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Comparative evaluation of removal of gutta percha from root canals using different rotary retreatment file systems through CBCT - An in vitro study.

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Abstract

Aim : The aim of the study was to evaluate the efficacy of Protaper universal Retreatment system, HyFlex Remover and Neoendo Retreatment files for removal of gutta-percha from the straight root canals by the help of cone-beam computed tomography (CBCT).

Materials and methods : Thirty freshly extracted single-rooted and single-canal premolar teeth were selected for this study. The teeth were decoronated at 16 mm working length, and biomechanical preparation was performed using protaper gold files. Obturation was done with lateral condensation using AH Plus sealer and gutta percha. The all-experimental teeth were then randomly divided into 3 groups. All the canals were then retreated with either Protaper D retreatment files,HyFlex Remover files and Neoendo retreatment files. The pre and post volumetric analysis done through CBCT using

OnDemand 3D software and Statistical analysis was performed via one-way ANOVA test.

Results : None of these file systems could completely remove the filling material from the canals. Data analysis showed significant differences between all groups in the apical and middle thirds ($P<0.05$).

Conclusions : The Protaper D showed more efficient in removal of obturationg material in cervical and middle third of the root canal, HyFlex remover showed intermediate result and Neoendo showed poorest results in removal of obturating materials.

Keywords : Endodontics, Retreatment, Guta percha

Introduction

The persistence of microorganisms in the root canal system following cleaning and shaping or the recolonization of the root canal space by bacteria as a result of coronal or apical microleakage are both related with post-treatment illness.

Since a very long time ago, endodontics has served as dentistry's standard-bearer. Endodontics has advanced significantly recently, but the rate of advancement has not yet slowed down. This improved the prognosis for teeth that had undergone endodontic treatment and allowed for a better detection of periapical diseases. However, even though they were rare, there have been instances of root canal failure that persisted.[1]

Endodontic therapy's long-term success depends on meticulously cleaning out the root canal system and then obturating it in three dimensions.[2] Because of its ability to seal the endodontic space three-dimensionally, especially when thermoplasticized, and because it can be removed from the endodontic space easily during retreatment with or without the use of a solvent, gutta percha is the most frequently used filling material. To strengthen the binding between gutta percha and dentin, it has been suggested that a sealer be used in conjunction with gutta percha. Many different sealers have been employed, and new items are constantly being marked.[3] Failures are a success's foundation. Failures in endodontic treatment are common and necessitate retreatment.[4]

After receiving a root canal, a chronic and secondary intraradicular infection is the main cause of post-treatment illness. The majority of the time, retreatment is recommended for teeth with apical periodontitis that either persisted or progressed after the original root canal procedure. These failures happen for a variety of reasons, including access-related, instrumentation-related, ledge formation, separated instruments, foreign objects, missing canals, access cavity perforations, poor cleaning, and obturation-related owing to coronal leaking.[5] Non-surgical retreatment is frequently regarded as the preferred management method in failed endodontic patients because of its high success rate.

The main objective of a root canal retreatment is to completely remove any remaining obturating materials. This is followed by a thorough cleaning, reshaping, and three-dimensional obturation of the root canal system.[6] Although it can be challenging to entirely remove the filling material, gutta percha can be removed from the root canals using gutta percha solvents, H files, retreatment files, ultrasonic devices, lasers, etc.

Traditionally, extracting gutta percha using hand equipment and either solvent or no solvent can be a laborious procedure. Therefore, using rotary NiTi instruments in endodontic retreatment is now highly advised due to their improved speed and quality, which also has benefits for the patient and clinician over using hand files.

AH Plus is an epoxy resin-amine based sealant. In two tubes, one containing epoxide paste and the other containing amine paste. According to some researches, the Gutta Flow root filler was easier to remove from the canal than gutta percha and AH plus sealer.

Protaper NiTi rotary system has been upgraded to the protaper retreatment system which includes shaping, finishing and retreatment files. The three retreatment instruments are designed for removing filling materials from root canals and have different tapers and diameters at tip. D1, D2, D3 have diameter sizes 30, 25, 20 with 0.09 taper, 0.08 taper, 0.07 taper respectively. Full length of these retreatment files are 16mm for D1, 18mm for D2, and 22 mm for D3. These files have convex, triangular cross-section and D1 has an active working cutting tip that facilates its penetration into filling materials.

HyFlex Remover is the newly introduced retreatment file for removal of root canal filling. This is single file system. This file follows the root canal anatomy and it is efficient without any solvent. It has a non cutting tip. Tip diameter size is 30 with taper 0.07.

Neoendo retreatment files consists of three instruments N1 (size 30, 0.09 taper) for coronal one third which is 16 mm in length and has a blue ring, N2 (size 25, 0.08 taper) for middle one third which is 18 mm in length has a red ring and N3 (size 20, 0.07 taper) for apical one third which is 25 mm length and has a yellow ring.

In comparison to traditional computed tomography (CT), cone-beam computed tomography (CBCT) produces 3-D pictures at a lower cost and with less radiation exposure. A modified version of the developer of the original cone beam technique is used to reconstruct these images in 3-D. Cone-beam computed tomography (CBCT) can estimate the volume of the remaining gutta percha in the root canals and provide 3D volumetric analysis.

The aim of this invitro study was to evaluate and compare the efficacy of three rotary instrumentation systems that is **Protaper Retreatment system, HyFlex Remover** and **Neoendo Retreatment files** for removal of gutta percha from root canal.

Materials & Methods

A 1% thymol solution was used to preserve 30 single-rooted human premolar teeth that had been extracted within the previous three months. To rule out the occurrence of multiple root canals, calcification, or resorption, all teeth were digitally radiographed from the buccolingual and mesiodistal views using an RVG sensor and gomax x-ray system. To get rid of any calculus or soft tissue debris, teeth were cleansed and ultrasonic scaling was performed.

Figure 1

Under water cooling, the teeth were accessible using a high-speed round bur size 4 and an Endo-Z bur from Dentsply Maillefer in Ballaigues, Switzerland. By deducting 1 mm from the length at which the file tip protruded apically, working length was calculated. Patency was kept up with a 10 K file. A diamond disc set to a typical 16mm length and run at low speed was used to decoronate the roots. Then, utilising the Protaper Gold Rotary File System in accordance with the manufacturer's instructions, biomechanical preparation was completed. The F2 Protaper file was used to prepare all canals. The files were coated with ethylenediaminetetraacetic acid (EDTA), which has a 17

percent concentration, throughout use. Between each filing, the root canals were irrigated with sodium hypochlorite, EDTA, and then saline.

After instrumentation was complete, paper points were used to dry the canals. All teeth had a confirmed tug back. All of the affected teeth underwent endodontic treatment, utilising the appropriate protaper gutta percha (Densply/Maillefer) and AH Plus (Densply De Trey, Konstanz, Germany) root canal sealer as obturating material. According to the manufacturer's directions, the sealer was blended before use until it had a thick consistency.

To check the quality of the root filling, digital x-rays were acquired buccolingually and mesiodistally for all samples. For 10 hours, all specimens were kept in a humidified incubator at 37°C and 100% humidity to allow the sealer to fully set. Following that, the samples were randomly assigned into groups 1 through 3 based on the retreatment method: **Group 1 Protaper D, Group 2 Hyflex Remover, and Group 3 Neoendo Retreatment files.**

Figure 2: Three-dimensional volumetric analysis of filling material using cone beam computed tomography

For image capture, the specimens were mounted on modelling wax blocks and set on the cone beam 3D imaging system's chin rest. We acquired axial, frontal, and sagittal slices. A primary CBCT scan was utilised to measure the root canal filling volume.

Removal of obturation materials

Samples were randomly divided into three groups according to the files used for the retreatment procedure:

Group 1 (ProTaper D retreatment kit)

According to the manufacturer's recommendations, this group underwent a retreatment utilising ProTaper D Universal Retreatment files applied in a crown-down motion while brushing and pressing laterally. In order to determine the working length, the following instruments were used: D1 (30/0.09) for the cervical third, D2 (25/0.08) for the middle third, and D3 (20/0.07) for the apical third. When the D3 instrument reached its working length and no more root canal filling material could be retrieved on it, instrumentation was finished.

Group 2 (HyFlex Remover)

length of 19 mm According to the manufacturer's instructions, a single file is used to remove root canal filling material from the canal up to the working length in a crown down, brushing motion with lateral pushing movements.

Group 3 (Neoendo retreatment files)

At first N1 (size 30, 0.09 taper) was used for coronal one third which has a blue ring, then N2 (size 25, 0.08 taper) for middle one third which has a red ring and N3 (size 20, 0.07 taper) for apical one third which has a yellow ring in the crown down motion using light brushing and lateral pressure according to the manufacturer's instructions. N3 was used upto the working length.

Perforation, ledges, blockades, and instrument separation were among the possible procedural errors that were noted. When an instrument fractured, the divided portion was removed with a hand file. The time taken to remove the damaged instrument won't be counted towards the working hour total. 5 ml of 20% EDTA and 5 ml of 2.5% NaOCL were used as the last rinse. Then, paper tips were used to dry the root canals. When the working time was up and no additional filler material was found on the files, the retreatment procedure was completed for all groups. Following retreatment, a second CBCT scan

of each root was performed at the same location as the first scan.

To eliminate inter operator variability, the same operator carried out all intra-canal procedures. At the end of the assessment of effective gutta-percha removal was done by calculating the obturating material remnants in each tooth at coronal, middle and apical third of the root canal.

The volume percentage of the remaining root canal filling were calculated and analysed by statistical methods. Statistical method used: ANOVA test.

CBCT Evaluation

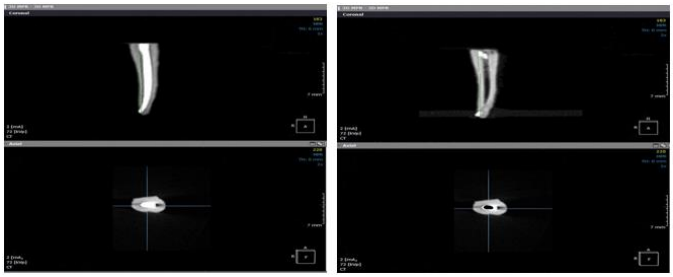


Figure 3: Group 1 Protaper D : Pre & Post CBCT images

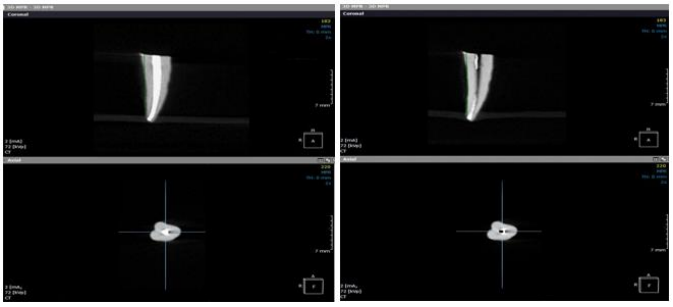


Figure 4: Group 2 HyFlex Remover : Pre & Post CBCT images

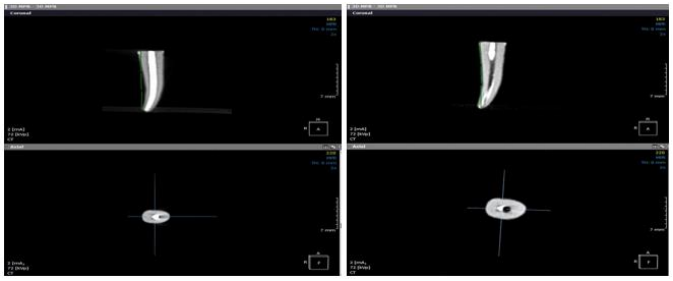


Figure 5: Group 3 Neoendo retreatment file : Pre & Post CBCT images

Statistical analysis

The data for the present study was evaluated in the Microsoft Excel 2007. The descriptive statistics included mean, standard deviation .The intragroup comparison for the different time intervals was done using paired t test to find the difference between the individual time intervals The level of the significance for the present study was fixed at 5%. The intergroup comparison for the difference of mean scores between independent groups was done using the One Way ANOVA test.

Results

The study was carried on 30 extracted single rooted mandibular premolars. The volume of Pre and post obturating materials were tested through CBCT scanning and analysis done by OnDemand 3D software. Data was analysed with the help of SPSS statistical software version (22.0). There was singnificant difference in residual obturating material in the apical, middle and cervical areas between the three retreatment techniques ($p<0.05$). In the Protaper D group the residual obturating material was less in coronal and middle third. In Neoendo the residual obturating material was more. Hyflex Remover showed intermediate results. Evaluations showed that none of the retreatment techniques were able to completely eliminate the root canal filling material from the root canal.

Table And Graph 1 : Intragroup Comparison of Pre And Post Filling Material Group I (Protaper D)

	Pre	Post	T value	P value	Significance
Cervical	0.860±0.197	0.368±0.152	4.656	0.010	Significant
Middle	0.676±0.059	0.203±0.055	13.428	0.001	Significant
Apical	0.566±0.083	0.198±0.146	7.305	0.001	Significant

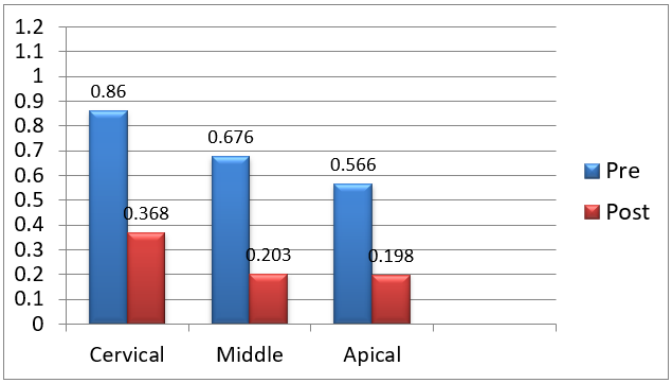


Table And Graph 2 : Intragroup Comparison of Pre And Post Filling Material Group 2 (Hyflex Remover)

	Pre	Post	T value	P value	Significance
Cervical	1.054±0.103	0.646±0.157	4.983	0.001	Significant
Middle	0.832±0.096	0.45±0.248	3.438	0.023	Significant
Apical	0.634±0.027	0.28±0.051	10.384	0.001	Significant

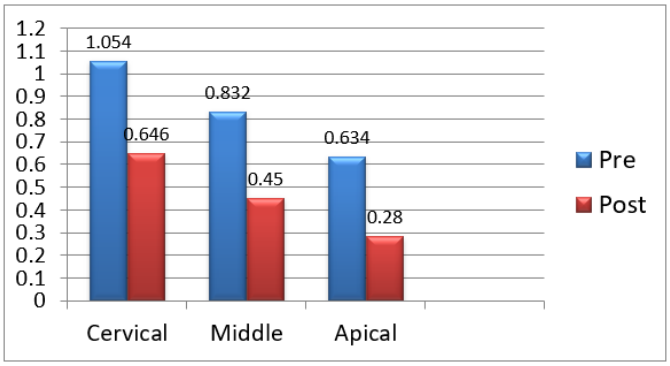
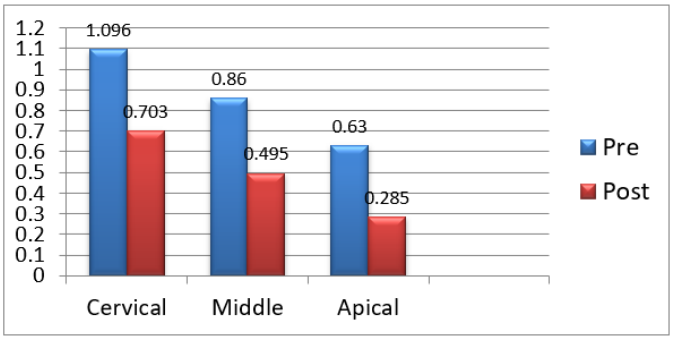
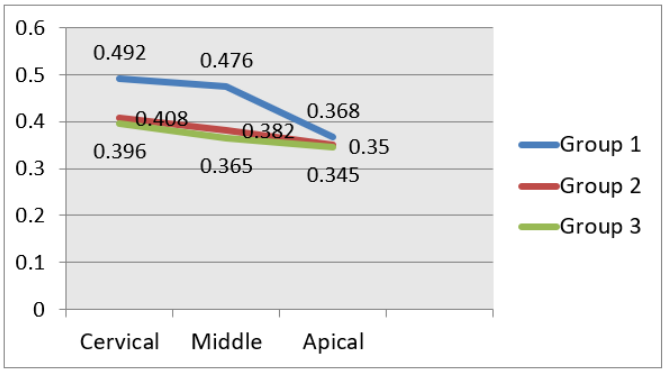


Table And Graph 3 : Intragroup Comparison of Pre And Post Filling Material Group 3 (Neoendo)

	Pre	Post	T value	P value	Significance
Cervical	1.096±0.068	0.703±0.151	5.323	0.001	Significant
Middle	0.860±0.150	0.495±0.207	4.786	0.001	Significant
Apical	0.630±0.125	0.285±0.087	13.328	0.001	Significant



Graph 4 : Intergroup Comparison of Volume of Gutta Percha Removal Between Three Groups at Cervical, Middle And Apical Level.



Discussion

In recent years, there has been an increase in demand for tooth preservation. It also covers instances where root canal therapy has been unsuccessful. A failed root canal treated tooth has two options for treatment: surgical intervention (apical surgery or extraction) or nonsurgical retreatment, with the latter option being the most favoured. After a retreatment process, the filling material may still contain bacteria and necrotic tissue, which could result in a chronic condition and re-infection of the root canal system.[7]

Failures are a success's foundation. Failures in endodontic therapy are not an exception, hence retreatment is necessary. According to Siqueira (2001), the main causes of endodontic failure are microbial infections that continue to exist in the root canal system and/or periradicular region. Therefore, periradicular surgery has been mainly supplanted by root canal retreatment for the treatment of ongoing or new diseases. Therefore, it's crucial to scrape off as much sealant and gutta-percha as you can during retreatment to find any traces of bacteria or necrotic tissue that might serve as the antigenic source.[8]

The goal of the current study was to evaluate the performance of the gutta-percha removal technique during a root canal retreatment operation. For a root canal retreatment operation to be successful, the old root canal filling material must be completely removed and there must be good debridement. Endodontic retreatment is accomplished using a variety of techniques, such as endodontic hand files, endodontic rotary files, ultrasonic files, and solvents like zylene, turpentine, and chloroform, among others.[7]

Traditionally, removing gutta-percha with hand files and either solvent or well-condensed root filling material can be a difficult and time-consuming process (de Oliveira et al. 2006). As a result, using rotating NiTi tools during root canal retreatment may reduce operator and patient fatigue. Due to the super-elasticity of Ni-Ti files, more centred canal preparations are possible with less canal transit and a lower occurrence of canal aberrations. Additionally, the improved taper preparation makes proper irrigation possible. When used with a crown-down strategy and a continuous reaming motion, these files have a higher cutting efficiency. As a result, it is possible to achieve rounder root canal preparations with less straightening and apical extrusion. Ni-Ti files still provide a separation risk despite their enhanced flexibility.

Mandibular premolars were chosen because they are mesiodistally flattened and have a larger buccolingual dimension, which makes it more difficult for endodontic instruments to touch all of the dentinal walls. During retreatment treatments, it's crucial to take into account the root canal system's morphology and the calibre of the initial root filling. For the three study groups in the current investigation, straight root canal configurations were taken. The samples were decoronated to a standard length of 16 mm in order to standardise the process and ensure that length variations would not affect the outcomes. Additionally, the same operator used the same techniques to form the root canals in all of the samples.[4]

Using a single cone method, the root canals were sealed off with gutta-percha and sealant. Different sealers have various compositions and adhesion characteristics. An essential characteristic that is connected to the simplicity of removal is adhesion to the dentin. In the current investigation, AH Plus sealer—which can adhere to canal dentin—was employed. For the investigation, a NiTi rotary retreatment system that has been recommended for retreatment due to its safety, effectiveness, and speed in removing gutta-percha and sealer was chosen.

The study's main finding was that none of the methods or techniques were capable of completely or 100% successfully removing the gutta-percha from the samples' root canals. There is no technology that is 100% efficient in removing gutta-percha, according to Hulsmeann et al., who also investigated the cleaning capacity of rotating instruments in retreatment. Other earlier research have also validated this study's finding.[7]

The current study analysed the volume of obturation material that remained before and after retreatment, and it revealed that all groups considerably eliminated the filling material when comparing pre- and post-retreatment CBCT pictures ($P<0.05$). According to the study's findings, Protaper D retreatment files removed a higher percentage of obturating material than Hyflex remover and Neoendo retreatment files.

PK Thaju Raj et al. conducted a study and they conducted that the Protaper D retreatment files showed overall better performance compared with D-RaCe files and H-files. The Protaper D files performed better at middle third compared with others. The PTUR files and

D-RaCe files performed equally at apical third better than H-files.[1]

Das S. et al conducted a study to compare the relative efficacy of three rotary instrumentation systems (Protaper D, Mtwo retreatment files, and R-Endo files) for removal of gutta-percha from root canal during endodontic retreatment. Protaper D group was found to have less remnant filling material as compared to the other groups in coronal and middle third with/ without the use of solvent, but a significant difference was observed between Protaper D and Mtwo and and R-Endo in the nonsolvent groups ($P<0.05$). Mtwo group demonstrated less amount of remaining filling material in the nonsolvent group.[9]

Studies done by Tasdemir et al. and Bramante et al. demonstrated that Protaper Universal retreatment files and Mtwo NiTi rotary instrumentation system are faster and more efficient in removal of obturating material that hand files.[10] Rotary NiTi instruments have also been proposed for removal of filling materials from root canal walls and various studies reported their efficacy in cleaning ability and safety.[8]

Gu et al. study showed that the better performance of ProTaper Universal retreatment instruments may be related to their taper design. D1, D2 and D3 have three progressive tapers and lengths. This design may enable the instruments to remove not only GP but also the superficial layer of dentine during root filling removal.[10]

Coltene has now released the Hyflex Remover as a retreatment rotary file. It is a single file system that was available in two lengths when it first hit the market: 19 mm and 23 mm. To remove obturation materials from the root canal during a nonsurgical endodontic retreatment, HyFlex Remover is advised. Retreatment may be necessary due to an endodontic failure during the initial process, a re-infection (new decay), a shattered crown, a fractured treated tooth, or the need to remodel an existing restoration.

During a nonsurgical endodontic retreatment, the gutta-percha obturation material can be removed using a file called the HyFlex Remover. HyFlex Remover mechanically removes the gutta-percha material from the root canal without the need for a solvent, making it a crucial component of the retreatment. After utilising HyFlex Remover to remove the gutta-percha from the root canal, the dentist can continue with the canal reshaping using his standard tools and shaping technique. HyFlex EDM shaping files must be used with the method for optimal results.[11]

In terms of removing obturation material, Hyflex Remover demonstrated overall better outcomes than neoendo retreatment files, although it was less effective than Protaper D. Since Hyflex Remover has not been studied for retreatment, more research is necessary to determine its effectiveness.

The cross section of the Neoendo retreatment files is parallelogram-shaped, and the rake angle is positive. The contact between the file and the dentin is only possible at one or two spots at any given cross section due to the parallelogram cross section. In turn, this will lessen binding and ensure that there is little to no screwing in, enhancing cutting safety and effectiveness.

In a study comparing the NeoEndo and WaveOne retreatment systems for the efficient removal of gutta percha and epoxy resin-based sealer during the retreatment of straight root canals, Wahane KD et al. came to the conclusion that the WaveOne system was superior to the NeoEndo retreatment system for the removal of filling material.[12]

We employed CBCT scanning as a non-invasive technique that enables detailed visualisation of morphological characteristics. This technique is easy to

use, effective, and sensitive enough to spot small patches of leftover filler on canal walls. Without harming the teeth, CBCT scanning enables three-dimensional examination of the root canal system. By measuring the amount of filling material inside the root canals before and after retreatment procedures, this method provides repeatable data and enables the assessment of endodontic retreatment.[13]

The ProTaper D, Hyflex remover, and Neoendo systems all performed significantly differently in the removal of filler material, according to the CBCT test. In comparison to the Hyflex remover and Neoendo, the mean volume of filler materials still present in the canals was lower using the ProTaper D system. Thus, filler materials were more effectively removed using the ProTaper D system.

Conclusion

It was determined, within the constraints of the current investigation, that all of the examined methods removed root canal filling during retreatment procedures successfully. The Neoendo showed the worst results in the removal of obturating materials, while HyFlex removed showed intermediate results. The Protaper D demonstrated greater efficiency in the removal of obturation material in the cervical and middle third of the root canal.

CBCT proved to be a useful tool for measuring the 3D guuta percha remains without impairing the tooth structure. No technique examined in this study was able to entirely eliminate gutta-percha from the canals. To assess post-instrumentation pain and prognosis in the use of these systems, additional in vivo investigations are needed.

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