated using 3 different techniques i.e Matched taper single cone (MTSC) technique, Downpack Backfill (DBF) technique and Cold Lateral Compaction (CLC) technique.
Prior to this, the canals were dried using absorbent paper points and AH plus resin based-sealer was used.
The MTSC technique involved the use of a single F2 size ProTaper Gutta Percha cone. The DBF technique used F2 gutta percha cone that was sheared off upto apical third and then backfilled with

thermoplasticized gutta percha. Finally, the CLC technique involved the use of no. 25 gutta percha with a 2 % taper, laterally compacted with additional 2 % cones.

Additional gutta percha was sheared off and Cavit G was used as temporary filling material. The obturation quality was checked prior to analysis by taking radiographs in mesio-distal and bucco-lingual direction. Teeth were stored in 100% humidity at 37 degree celsius for one week to ensure complete setting of the resin based sealer.

Retreatment Procedure

Each group was further subdivided into three subgroups (n= 6) based on the rotary file system used for retreatment:

1. Subgroup A: Protaper Universal Retreatment file
2. Subgroup B: Coltene Micromega Hyflex Remover
3. Subgroup C: Neoendo Retreatment file

A calibrated operator carried out the retreatment. A digital timer was used to record the retreatment time. Canal retreatment was considered complete when no debris was visible on the flutes of the retreatment file. Each file was utilised for one sample and then discarded. Final saline rinse, then dry the canal with absorbent paper points.

Debris Assessment

Following retreatment, the teeth were sectioned vertically to expose the root canal system. The sections were then observed under a stereomicroscope to assess the amount of remaining debris. Debris assessment was conducted at three distinct levels corresponding to the thirds of the tooth root: coronal, middle, and apical. Images of the sections were captured, and the debris was quantified using ImageJ software. The following criteria were used: [11]

0 = none to slight presence (0%–25%) of residual debris covered the dentinal surface,

1 = presence of 25% to 50% of residual debris on the surface,

2 = moderate presence (50%–75%) of residual debris,

3 = the entire or almost the entire surface (75%–100%) is covered with residual debris.

Statistical Analysis

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) software program, version 23.0 (IBM, Chicago, Illinois) software. The Kruskal-Wallis test was used to compare the time taken for retreatment among the obturation technique and file system subgroups. Post hoc tests were conducted for pairwise comparisons. Debris scores for each third of the root were analyzed using two way anova. The significance level was set at $p < 0.05$.

Ethical Considerations

This study was conducted following ethical guidelines and with approval from the institutional review board [**SRB/SDC/ENDO-2101/23/050]** and in accordance with the PRILE 2021 guidelines [12]. Informed consent was obtained for the use of extracted teeth.

RESULTS

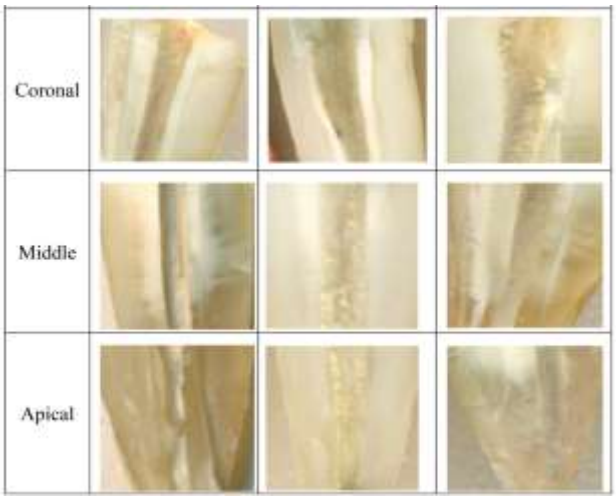

FIGURE 1: shows examples of split teeth to examine the remaining debris in Coronal, middle and apical third of the canal. The examination is done via stereomicroscope and the area of debris noted is calculated in the ImageJ software.

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GROUP	***OBTURATION***	***AVG TIME***
	Downpack Backfill	3:59
	Lateral Condensation	3:18
Protaper	Single Cone	1:02
	Downpack Backfill	1:48
	Lateral Condensation	2:08
Coltene	Single Cone	1:00
	Downpack Backfill	2:42
	Lateral Condensation	2:05
Neoendo	Single Cone	2:40

Table 1 : Average time taken for GP retrieval in 3 different groups and 3 different obturating techniques.

The table 1 shows the Average time taken for GP retrieval in 3 different groups and 3 different obturating techniques.

GROUP	***OBTURATION***	***GP SCORE***
	Downpack Backfill	2
	Lateral Condensation	1
Protaper	Single Cone	1
	Downpack Backfill	1
	Lateral Condensation	1
Coltene	Single Cone	0

	Downpack Backfill	3
	Lateral Condensation	2
Neoendo	Single Cone	1

Table 2: Average of debris scores noted via Stereomicroscopic analysis for different file groups and obturation combinations.

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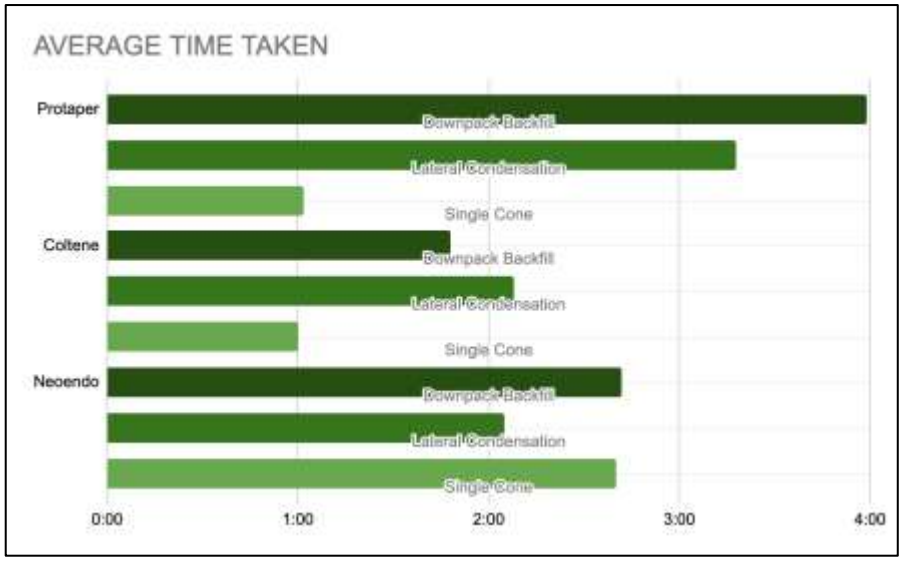

Figure 2: Graphical representation of the time based performance of Protaper Universal Retreatment file, Coltene's Hyflex Remover and Neoendo Retreatment file in teeth with different obturations.

Figure 3: Graphical representation average debris scores of Protaper Universal Retreatment file, Coltene's Hyflex Remover and Neoendo Retreatment file in teeth with different obturations.

Time Taken and Retrieval Efficiency

- Coltene Group and Single Cone Obturations demonstrated significantly lower average time ($p<0.05$) required for retreatment and shorter retrieval time from the canal compared to other obturation techniques. (fig 2)

- Overall, Single Cone Obturation exhibited the shortest retrieval time ($p<0.05$), while the ProTaper and Downpack Backfill obturation method required the maximum time for retreatment. (Fig 3)

Remaining Gutta-Percha (GP) and Debris

- Coltene Group and Single Cone Obturations showed less average remaining GP after retreatment and lower debris scores compared to other techniques ($p<0.05$).

- There was no significant difference observed between the Downpack Backfill system and Lateral Condensation techniques regarding the remaining GP and debris score during retreatment.

Discussion

The efficiency of root canal retreatment is a critical concern in endodontics, particularly in cases where obturation materials need to be removed to address recurrent or persistent infections [13]. In this study, we evaluated the effectiveness of retreatment files in teeth obturated with three different techniques: lateral condensation, single cone, and downpack backfilling. Furthermore, we evaluated the effect of several rotating file systems on the retreatment process.

The results of our study revealed several noteworthy findings. First, Coltene, a heat-treated single-file system with a unique triple helix cross-section, exhibited notable efficiency in negotiating through Gutta Percha. This efficiency translated into reduced retreatment times, highlighting its potential as a time-conserving option. These findings are in line with previous research indicating that single-file systems may offer advantages in terms of simplicity and efficiency in certain clinical scenarios [14] [15].

Commented [1]: Harish Selvaraj, Pradeep Solete, Ganesh Jeevanandan, Delphine Priscilla Antony S, & Adimulapu Hima Sandeep. (2023). Comparative Evaluation of Time Taken to Retrieve Gutta Percha Using Two Different Solvents and A Novel Heat Treated Retreatment File System In Root Canal Treated Teeth - An In Vitro Study . Journal of Population Therapeutics and Clinical Pharmacology, 30(14), 116–122. https://doi.org/10.47750/jptcp.2023.30.14.015

However, it is critical to recognise the study's shortcomings. One significant drawback is the lack of sophisticated assessments, like scanning electron microscopy (SEM), to analyse the residual Gutta Percha and the cleanliness of the root canals following retreatment. SEM can give precise insights into the efficiency of various retreatment processes, highlighting areas for improvement [16].

Furthermore, it is important to note that our findings on the greater efficacy of the Coltene group may not be directly comparable to the results of other investigations. Variations in research design, methodology, and the single-file systems utilised can all lead to different results. For example, Sankar et al. found that RS3 files performed better in their investigation [17,18]. This underscores the importance of considering individual study contexts and objectives when interpreting and applying research findings [19].

In the discussion of the effect of irrigation in between the use of files for endodontic retreatment, it is crucial to acknowledge the pivotal role of irrigation in the success of the retreatment procedure [20]. Effective irrigation serves several essential functions, including the dissolution of organic and inorganic debris, disinfection of the root canal system, and facilitation of file movement by lubricating the canal walls [20]. By flushing out debris and bacteria, irrigation helps to enhance the efficiency of the retreatment process and promote thorough cleaning of the root canal system . Moreover, irrigation aids in the removal of remaining gutta-percha and sealer remnants, which can be challenging to eliminate solely through mechanical instrumentation [21,22]. However, the choice of irrigation solution and technique can significantly influence the outcomes of retreatment procedures.

In the context of our study and the broader body of literature, it is evident that retreatment files alone may not be sufficient for complete Gutta Percha retrieval, especially when dealing with diverse obturation techniques [23,24]. The effectiveness of these files appears to vary depending on the type of obturation employed. As such, a tailored approach to retreatment, which considers the specific characteristics of the initial obturation, is essential. Adjunctive techniques such as the use of solvents, H-files, and ultrasonics have been suggested in previous research as valuable tools for achieving thorough canal cleaning and disinfection [25,26]. Therefore, endodontists should carefully assess each case and select the most appropriate combination of tools and techniques to optimize retreatment outcomes.

Conclusion

In conclusion, this in vitro study sheds light on the efficiency of retreatment files in the context of different obturation techniques. The Coltene heat-treated single-file system demonstrated notable efficacy in Gutta Percha negotiation, resulting in reduced retreatment times. However, it's essential to acknowledge the study's limitations, including the absence of advanced assessments like SEM.

Our findings emphasize the need for a personalized approach to retreatment, considering the specific obturation characteristics of each case. While retreatment files play a valuable role, they

may not guarantee complete Gutta Percha retrieval. Therefore, a comprehensive strategy, possibly involving solvents, H-files, or ultrasonics, should be considered to ensure thorough canal cleaning and disinfection, ultimately enhancing the success of endodontic retreatment procedures. The choice of technique should be guided by clinical judgment and the unique attributes of each case.

This study contributes to the ongoing discussion on optimizing retreatment protocols and highlights the importance of adaptability in endodontic practice. Further research, including advanced imaging techniques, can provide additional insights into the intricacies of retreatment efficacy and guide future advancements in this essential aspect of endodontics.

References

[1] Taşdemir T, Er K, Yildirim T, et al. Efficacy of three rotary NiTi instruments in removing gutta-percha from root canals. Int Endod J. 2008;41:191–196.

[2] Swathi S, Antony DP, Solete P, et al. Comparative evaluation of remaining dentin thickness, canal centering ability and apical deformity between ProFit S3 and Protaper gold - A nano CT study. Saudi Dent J. 2024;36:650–655.

[3] Shim K-S, Oh S, Kum K, et al. Mechanical and Metallurgical Properties of Various Nickel-Titanium Rotary Instruments. Biomed Res Int. 2017;2017:4528601.

[4] Lakshmanan L, Ramakrishnan M, Jeevanandan G. Comparison of obturation quality, instrumentation time and post-operative pain using manual K-files and pediatric rotary files in primary molars a double blinded randomised clinical trial. Braz Dent Sci. 2023;26:e3497.

[5] Swathi S, Antony SDP, Solete P. Evaluating the effectiveness of different irrigant solutions in removing the smear layer and opening the dentinal canals: A scanning electron microscopic study. J Int Oral Health. 2024;16:76–81.

[6] Preethy NA, Jeevanandan G, Mathew MG, et al. Evaluation of Quality of Obturation Using Two Different Rotary Files and Hand Files in Primary Teeth: A Randomized Controlled Trial. Int J Clin Pediatr Dent. 2021;14:471–474.

[7] Shah T, Ramesh S, Sugumaran S, et al. Endodontic retreatment efficacy with and without solvents: A systematic review. J Conserv Dent Endod. 2023;26:610–615.

[8] Jose J, Thamilselvan A, Teja KV, et al. Influence of access cavity design, sodium hypochlorite formulation and XP-endo Shaper usage on apical debris extrusion - A laboratory investigation. Aust Endod J. 2023;49:6–12.

[9] Winkler A, Adler P, Ludwig J, et al. Endodontic Outcome of Root Canal Treatment Using

Different Obturation Techniques: A Clinical Study. Dent J [Internet]. 2023;11. Available from: http://dx.doi.org/10.3390/dj11080200.

[10] Athkuri S, Mandava J, Chalasani U, et al. Effect of different obturating techniques and sealers on the removal of filling materials during endodontic retreatment. J Conserv Dent. 2019;22:578–582.

[11] Somma F, Cammarota G, Plotino G, et al. The effectiveness of manual and mechanical instrumentation for the retreatment of three different root canal filling materials. J Endod. 2008;34:466–469.

[12] Nagendrababu V, Murray PE, Ordinola-Zapata R, et al. PRILE 2021 guidelines for reporting laboratory studies in Endodontology: explanation and elaboration. Int Endod J. 2021;54:1491–1515.

[13] Sadat Shojaee N, Vakilinezhad E, Shokouhi MM. In Vitro Comparison of Efficacy of Neolix and ProTaper Universal Retreatment Rotary Systems in Removal of Gutta-Percha Combined with Two Different Sealers. J Dent. 2019;20:285–291.

[14] Kim Y, Chang SW, Oh S. Buckling resistance, torque, and force generation during retreatment with D-RaCe, HyFlex Remover, and Mtwo retreatment files. Restor Dent Endod. 2023;48:e10.

[15] Comparative evaluation of time taken to retrieve Gutta percha using two different solvents and A novel heat treated retreatment file system in root canal treated teeth - an in vitro study. J Popul Ther Clin Pharmacol [Internet]. 2023;30. Available from: https://www.jptcp.com/index.php/jptcp/article/view/2040/2091.

[16] Ashraf H, Zargar N, Zandi B, et al. The Evaluation of Debris and Smear Layer Generated by Three Rotary Instruments Neo NiTi, 2Shape and Revo_S: An Scanning Electron Microscopic Study. Iran Endod J. 2023;18:96–103.

[17] Sankar A, Solete P, Jeevanandan G, et al. Comparative evaluation of solite RS3 and HyFlex remover retreatment files in conserving remaining dentin thickness during endodontic retreatment using cone beam computed tomography: An in vitro analysis. Cureus [Internet]. 2024; Available from: https://www.cureus.com/articles/242783-comparative-evaluation-of-solite-rs3-and-hyflex-remover-retreatment-files-in-conserving-remaining-dentin-thickness-during-endodontic-retreatment-using-cone-beam-computed-tomography-an-in-vitro-analysis.

[18] Influence of heat treated files on conserving the remaining dentin thickness during endodontic retreatment – An invitro CBCT study. Journal of King Saud University - Science. 2023;35:102969.

[19] Sagare SV, Chandra P, Kaur T, et al. A Comparative Study of the Efficacy of WaveOne and NeoEndo Retreatment File System for the Removal of Gutta Percha from the Root Canal. J Pharm Bioallied Sci. 2021;13:S1682–S1685.

[20] S DPA, Solete P, Jeevanandan G, et al. Effect of Various Irrigant Activation Methods and Its Penetration in the Apical Third of Root Canal-In Vitro Study. Eur J Dent. 2023;17:57–61.

[21] Choudhari S, Venkata Teja K, Ramesh S, et al. Assessment of Apical Pressures in Single and Joining Canals - An Ex Vivo Study Based on Computational Fluid Dynamic Analysis. Eur Endod J. 2024;9:89–94.

[22] Sharma S, Ramesh S, Rayapudi J. Biomechanical performance of mandibular molars with deep mesio-occlusal-distal cavities rehabilitated with horizontal posts: A 3D finite element analysis. Int J Dent. 2023;2023:3379373.

[23] Mittal A, Dadu S, Singh NS, et al. Comparative Assessment of Canal Transportation and Centering Ability of Reciproc and One Shape File Systems Using CBCT-An In Vitro Study. J Clin Diagn Res. 2017;11:ZC31–ZC34.

[24] Nevares G, de Albuquerque DS, Freire LG, et al. Efficacy of ProTaper NEXT Compared with Reciproc in Removing Obturation Material from Severely Curved Root Canals: A Micro-Computed Tomography Study. J Endod. 2016;42:803–808.

[25] Sumanthini MV, Aggarwal S, Patil A, et al. Retreatment efficacy of hand vs rotary instrumentation in oval-shaped root canals: An in vitro study. World J Dent. 2022;13:454–459.

[26] Malur MH, Chandra A. Curvature height and distance of MB canal of mandibular molar with Schneider angle and its comparison with canal access angle. J Oral Biol Craniofac Res. 2018;8:212–216.