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Original Research Article

Comparison of Efficacy of ProTaper Universal Rotary Retreatment Files and Mtwo Retreatment Files in the Removal of Gutta-Percha in Single-Rooted Premolars during Root Canal Retreatment

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Abstract: *Root canal treatment is an essential procedure to preserve infected teeth; however, approximately 8.2% of cases require retreatment due to persistent microbial infection. Rotary endodontic systems such as Mtwo® and ProTaper-D® have been developed to enhance the efficiency and safety of gutta-percha removal during re-endodontic therapy.* ***Objective:*** *To compare the efficacy of Mtwo® and ProTaper-D® retreatment file systems in removing gutta-percha and the time required for canal cleaning in endodontically treated mandibular premolars.* ***Methods:*** *A laboratory-based experimental study was conducted on 320 extracted mandibular premolars that were obturated and randomly divided into two groups: Mtwo® and ProTaper-D® retreatment systems. After chloroform-assisted softening, gutta-percha was removed using the respective rotary files. Cone-beam computed tomography (CBCT) was used to assess the volume of residual filling material, and cleaning time was recorded in seconds. Data normality was confirmed using the Shapiro–Wilk test, and comparisons were made using paired t-tests, with a significance level set at $p < 0.05$. Ethical approval was obtained before study initiation.* ***Results:*** *Among 320 specimens, the mean residual gutta-percha volume was 41.43 ± 6.17 mm³ in the Mtwo® group and 36.90 ± 6.01 mm³ in the ProTaper-D® group. The mean cleaning time was 236.76 ± 16.53 s for Mtwo® and 278.15 ± 17.69 s for ProTaper-D®. Statistically significant differences ($p = 0.000$) were observed for both residual material and cleaning time, indicating that the ProTaper-D® system achieved more effective cleaning but required a longer time compared to Mtwo®.* ***Conclusion:*** *Neither Mtwo® nor ProTaper-D® retreatment systems completely removed gutta-percha from root canals. Although ProTaper-D® demonstrated superior cleaning efficacy, it required more time to complete the procedure. Both systems showed comparable overall performance and can be used effectively in endodontic retreatment.*

Keywords: Cone-Beam Computed Tomography; Endodontics; Gutta-Percha; MTWO Retreatment Files; ProTaper Retreatment Files; Root Canal Therapy

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Introduction

Pulpal and periapical diseases are caused primarily by caries and trauma, which result in inflammation or necrosis of the dental pulp and subsequent periapical pathology. These diseases are most effectively treated through root canal treatment (RCT) (1). Root canal treatment serves as the standard therapeutic approach for such infected or diseased teeth, aiming to preserve natural dentition. The procedure involves cleaning and shaping the root canals, followed by obturation with biocompatible filling materials to ensure a hermetic seal (1, 2). Studies have demonstrated a remarkably high survival rate of teeth following successful endodontic therapy, with billions of teeth being saved from extraction globally (3).

However, despite its high success rate, some endodontically treated teeth fail to heal, leading to persistent or recurrent periapical infection. This failure is typically due to residual microbial contamination within the canal system or the periapical tissues. A 2022 systematic review and meta-analysis estimated that approximately 8.2% of root canal-treated teeth worldwide require retreatment (4). The primary cause of such failures is the persistence of microbial infection following initial treatment (2, 5, 6). Contrary to popular belief, procedural errors—such as instrument fractures or ledge formation—are less frequently responsible for failure than the inability to maintain sterility within the canal system after obturation (7).

The objective of re-endodontic (retreatment) procedures is to eliminate infected filling materials (mainly gutta-percha) and thoroughly disinfect the canal system to restore asepsis (3, 7). Removal of gutta-percha is a technically demanding process that traditionally relied on hand instruments, heat, and solvents. Historically, methods using hand-driven K-files, H-files, or LASER-assisted techniques were employed, though these were often time-consuming and operator-dependent (8, 9).

In recent years, rotary file systems have revolutionized endodontic retreatment by offering greater efficiency, reduced procedural time, and enhanced cleaning ability compared to traditional hand files (7). These rotary instruments effectively remove both gutta-percha and sealer remnants (10, 11). Structurally, a rotary file consists of two main sections: (i) an attachment portion made of copper and (ii) a working segment composed of nickel-titanium (NiTi), which provides superior flexibility and cyclic fatigue resistance, allowing safe navigation through curved canals.

Among modern systems, VDW Mtwo R and ProTaper D systems are widely utilized. The VDW Mtwo R system includes two NiTi rotary instruments—R15/.05 and R25/.05—used sequentially to reach full working length and efficiently remove gutta-percha through active cutting tips (9). Conversely, the ProTaper D system consists of three instruments: D1 (30/.09) for the coronal third, D2 (25/.08) for the middle third, and D3 (20/.07) for the apical third, providing a progressively tapered design for complete canal debridement (12).

Together, these advancements in rotary instrumentation have significantly improved the predictability, efficiency, and success of endodontic retreatment procedures, reducing operator fatigue and enhancing clinical outcomes.

Methodology

Using 'Open EPI', with Mean + SD 36.76±8.6 (MTWO group) versus 40.54±14.2 (ProTaper Universal group), keeping alpha risk 5% and

power of the test 80%, the sample size was calculated to be 304. Still, to add more power to the study, we increased the sample size to 320. Each group had 160 patients selected by a consecutive nonprobability sampling technique. Inclusion criteria were single canal mandibular premolar teeth with straight canals, a working length of 16 mm or 18 mm measured from the apical foramina using an endo-ring, and in good health, free from caries, calculus, and other anomalies. These teeth are often chosen for orthodontic extractions. Exclusion criteria were patients having non-mandibular carious teeth.

A total of 320 mandibular premolars were obtained from patients of the orthodontics department of Sardar Begum Dental College after ethical approval from the institute's ethical committee. The teeth were prepared for the study by being mechanically cleaned and then disinfected using sodium hypochlorite. Afterwards, a uniform working length of 18 mm was taken by crossing the apical foramina through a 15k file and then taking a periapical radiograph. The same procedure was repeated for all the selected 304 teeth to obtain a uniform working length of 18mm. Canals were shaped and prepared with rotary files, and after filing with each file, the canals were washed with 5.25% NaOCl. All canals were prepared to Major Apical File (MAF) 35. After preparation, canals were obturated with gutta-percha and sealer. Gutta-percha was laterally condensed, and accessory GPs were used to achieve proper obturation. The cavity was sealed using Cavit (a temporary filling material). Subsequently, the prepared and obturated teeth were kept in a thermocycler at 37 degrees for 30 days to mimic oral conditions. After the prescribed period, the teeth were assigned cleaning by either the Mtwo retreatment file system (Group A) or the Protaper Universal Rotary Retreatment files (Group B) by random allocation through the lottery method. Each group received an equal number of teeth (n=160). The procedure was initiated by reopening the cavity, and the canals were re-cleaned from obturation material with the help of chloroform. 1-2ml of chloroform was added for 1 minute in each canal to soften the Gutta-percha and facilitate the entry of rotary files into the canal. Mtwo retreatment file system and Protaper Universal Rotary Retreatment files were used in both groups, respectively. Canals were assessed to ascertain the mean of residual filling material of both rotary files by placing longitudinal grooves on the roots' outer surface. The teeth were sectioned into two parts/halves with the help of a chisel and a mallet. Samples were evaluated to assess the amount of residual gutta-percha using cone beam computerized tomography (CBCT) scans.

Results

There was a total of 320 teeth divided into two groups: one was treated by MTWO Retreatment Files, and the second group of teeth was treated with Protaper Retreatment Files.

The normality of the data was assessed using the Shapiro-Wilk test. The results indicated that the residual gutta-percha in MTWO files (W = [.998], p = [1.000]), ProTaper files (W = [.994], p = [.741]), time taken by MTWO (W= [.996], p=[.936])and time taken by Protaper files(W= [.994], p=[.800]) was normally distributed. Remember that a P value greater than 0.05 in the Shapiro-Wilk test indicates that the data is usually distributed, as it is also evident from the histograms, which are provided below.

We determined that the mean value of residual gutta-percha in canals treated by MTWO files was 41.43 ± 6.17 mm^3, as shown in Table 1. We also found that the mean value of residual gutta-percha in canals treated by Protaper files was 36.90 ± 6.01 mm^3, as shown in Table 1.

Furthermore, we noted that there was a statistically significant difference between the efficacy of ProTaper files and MTWO files in cleaning the canals (P value 0.000) by using a paired samples t-test as shown in Table 2.

The average time taken by MTWO to clean the canals was 236.76±16.53 seconds, as shown in Table 1. Similarly, the average time taken by ProTaper Retreatment Files to clean the canals was 278.15±17.69 seconds, as shown in Table 1. Moreover, we found that there was a statistically significant difference between the average time taken by MTWO and ProTaper files in cleaning the canals (P value 0.000) by using a paired samples t-test as shown in Table 2.

Table 1: Mean and S.D. of various variables of the study.

Variable	Value
Time taken by MTWO Retreatment Files (seconds)	236.78 ± 16.53
Time taken by ProTaper Retreatment Files (seconds)	278.15 ± 17.69
Residual gutta-percha in MTWO-treated Canals (mm^3)	41.43 ± 6.17
Residual gutta-percha in Protaper-treated Canals (mm^3)	36.90 ± 6.01

Values are mean ± SD.

Table 2: Student T Test Showing Level of Significance Between Time Taken to Clean the Canal by Mtwo and Protaper Retreatment Files, as well as Residual Gutta Percha in Mtwo and ProTaper Retreatment Files.

Variable	Mean	S. D	Mean Difference	P value
Time taken by MTWO Retreatment Files (seconds)	236.78	16.53	41.38	0.000
Time taken by ProTaper Retreatment Files (seconds)	278.15	17.69		
Residual Gutta Percha in MTWO Retreated Canals (mm^3)	41.43	6.17	4.52537	0.000
Residual Gutta Percha in ProTaper Retreated Canals (mm^3)	36.90	6.01		

Discussion

Failure of endodontic treatment may occur due to the persistence of residual bacteria within the root canal system, often resulting from inadequate biomechanical preparation, incomplete obturation, or improper post-endodontic restoration, ultimately leading to apical or coronal leakage (10, 13). Therefore, in re-root canal treatment (re-RCT) cases, the removal of as much gutta-percha as possible is essential to eliminate infection, correct prior procedural errors, and ensure optimal cleaning and sealing of the canal—factors crucial for long-term clinical success (10, 13).

In our study, it was observed that neither ProTaper retreatment files nor Mtwo retreatment files completely removed gutta-percha from the canal walls. This finding aligns with the results of Madarati et al., who conducted their study in Saudi Arabia using five different retreatment file systems—including ProTaper and Mtwo—and reported that none of the systems achieved complete gutta-percha removal from canal walls (14). Similarly, Aly et al. in Egypt also found that both ProTaper and Mtwo files were unable to eliminate gutta-percha residues during retreatment procedures (10) completely.

Our study, however, demonstrated that ProTaper retreatment files were more effective in gutta-percha removal compared to Mtwo retreatment files. These results are in agreement with findings from Khedmat et al. in Iran, who also reported that the ProTaper system performed more efficiently than the Mtwo system in removing gutta-percha from canal walls (9). Likewise, Chudasama et al. in India found that the ProTaper Universal system exhibited superior efficacy in removing gutta-percha from retreated canal walls compared to the Mtwo retreatment system (15).

In contrast, Madhu et al. reported that the Mtwo system was more effective than the ProTaper Universal system in removing gutta-percha from retreated canals. This discrepancy could be attributed to the smaller sample size of their study (40 endodontically retreated teeth) compared to our larger sample size of 300 teeth. Additionally, Yadav et al. also reported that Mtwo retreatment files left less residual gutta-percha and sealer volume compared to ProTaper files.

It is essential to recognize that the ProTaper retreatment file system features three files with progressively tapering ends and variable lengths, which may facilitate superior gutta-percha removal compared to Mtwo. These design characteristics allow ProTaper to remove gutta-percha not only from the canal lumen but also from the superficial layer of root dentin. The rotary motion of ProTaper further enhances its ability to displace and extract gutta-percha toward the coronal orifice, as also observed by Gu LS et al. Moreover, the S-shaped cross-section of Mtwo retreatment files, coupled with their cutting tip and increasing pitch length from apical to coronal, enables efficient cutting and navigation through obturation material—potentially giving an impression of higher efficiency in some studies, though this may not reflect accurate material removal.

In our study, we also noted a statistically significant difference in the time required for canal cleaning, with ProTaper retreatment files achieving gutta-percha removal in less time than Mtwo retreatment files. This finding is consistent with the results of Bramante et al., who demonstrated that ProTaper files required less time to clean canals compared to Mtwo files (16). Conversely, Rani et al. in India found no significant difference in the time taken by the two systems (17). At the same time, Jaiswal et al. reported that Mtwo files achieved more efficient cleaning with reduced working time compared to ProTaper retreatment files (18).

Overall, our findings reinforce that while neither system ensures complete gutta-percha removal, the ProTaper retreatment system appears to provide greater efficiency and faster cleaning time under standardized conditions, supporting its preference in complex re-endodontic procedures.

This study had several limitations. Its in-vitro design limits direct applicability to clinical settings, and the absence of chemical analysis for the solvent restricts understanding of its effect on gutta-percha removal. The study was conducted only on straight, single-rooted teeth, making the results less generalizable to curved or multi-rooted canals. Additionally, as a single-center study, its findings may not reflect broader clinical variations. Future in-vivo and multi-center studies are recommended to enhance clinical relevance and validate these results.

Conclusion

Neither Mtwo® nor ProTaper-D® retreatment systems completely removed gutta-percha from root canals. Although ProTaper-D® demonstrated superior cleaning efficacy, it required more time to complete the procedure. Both systems showed comparable overall performance and can be used effectively in endodontic retreatment.

Declarations

Data Availability statement
All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate
Approved by the department concerned. (IRBEC-23)

Consent for publication
Approved

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Conflict of interest

The authors declared the absence of a conflict of interest.

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All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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