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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

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ABSTRACT

Background: Non-surgical retreatment is a conservative alternative to periapical surgery for the treatment of persistent infections. It is essential to perform the retreatment procedure efficiently using appropriate instruments and solvents to achieve successful outcomes.

Objective: The objective of this study was to compare the efficiency of a novel heat treated retreatment file Solite RS3, in terms of time required for gutta-percha removal using two different solvents.

Methods: Sixty single-rooted teeth were selected and prepared using the Step Back technique. The canals were filled with AH Plus sealer using matched single cone taper technique. The teeth were divided into three groups, and the time taken to remove gutta-percha was recorded using a stopwatch. Statistical analysis was performed using the One way ANOVA.

Results: The solvent GP Solv took longer to remove gutta-percha compared to the Xylene and EDTA (Contro). The difference between time taken for GP retrieval between Xylene and GP Solv was statistically significant ($p<0.05$).

Conclusion: While the sample size and in vitro setting are limitations of this study, it can be inferred that Solite RS3 files were faster in removing gutta-percha using Xylene as a solvent. Within the limitations of the study, it can be concluded that there was a significant difference between Xylene and GP Solv in terms of time taken to retrieve the Gutta-percha.

Keywords: *Gutta-percha, Protaper Retreatment files, Retreatment, Retrieval, Root canal, Solite RS3, Medical, Conservation*

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INTRODUCTION

Root canal treatment success relies on achieving a fluid-tight seal in all dimensions of the root canal system. While the procedure has a success rate of 86-98%, certain factors may require retreatment, such as an improper seal, remaining tissue, incomplete cleaning, missed canals, or inadequate filling [1]. Non-surgical retreatment is generally preferred over surgical options. However, removing filling material can be challenging, especially in curved canals where it may be resistant and difficult to eliminate [2]. Proper removal of the filling material is crucial to eliminate bacteria and facilitate the healing process. Thus, complete removal of the obturating material is vital for successful root canal retreatment. One key factor in retreatment is the complete removal of all endodontic material from the root canal system to achieve treatment goals [3]. Clearing the root canal wall of this material is essential for effective disinfection and retreatment. Various devices have been used to retrieve the obturating material, with rotary NiTi files being more effective and less laborious compared to conventional files. These rotary files are efficient in removing material and creating a tapered preparation [4].

Methods for removing the obturation material include mechanical removal using hand and rotary instruments, chemical removal with solvents, and physical removal using heat and ultrasonic instruments [4,5]. The time required for removal can be influenced by thermal, mechanical, chemical, or combined methods. Studies indicate that rotary instruments are faster in removing the material than hand instruments due to their higher speed [6–9]. While successful removal of gutta-percha and sealer is crucial, the correlation between complete removal of root filling materials and the success of root canal retreatment is yet to be established. Nonetheless, it is essential to remove as much filling material as possible from inadequately prepared and/or filled root canal systems to uncover any remaining necrotic tissue or bacteria that may contribute to persistent diseases and allow for comprehensive chemomechanical reinstrumentation and disinfection of the root canal system [10] [11]. Various methods can be employed to remove root filling material, including endodontic hand files, engine-driven rotary instruments, heat-carrying devices, and ultrasonic devices [12–14]. Additionally, solvents can be used to soften and dissolve gutta-percha in the root canal, aiding in its penetration and removal. The higher solubility of gutta-percha in Xylene and GP Solv would have resulted in dissolution of GP and generation of frictional heat which causes GP to adhere to the root canal walls whereas with the use of EDTA, reduces the friction generated and facilitates complete removal of GP without adhesion of GP to the canal walls. However, the effectiveness of solvents in gutta-percha removal remains inconclusive. Some studies have suggested that solvents like Xylene may reduce gutta-percha remnants and working time during retreatment [15], while others have found no significant difference [16]. Furthermore, the use of d-Limonene as a solvent has also shown no improvement in working time or canal wall cleanliness [17]. Studies have investigated the effectiveness of rotary instruments in gutta-percha (GP) removal, there is a lack of research comparing their efficacy with different solvents. The aim of this study is to assess the effectiveness of a novel file system for root canal retreatment, called Solite RS3 retreatment files. The Solite RS3 files are heat treated and feature active cutting edges, tapers ranging from 6% to 8%, and tip diameters in the range of 0.20-0.30mm. These files disengage GP from the canal while preserving dentin and come in different lengths, tapers, and colors for easy identification. They are also flexible enough to navigate canal curves without damaging the root canal dentin. Previously our team has great experience in working on various research projects across multiple disciplines [7,18–31]. Now the current growing trends motivated us to pursue this project. Hence, the primary objective of this study is to compare the time needed to remove gutta-percha using the solvents GP Solv and Xylene and Solite RS3 files.

MATERIALS AND METHODS

Specimen Preparation

For this study, a total of 60 recently extracted teeth with a single fully developed root apex were selected. The research protocol was approved by the Institutional Ethical Committee and assigned the reference number SRB/SDC/ENDO-2067/19/018. In order to be included in the study, the teeth had to meet a specific inclusion criteria. These criteria included having a single canal,

exhibiting no cracks or fractures, and showing no signs of external or internal resorption. Additionally, the curvature of the canal had to be less than 15 degrees. To ensure the eligibility of the teeth, digital radiography was taken in both the mesiodistal and buccolingual angulations. This examination was performed to confirm the presence of a single straight canal without any anatomical variations or irregularities. Following the radiographic evaluation, the crowns of the selected teeth were removed using a diamond disk to standardize their length to 18 mm. By implementing these selection criteria and standardized procedures, the study aimed to minimize confounding factors and ensure a homogeneous sample of teeth with similar characteristics. This approach would enhance the reliability and validity of the study's findings regarding the efficacy of the Solite RS3 files for gutta-percha removal in root canal retreatment using these two different solvents.

Endodontic Treatment Protocol

Following the selection of teeth, they were divided into three groups based on the solvents used.

Group A - 17% EDTA (Control)

Group B - Xylene

Group C - GP Solv

An Endo access bur Size-1 (Dentsply, Maillefer) was used to gain access to the root canal system. #10 K-file was utilized to establish a glidepath in the canals. The cleaning and shaping of the canals were performed using the Crown-Down technique, with ProTaper Gold rotary files (Dentsply Maillefer, Ballaigues, Switzerland) a master apical file size F3 using X-Smart Plus Endo motor (Dentsply, Maillefer) at 250 rpm as per manufacturer's instructions. For irrigation and removal of the smear layer, a combination of 3% NaOCl and 17% EDTA was used. Subsequently, paper points were used to dry the root canals. To fill the canals, gutta-percha was employed through the matched single cone technique with the same taper as master apical file size in conjunction with the AH Plus sealer (Dentsply Sirona, Switzerland). Once the obturation process was completed, a temporary seal using Cavit G was used to seal the teeth, which were then placed at 37 degree celsius and 100% humidity so that the sealer could fully set. Radiographs were taken buccolingually and mesiodistally to assess if the obturation was adequate. These standardized procedures were employed to ensure consistency and reproducibility in the root canal treatment among the groups.

Gutta-Percha Retrieval

After one week of the obturation process, the teeth underwent retreatment using Solite RS3 retreatment files, based on their assigned groups. 0.5ml of EDTA for Group- A, Xylene for Group-B and GP-Solv (D-Tech) for Group- C in the canal using a soaked cotton pellet and a syringe and waited approximately for 10 minutes before rotary instrumentation using Solite RS3 at 200 rpm. Throughout the gutta-percha removal process, the root canals were periodically irrigated with 3% NaOCl, and a final rinse with saline solution was performed. To assess the efficacy of the retreatment preparation, digital radiographs were taken to examine the presence of any residual obturating material or sealer in the canals. The duration of the gutta-percha removal process was carefully recorded using a stopwatch.

Statistical Analysis

The study meticulously recorded the time required by each solvent to retrieve the endodontic material, and the data were systematically organized in an Excel spreadsheet. To analyze the collected data, statistical analysis was conducted using the IBM SPSS version 23.0 software. Specifically, One way ANOVA was employed to assess the significance of the results, with a p-value of >0.05 indicating statistical significance.

RESULTS

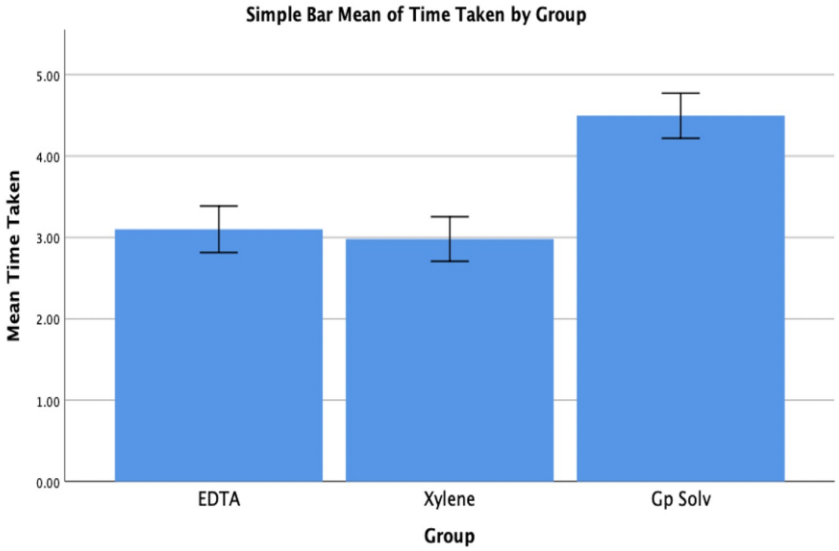

FIGURE 1: The bar graph depicts the mean time taken for the removal of GP using Solite RS3 file with EDTA,Xylene and GP Solv as solvents

TABLE 1: depicts the mean and standard deviation for the time taken for Gutta Percha Retrieval using the three different solvents EDTA, Xylene,GP Solv.

Descriptives				
Groups	N	Mean	Std. Deviation	Std. Error
EDTA	20	3.1000	.61044	.13650
Xylene	20	2.9800	.58634	.13111
GP Solv	20	4.4950	.59247	.13248
Total	60	3.5250	.90809	.11723

TABLE 2: depicts One way ANOVA of the time taken for Gutta Percha Retrieval using the three different solvents EDTA, Xylene, GP Solv. Statistically significant differences between groups for time taken to retrieve GP using different solvents (P<0.05).

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	28.371	2	14.185	39.868	.000
Within Groups	20.282	57	.356		
Total	48.653	59			

DISCUSSION

Endodontic failures can occur due to various factors, including inadequate cleaning, improper obturation, and missed canals, leading to postoperative complications such as pain, which may require retreatment [32]. Non-surgical retreatment is generally preferred over surgical intervention due to its less invasive nature. It has become the preferred approach for eliminating persistent periapical infections, replacing the need for endodontic surgery [33]. Previous studies have compared different file systems to assess their effectiveness in removing the obturating material [34][35]. Prior studies have utilized various methodologies, including two-dimensional digital radiography to ensure complete removal of the material [36,37]. However, this study assessed the efficacy of

different solvents to determine if there is a difference in the time taken for Gutta-percha retrieval using the Solite RS3 retreatment files.

In this study, the solvent Xylene (Group B) showed lesser time taken for complete retrieval of Gutta-percha followed by the EDTA (Group A) and GP Solv (Group C) respectively. This could be due to the good GP softening abilities of Xylene which makes GP more pliable and easier to remove from the root canal system during retreatment procedures and dissolves the gutta-percha, allowing for its efficient retrieval using endodontic files or other instruments. It also provides assistance in removing any residual sealer left on the root canal walls after gutta-percha removal. It helps dissolve and dislodge the sealer, facilitating its complete elimination during retreatment. Another important advantage of Xylene is that it has antimicrobial properties and can act as a disinfectant during the re-treatment process. It can help eliminate any remaining residual bacteria or debris in the root canal system, promoting a more thorough cleaning and disinfection [38];[39,40]

EDTA produced comparable results to that of xylene, however it is an effective chelating agent rather than a gutta-percha solvent and its ability to dissolve sealer materials, such as resin-based sealers is limited. Also EDTA has the potential to irritate periapical tissues if it comes into contact with them during the retreatment process. Care must be taken to ensure proper application and minimal extrusion while using EDTA to avoid any adverse effects on the surrounding tissues. EDTA can also cause weakening of dentin if used for prolonged time in the canal. Overuse or excessive contact time of EDTA with dentin may lead to dentin demineralization and subsequent structural compromise [41–43]

GP Solv which contains d-Limonene primarily is derived from citrus fruits, making it a natural alternative to chemical solvents. This solvent showed a longer duration of time for Gutta-percha retrieval than Xylene and EDTA groups. d-Limonene may also have the potential to irritate periapical tissues if it comes into contact with them during the retreatment procedure. This can lead to inflammation and discomfort for the patient. The use of GP Solv as a gutta-percha solvent may increase the overall treatment time. The solvent requires sufficient contact time to effectively dissolve the gutta-percha, which can prolong the retreatment procedure. While there have been studies exploring the solvency properties of d-Limonene, there is limited scientific evidence regarding its efficacy and safety as a gutta-percha solvent in endodontic retreatment. Further research is needed to establish its effectiveness. Furthermore, the use of any solvent can introduce uncertainty in determining the working length and may further irritate periapical tissues [44–48]. Rotary instruments are favored over hand instruments in retreatment procedures as they effectively plasticize the gutta-percha through friction, facilitating its easy removal. Rotary instruments also tend to reduce operator fatigue, working time, and help maintain the canal shape [35]. In the present study, a novel file system called Solite RS3 retreatment files were utilized. Solite retreatment files come in three different tapers, lengths, and color codes for easy identification. The three files are RS1 (blue), RS2 (red), and RS3 (yellow). RS2 and RS3 files are heat treated, enabling them to flex through the canal systems. The study results indicated that Solite files took slightly more time than for gutta-percha retrieval with the solvent GP Solv, although there was no significant difference between Xylene and EDTA. This could be attributed to the flexibility of the Solite files and their reduced stiffness due to heat treatment, which may have affected the speed of gutta-percha removal. By presenting these findings, the study contributes to the understanding of the performance of different solvents used in root canal retreatment and provides insights into the potential advantages and considerations when using the Solite RS3 retreatment files.

CONCLUSION

The limitations of the current study were limited sample size, single rooted teeth and in-vitro study. Within the limitations of the study, it can be concluded that there was a significant difference between Xylene and GP Solv in terms of time taken to retrieve the Gutta-percha.

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