Frontiers in Health InformaticsISSN-Online: 2676-7104 www.healthinformaticsjournal.com
2024; Vol 13: Issue 3 Open Access

# COMPARATIVE EVALUATION OF SINGLE VERSUS MULTIPLE CONTINUOUS ROTATING FILE SYSTEMS USED IN THE RETREATMENT OF TEETH OBTURATED BY COLD LATERAL COMPACTION AND WARM VERTICAL COMPACTION : AN IN VITRO CONE BEAM COMPUTED TOMOGRAPHY STUDY

***RUNNING TITLE: ENDODONTIC RETREATMENT OF DIFFERENT TECHNIQUES OF OBTURATION BY TWO DIFFERENT FILE SYSTEMS***

**[1.]Dr. Prajakta S. Kulkarni [2.]Dr. Pranav D. Patil [3.]Dr. Sharad B. Kamat [4.]Dr. Prajakta G. Chougule [5.]Dr. Shweta V. Sagare [6.]Dr. Harshata Tirtalli Sathish**

1. Postgraduate student, Department of Conservative Dentistry and Endodontics, Bharati Vidyapeeth (Deemed to be University) Dental College, and Hospital, Sangli 416416
2. Associate Professor, Department of Conservative Dentistry and Endodontics, Bharati Vidyapeeth (Deemed to be University) Dental College, and Hospital, Sangli 416416
3. Professor and Head, Department of Conservative Dentistry and Endodontics, (Deemed to be University) Bharati Vidyapeeth Dental College, and Hospital, Sangli 416416
4. Associate Professor, Department of Conservative Dentistry and Endodontics, Bharati Vidyapeeth (Deemed to be University) Dental College, and Hospital, Sangli 416416
5. Associate Professor, Department of Conservative Dentistry and Endodontics, Bharati Vidyapeeth (Deemed to be University) Dental College, and Hospital, Sangli 416416
6. Postgraduate student, Department of Conservative Dentistry and Endodontics, Bharati Vidyapeeth (Deemed to be University) Dental College, and Hospital, Sangli 416416

CORRESPONDING AUTHOR'S DETAILS:

1. Dr. Prajakta Kulkarni, Bharati Vidyapeeth (Deemed to be University) Dental College and Hospital, Sangli 416416
2. dr.prajakta99@gmail.com

Cite this paper as: Dr. Prajakta S. Kulkarni,.Dr. Pranav D. Patil,.Dr. Sharad B. Kamat,.Dr. Prajakta G. Chougule,.Dr. Shweta V. Sagare,.Dr. Harshata Tirtalli Sathish (2024) COMPARATIVE EVALUATION OF SINGLE VERSUS MULTIPLE CONTINUOUS ROTATING FILE SYSTEMS USED IN THE RETREATMENT OF TEETH OBTURATED BY COLD LATERAL COMPACTION AND WARM VERTICAL COMPACTION : AN IN VITRO CONE BEAM COMPUTED TOMOGRAPHY STUDY. *Frontiers in Health Informatics, 13* (3), 7761-7770

***Abstract***

***Introduction :*** *An ideal instrument for endodontic retreatment has to allow complete removal of gutta-percha in a short duration, without debris extrusion or alteration of the root canal space as well as no instrument separation or occurrence of other unwanted events, regardless the obturation technique used. Multiple retreatment file system offers specific design to remove obturation material from root canals. The latest innovations in endodontic instrumentation with design and metal treatment led to the development and application of new single-file systems.*

***Aim:*** *The aim of this in vitro study was to compare and evaluate single versus multiple continuous rotating file systems used in the retreatment of teeth obturated by cold lateral compaction and warm vertical compaction.*
***Methods and Materials:*** *The root canals of 68 extracted human mandibular single-rooted premolars were prepared and randomly divided into two groups. The root canals were obturated using cold lateral condensation in group I and warm vertical compaction in group II. respectively. Then specimens in each group were randomly divided into two subgroups for retreatment with Hyflex Remover and Protaper Universal Retreatment file system. Pre and post retreatment, cone beam computed tomography evaluation was done to check the volumetric analysis. Also, time analysis was done to measure the time taken by the instrumentation while removing the obturating material. A p-value≤0.05 was considered as statistically significant. The data was analysed using the one-way ANOVA followed by Tukey's post hoc test was applied.*
***Results:*** *The remaining filling material in the canals treated with Hyflex R in WVC was highest being 12.1%. Time taken by Hyflex R in WVC was the highest 140.2sec.* ***Conclusion:*** *ProTaper R removed filling material more efficiently compared to Hyflex Remover and took less time to remove root filling material in both of the obturating techniques.*
***Keywords:*** *Hyflex Remover; Obturation; ProTaper Retreatment Files; Root Canal Retreatment*

## INTRODUCTION

Endodontic therapy aims to eliminate any potential for recurrence of the infection by thoroughly cleaning the root canals of the bacterially infected pulp tissue and performing meticulous debridement to form and prepare the canal space for obturation with inert material.[1] The procedure involves the removal of infected or inflamed pulp tissue, which comprises nerves, blood vessels, and connective tissue, from within the tooth's pulp chamber and root canals. Furthermore, the void left by the removed pulp has to be meticulously cleaned, disinfected, shaped, and then filled with a biocompatible material to prevent recontamination.[2] Persistent infection occurs most frequently when the original treatment falls short of acceptable technical standards, missed canals, inadequate shaping, cleaning and obturation of the root canal system, then the endodontic failures is predictable [3]. The success of endodontic retreatment is dependent on many variables including diagnosis, complete access, identification of canals and use of concepts and techniques directed toward 3- dimensional cleaning, shaping and obturation. [3]
Out of all obturation techniques, of the currently employed ones are cold lateral condensation (CLC) and warm vertical compaction (WVC). The CLC technique has a higher level of safety, cost-efficient, with favourable clinical results. It is considered as the gold standard root canal obturation technique. WVC uses heat to produce a homogenous obturation that leads to the continuous adaption to the canal walls. The hermetic seal and stronger adhesion to dentine produced by heated gutta-percha results in better canal irregularities in fillings than cold gutta-percha points creating a three-dimensional obturation.[5]

There are several Ni-Ti rotary instruments that have been proposed for retreatment, that have developed to improve efficiency and success rates. An ideal instrument for endodontic retreatment has to allow complete removal of gutta-percha in a short duration, without debris extrusion or alteration of the root canal space as well as no instrument separation or occurrence of other unwanted events. Multiple retreatment file system offers specific design to remove obturation material from root canals.[6] The latest innovations in endodontic instrumentation with design and metal treatment led to

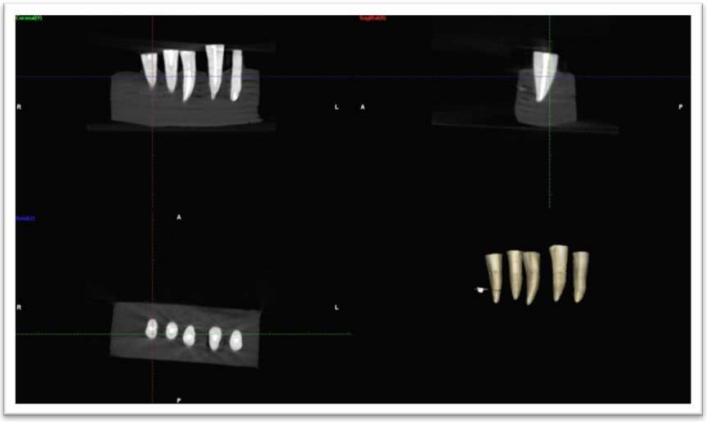
the development and application of new single-file systems. These files have shown effectiveness and efficiency in root canal preparation, being able to address more canal walls compared with conventional multifile systems. Their improved mechanical properties can potentially make them suitable for gutta-percha removal.[6]

As the evaluation of remaining volume in endodontic retreatment cases remains crucial parameter in the long term prognosis and success rate, our literature search focused on the retrieval of gutta percha from different obturation techniques using different rotary instruments.

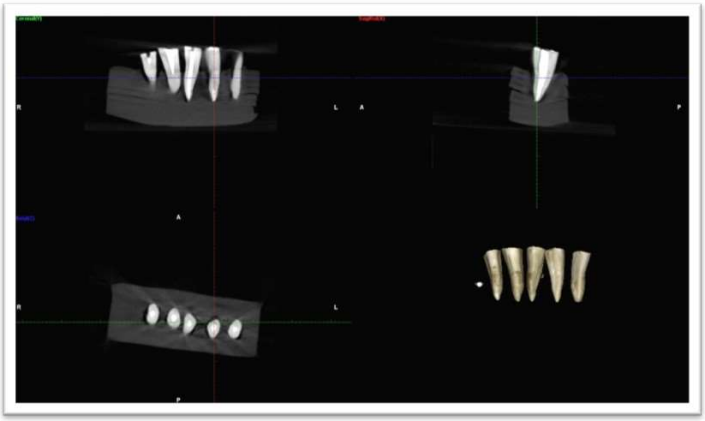
The null hypothesis tested was that there is no difference in volumetric analysis as well as time taken for the retrieval of GP between Protaper Retreatment File system (Protaper R) and Hyflex Remover (Hyflex R) File System

## MATERIALS AND METHOD

**Study Procedure:** This in-vitro study was conducted in the Department of Conservative Dentistry and Endodontics at Bharati Vidyapeeth (Deemed to be University) Dental College and Hospital, Sangli. The study was approved by the Institutional Ethical Committee (BV(DU)MC&H/Sangli/IEC/Dissertation2021-2022/D-70). This in vitro study was done using 68 Single rooted mandibular premolars extracted for orthodontic purpose. Samples were stored in 10% buffered formalin for 24hrs. Decoronation done at CEJ with a diamond disk bur to obtain a root length of 13mm to facilitate straight line access for instrumentation and obturation. This followed access refinement with Round bur no.2. Apical patency verification with no. 10k file and working length was established 1mm shorter of apical length at the point at which the file was first visible beyond apex. Biomechanical preparation of the root canal was done with protaper gold. Irrigation was done after each instrumentation – 2ml of 3% of Sodium hypochlorite (NaOCl) using 30G side-vented irrigating needle, between each file followed by using 1 mL of 17% Ethylenediamine Tetraa-cetic Acid (EDTA) 1 mm short of WL. 5 ml Normal Saline was used as a final rinse. Then samples were randomly divided into 2 groups for the obturation, group I. CLC and group II. WVC. Bioceramic sealer was used for both groups. CBCT evaluation – Pre- Retreatment CBCT evaluation was done to check the measurement of the Volume analysis – percentage of volume of obturating material was carried out.

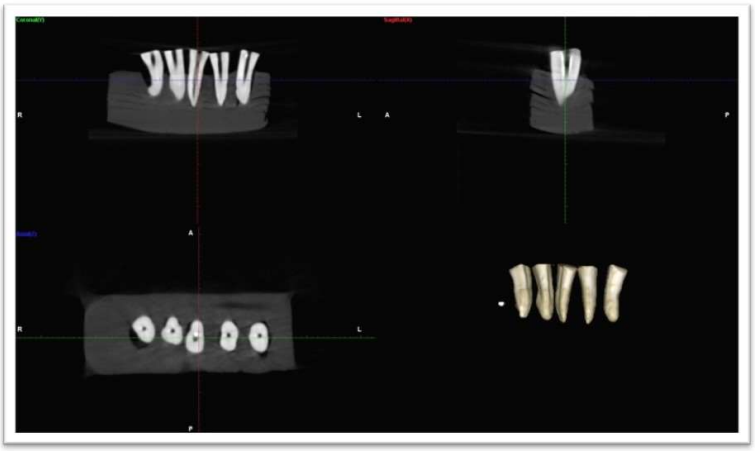


[Table/Fig-1]: Group I- Teeth obturated with cold lateral compaction

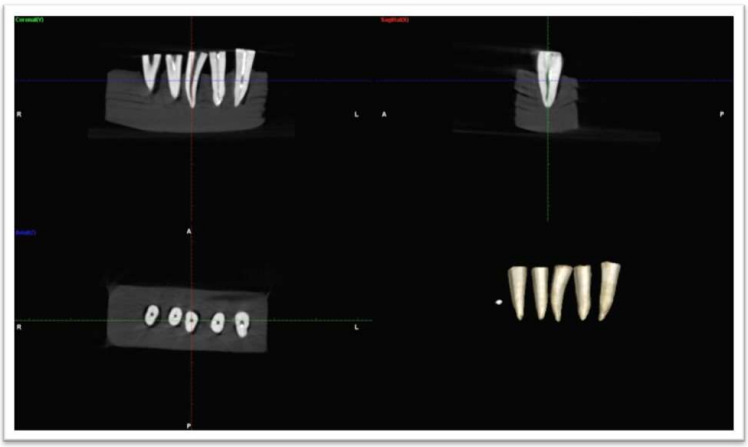


[Table/Fig-2]: Group II- Teeth obturated with warm vertical compaction

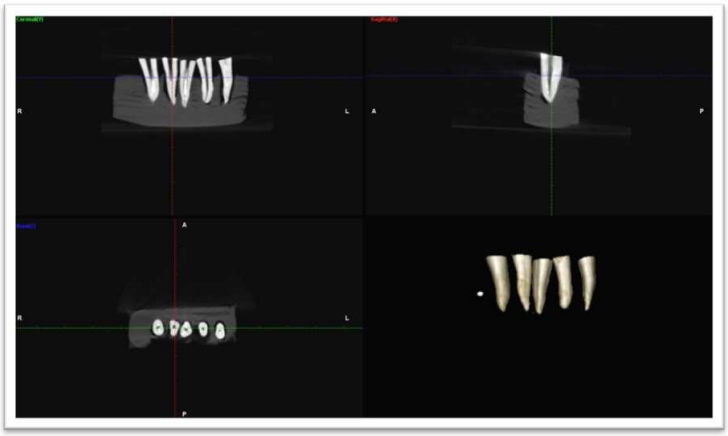
Teeth were stored for 7 days in 37º C 100% humidity for the setting of obturating material.
Then Each group was divided into 2 subgroups for the retreatment with different file systems.
GROUP IA. Hyflex Remover (Coltene) in teeth obturated with CLC, GROUP IIB. Protaper Retreatment files (Dentsply Sirona) in teeth obturated with CLC, GROUP IIA. Hyflex Remover in teeth obturated with WVC, GROUP IIB. Protaper Retreatment files in teeth obturated with WVC Single Solvent (RC solv) was used in each group. Post retreatment, CBCT evaluation was done to check, the Volume analysis – percentage of volume of remaining obturating material.



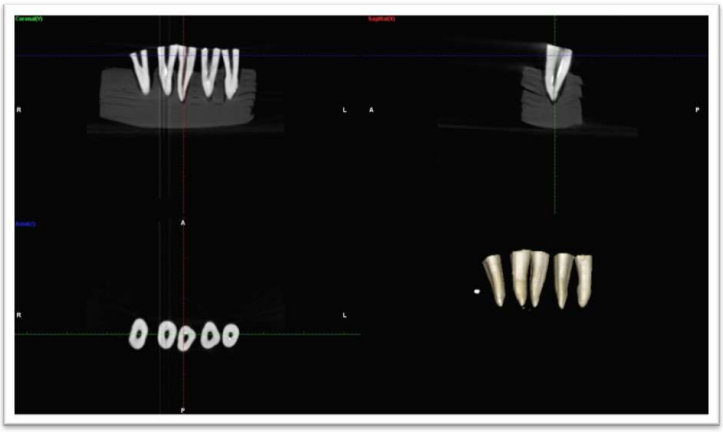
[Table/Fig-3]: GROUP IA. Hyflex R in teeth obturated with CLC



[Table/Fig-4]: GROUP IB. Protaper R in teeth obturated with CLC



[Table/Fig-5]: GROUP IIA. Hyflex R in teeth obturated with WVC



[Table/Fig-6]: GROUP IIA. Hyflex R in teeth obturated with WVC

**CBCT ANALYSIS**:

All specimens were placed on wax sheet and mounted for CBCT exposure using bar for chin rest and all the specimens were exposed. The CBCT scans were obtained using ProMax 3D Mid (Planmeca OY, Helsinki, Finland). By FOV of 4.5 × 4.5 $cm^2$ and an isotropic resolution of 0.1 mm, with 12.28 s exposure time, the samples were exposed to 90 kV and 8 mA. The radiopaque root fillings created the

artifacts were decreased/eliminated using inbuilt software (Romexis v3.20, Planmeca OY, Helsinki, Finland).
A region of interest (ROI) was selected using the software, by outlining the external margins of the filling along the entire length of the canal at 3 to 5 zones. The measurements were done using a software to compute the entire volume of the filling material present in the canal in mm3. The percentage of volume of remaining filling material was calculated with the following equation:

$$\frac{\text{Volume of remaining filling material x100}}{\text{Volume of original filling material}} = \text{volume \% of remaining filling material}$$

**TIME ANALYSIS -**Time analysis was done to measure the time taken by the instrumentation.

- T1 = Time taken by the retreatment file to reach the working length
- T2 = Time taken by the retreatment file to remove the obturating material.
- T = T1 + T2

**STATISTICAL ANALYSIS**

With Statistical Package for Social Sciences, statistical analysis was done (IBM SPSS Statistic for window, version 21.0. Armonk, NY: IBM Corp.) at 95% CI and 80% power to the study. To check for normal distribution of the data, Kolmogorov-Smirnov and Shapiro Wilk test was done. Descriptive statistics was performed in terms of Mean, Std Deviation, One Way ANOVA followed by Tukey's post hoc test to compare volume and time between groups.
Statistical significance was kept at $p<0.05$ and $p<0.001$ was considered highly significant.

**RESULTS**

| | N | Mean | Std. Deviation | Minimum | Maximum | F value | P value |
|---|---|---|---|---|---|---|---|
| Group IA | 17 | 11.7594 | 13.32972 | .00 | 38.46 | 0.020 | **0**.996 |
| Group IB | 17 | 11.2088 | 12.18255 | .00 | 40.00 | | |
| Group IIA | 17 | 12.1188 | 10.87651 | .00 | 31.25 | | |
| Group IIB | 17 | 11.7629 | 6.37688 | .00 | 19.05 | | |
| Total | 68 | 11.7125 | 10.76766 | .00 | 40.00 | | |

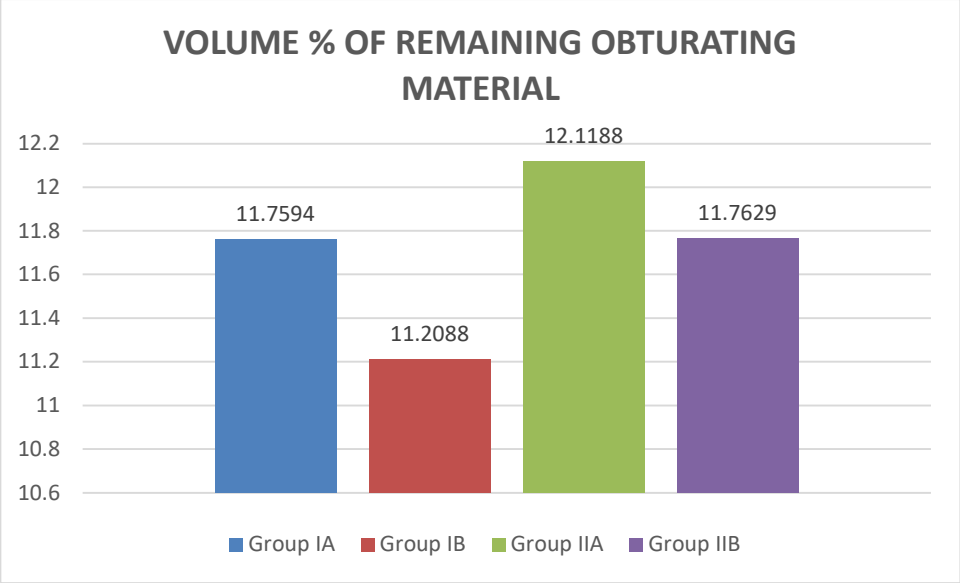
[Table/Fig-7]: - Comparison of volume % of remaining obturating material
Volume % of remaining obturating material was 11.75±13.32 of Group IA,11.20±12.18 of Group IB ,12.11±10.87 of Group IIA and 11.76±6.37 of Group IIB respectively. Comparison showed no statistically significant difference in % volume of remaining material between Groups .($p>0.05$)

| | N | Mean | Std. Deviation | Minimum | Maximum | F value | P value |
|---|---|---|---|---|---|---|---|
| Group IA | 17 | 123.3529 | 10.66502 | 103.00 | 144.00 | 8.502 | **<0.001** |
| Group IB | 17 | 110.2941 | 9.84736 | 92.00 | 133.00 | | |
| Group IIA | 17 | 140.1765 | 29.40713 | 87.00 | 174.00 | | |

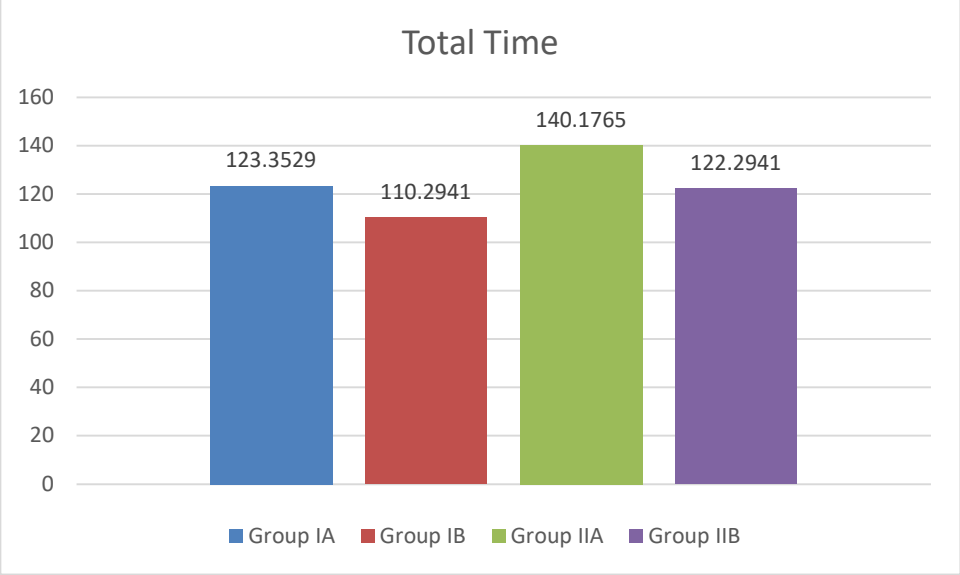
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Group IIB | 17 | 122.2941 | 11.48240 | 96.00 | 146.00 | | |
| Total | 68 | 124.0294 | 20.08041 | 87.00 | 174.00 | | |

[Table/Fig-8]: - Comparison of total time between Group IA, IB , IIA and IIB

Total time for Group IA was 123.35±10.66, 110.29±9.84 Group IB, 140.17±29.40 for Group IIA and 122.29±11.48 for group IIB respectively. There was statistically high significant difference total time between respectively.($p<0.001$)




[Table/Fig-9]: - Comparison of volume % of remaining obturating material between Group IA, IB , IIA and IIB




[Table/Fig-10]: Comparison of total time taken between Group IA, IB , IIA and IIB

**DISCUSSION**

Endodontic nonsurgical retreatment is a comprehensive field having its own science, literature, varied

technologies, best materials, and escalating range of techniques that are necessary to achieve clinical success [7]. The results of this study indicated the WVC technique resulted in significantly greater amount of volume of the obturation than CLC, similar to the results of Bhandi S. et al [8]. There may be several reasons for this difference first being, with the flow of plasticized gutta-percha in WVC, irregularities, fins, recesses, and accessory and lateral canals can be filled, thus providing better adaptation to the dentinal walls and better sealing ability than CLC[8]. Also, the heated material has the ability to flow into root canal irregularities, which results with a lower percentage of voids and greater mass of gutta-percha than CLC [9]. The presence of spreader tracts and the greater amount of sealer in CLC reduces the adaptation of gutta-percha and the homogenous obturation material mass [10]. WVC technique utilized some form of heat to plasticize the gutta-percha and provides more homogenous dense root canal filling with a lower percentage of voids and greater mass of gutta-percha than CLC. Therefore, superior obturation quality is one of the main reasons in more difficult removal of root canal filling.

Rotary NiTi instruments have been proposed for the removal of filling materials from root canal walls and various studies reported their efficacy, cleaning ability, safety and less time consuming.[11,12,13] Gu et al., and Mittal & Jain found that on comparison, ProTaper retreatment files were superior for removal of gutta-percha to H-files and K-flex files [9,15]. ProTaper Ni-Ti instruments is more competent and requires less time for removal of GP. [16]
In the present study we used CBCT to evaluate the remaining obturating material present after retreatment with the different system as a non-invasive and quantitative method to estimate the volume of obturating material.

Protaper R comprises of three retreatment files (D1, D2, D3). D1 (30/.09) is worked in the coronal third, D2 (25/.08) in the middle third, and D3 (20/.07) throughout the entire length of the root canal. The retreatment instruments are used at a constant speed of 500 RPM for D1 and 400 RPM for D2 and D3, with a torque of 3Nm. These instruments have a convex triangular cross section similar to the Protaper shaping and finishing files. The application of these instruments during retreatment procedure was done according to manufacturers' instruction.[15,17] The HyFlex R, single-file retreatment system has been recently introduced has a modified triangular cross-sectional shape and is made using C-wire technology. It includes a single retreatment instrument having controlled memory which makes it easy to use. A small amount of solvent containing orange oil (RC Solv) was used as a solvent.[18]

The results of the study revealed that the mean value of the percentage of the remaining obturating material in Group IA is 11.7% was higher than that of Group IB 11.2%. And for Group IIA is 12.1% which is more than Group IIB 11.7%. As previously observed by Hülsmann and Bluhm [19], the presence of different results concerning the cleaning ability of Ni-Ti rotary files could depend on the characteristics of the cross-sectional design of the instruments. Protaper R system removes large amounts of GP in spirals around the instruments, whereas the C-wire type crosssection files of Hyflex R remove the GP in small increments that do not adhere to the instruments. Protaper R system both softens the GP by rotation and cuts it. The heat-treated files of Hyflex R present with improved flexibility and resistance to cyclic fatigue when compared to conventional NiTi. This controlled memory effect allows these endodontic instrument to maintain the shape of the canal even when it has been removed from the canal. [20]
The active tip of the D1 file of Protaper R system might facilitate the penetration of the subsequent files (D2 and D3) as compared to Hyflex R file which have non cutting tip making it difficult in coronal

penetration into the obturating material. The nonactive tips of D2 and D3 help in reducing the possibilities of ledging, perforation, and stripping while removing the filling materials. The negative cutting angles and the absence of radial land aids in a cutting action rather than a planing action [20]. Furthermore, the rotary movements of these engine-driven files produce a certain degree of frictional heat which plasticizes GP causing less resistance and easier to remove. [9,11,20]

The results of the study also revealed that the mean value of the total time for the removal of the obturating material in Group IA is 123.3sec, was higher than that of Group IB 110.2sec. And for Group IIA is 140.2sec, which is less than Group IIB 110.2sec.

The Protaper R resulted in the shortest working time. It is possible that the frictional heat produced by rotary movements of Protaper R alters the GP, making it less resistance and easier to remove. These features may enable the retreatment instruments to cut not only GP but also the superficial layer of dentine during root filling removal. [9]

As has been shown in the literature, it was impossible to remove all traces of obturating material from root canals, regardless the technique used. The majority of remnants on the canal walls appeared to be sealer, which is consistent with other. Overall the results of the study revealed that irrespective of the technique employed, some amount of obturating material left in the canal.

## CONCLUSION

There was statistically no significant difference for the efficacy as well as the time taken by Protaper R and Hyflex R in teeth obturated with CLC and WVC ($p>0.05$) and complete removal of the obturating material was not possible regardless the obturation technique used.

Within the limitations of the study, it can be concluded that Protaper R was more efficient than Hyflex R System in the removal of the obturating material as well as the time taken for the retreatment regardless the technique used for the obturation.

## REFERENCES

1. Kenneth M, Hargreaves SC. Cohen's pathways of the pulp. Missouri: Mosby Elsevier; 2011. p. 231.
2. Urkande NK, Mankar N, Nikhade PP, Chandak M. Beyond Tradition: Non-surgical Endodontics and Vital Pulp Therapy as a Dynamic Combination. Cureus. 2023 Aug 25;15(8):e44134.
3. Nagpal, J., Chhibber, R., Sindhu, B., Mahajan, P., Manhas, S., & Makkar, S. (2020). Endodontic Retreatment - A Nightmare to dentist : An Overview. Journal of Current Medical Research and Opinion, 3(07), 494–502.
4. Dr. Kanchan Bhagat, Dr. Ankush Jasrotia, Dr. Ravinder Kumar Bhagat. A comparison of cold lateral compaction and warm vertical compaction using continuous wave of compaction technique. Int J Appl Dent Sci 2021;7(2):244-246.
5. Samadi F, Jaiswal J, Saha S, Garg N, Chowdhary S, Samadi F, Tripathi VP. A Comparative Evaluation of Efficacy of Different Obturation Techniques used in Root Canal Treatment of Anterior Teeth: An in vitro Study. Int J Clin Pediatr Dent. 2014 Jan;7(1):1-5. doi: 10.5005/jp-journals-10005-1224. Epub 2014 Apr 26.
6. Azim AA, Wang HH, Tarrosh M, Azim KA, Piasecki L. Comparison between Single-file Rotary Systems: Part 1-Efficiency, Effectiveness, and Adverse Effects in Endodontic Retreatment. J Endod. 2018 Nov;44(11):1720-1724.

7. Ruddle CJ. Nonsurgical retreatment. J Endod. 2004 Dec;30(12):827-45. doi: 10.1097/01.don.0000145033.15701.2d.
8. Bhandi S, Mashyakhy M, Abumelha AS, Alkahtany MF, Jamal M, Chohan H, Raj AT, Testarelli L, Reda R, Patil S. Complete Obturation—Cold Lateral Condensation vs. Thermoplastic Techniques: A Systematic Review of Micro-CT Studies. *Materials*. 2021; 14(14):4013.
9. Gu LS, Ling JQ, Wei X, Huang XY. Efficacy of ProTaper Universal rotary retreatment system for gutta-percha removal from root canals. Int Endod J. 2008 Apr;41(4):288-95. doi: 10.1111/j.1365-2591.2007.01350.x. Epub 2007 Dec 12.
10. Canakci BC, Sungur R, Er O. Comparison of warm vertical compaction and cold lateral condensation of α, β gutta-percha and resilon on apically extruded debris during retreatment. Niger J Clin Pract. 2019 Jul;22(7):926-931.
11. Bramante CM, Fidelis NS, Assumpção TS, Bernardineli N, Garcia RB, Bramante AS, de Moraes IG. Heat release, time required, and cleaning ability of MTwo R and ProTaper universal retreatment systems in the removal of filling material. J Endod. 2010 Nov;36(11):1870-3. doi: 10.1016/j.joen.2010.08.013.
12. Xu LL, Zhang L, Zhou XD, Wang R, Deng YH, Huang DM. Residual filling material in dentinal tubules after gutta-percha removal observed with scanning electron microscopy. J Endod. 2012 Mar;38(3):293-6. doi: 10.1016/j.joen.2011.11.016. Epub 2012 Jan 23.
13. Chandrasekar, Ebenezar AV, Kumar M, Sivakumar A. A comparative evaluation of gutta percha removal and extrusion of apical debris by rotary and hand files. J Clin Diagn Res. 2014 Nov;8(11):ZC110-4.
14. Giuliani V, Cocchetti R, Pagavino G. Efficacy of ProTaper universal retreatment files in removing filling materials during root canal retreatment. J Endod. 2008 Nov;34(11):1381-1384. doi: 10.1016/j.joen.2008.08.002. Epub 2008 Sep 16.
15. Mittal N, Jain J. Spiral computed tomography assessment of the efficacy of different rotary versus hand retreatment system. J Conserv Dent. 2014;17(1):8-12.
16. Khalilak Z, Vatanpour M, Dadresanfar B, Moshkelgosha P, Nourbakhsh H. In Vitro Comparison of Gutta-Percha Removal with H-File and ProTaper with or without Chloroform. Iran Endod J. 2013;8(1):6-9.
17. Scelza MF, Coil JM, Maciel AC, Oliveira LR, Scelza P. Comparative SEM evaluation of three solvents used in endodontic retreatment:an ex vivo study. J Appl Oral Sci. 2008;16(1):24–9.
18. Frajlich SR, Goldberg F, Massone EJ, Cantarini C, Artaza LP. Comparative study of retreatment of Thermafil and lateral condensation endodontic fillings. Int Endod J. 1998 Sep;31(5):354-7. doi: 10.1046/j.1365-2591.1998.00168.x.
19. Hülsmann M, Bluhm V. Efficacy, cleaning ability and safety of different rotary NiTi instruments in root canal retreatment. Int Endod J. 2004 Jul;37(7):468-76.
20. Chan WS, Gulati K, Peters OA. Advancing Nitinol: From heat treatment to surface functionalization for nickel-titanium (NiTi) instruments in endodontics. Bioact Mater. 2022 Sep 27;22:91-111.