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Ability of XP- Endo Finisher and XP-Endo Finisher-R in Removal of debris from the root canal walls after Retreatment: An In-Vitro Study

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ABILITY OF XP- ENDO FINISHER AND XP-ENDO FINISHER-R IN REMOVAL OF DEBRIS FROM THE ROOT CANAL WALLS AFTER RETREATMENT: AN IN-VITRO STUDY

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Abstract

The aim of the present study was to evaluate the ability of XP-Endo Finisher (XP-F) and XP-Endo Finisher-R (XP-FR) instruments in cleaning the root canal dentinal walls from filling debris.
Root canals of 24 extracted human mandibular premolars (n=24) were prepared with R3 I-Race files (30/.04) and filled with warm vertical compacted gutta-percha (GP) and root canal resin sealer (Adseal, Meta Biomed Co., LTd., Cheongju City, Chungbuk, Korea). Root canals were then retreated using D-Race files and shaped with BT-Race 35/.04. After that, teeth were divided into three groups according to the final method of cleaning: Group A: Final irrigation with NaOCl only; Group B: Additional use of XP-Endo Finisher and Group C: Additional use XP-Endo Finisher-R. Teeth were rendered transparent for the evaluation of the residual GP/Sealer in buccolingual and mesiodistal directions. Statistical analysis was performed using the statistical software SPSS 24.0 for Windows.
All retreatment techniques used in this study left some filling material inside the root canals. Images in buccolingual and mesiodistal directions showed no significant differences between the groups ($p > 0.05$).
None of the finishers were able to completely remove the root canal filling material from root canal walls.

Keywords: Retreatment - XP- Finisher - XP-Finisher-R.

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CAPACITÉ DES LIMES XP-ENDO FINISHER ET XP-ENDO FINISHER-R À ÉLIMINER LES DÉBRIS DE LA PAROI CANALAIRE APRÈS RETRAITEMENT: UNE ÉTUDE IN VITRO

Résumé

Le but de la présente étude était d'évaluer la capacité des instruments XP-Endo Finisher et XP-Endo Finisher-R à nettoyer les parois dentinaires des canaux radiculaires des débris d'obturation.
Les canaux radiculaires de 24 prémolaires mandibulaires humaines extraites (N = 24) ont été préparés avec des limes R3 I-Race (30 / .04), et obturés avec de la gutta-percha compactée verticalement, et un ciment de scellement à base de résine (Adseal, Meta Biomed Co., LTd., Ville de Cheongju, Chungbuk, Corée). Les canaux radiculaires ont ensuite été retraités à l'aide des limes D-Race et mis en forme avec BT-Race 35 / .04. Les dents ont été divisées en trois groupes selon la méthode finale de nettoyage: groupe A: irrigation finale avec NaOCl seulement; groupe B: utilisation supplémentaire de l'XP-Endo Finisher et groupe C: utilisation supplémentaire de l'XP-Endo Finisher-R. Les dents ont été rendues transparentes pour l'évaluation du matériau d'obturation résiduel dans les directions bucco-linguales et mésio-distales. L'analyse statistique a été réalisée en utilisant le logiciel statistique SPSS 24.0 pour Windows.
Aucune des techniques de reprise de traitement utilisées dans cette étude n'a pu éliminer complètement le matériau d'obturation à l'intérieur du canal radiculaire. Les images bucco-linguales et mésio-distales n'ont montré aucune différence significative entre les groupes ($p > 0,05$). Aucun des instruments testés (XP-Endo Finisher, XP-Endo Finisher R) n'a été capable d'éliminer complètement le matériau d'obturation des parois du canal radiculaire.

Mots-clés: retraitement - XP- Finisher - XP-Finisher-R.

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Introduction

Root canal treatment (RCT) has a high success rate of more than 86% and 98% when properly made [1]. However, failures may occur that are often associated with poorly treated canals [2]. Canal anatomy, inadequate root filling, missed canals, insufficient cleaning, bacterial factors or coronal leakage can explain the recurrence of disease in 2 -14 % of the root canal treated teeth [3].

Chemo – mechanical instrumentation has a vital importance for a successful treatment outcome in retreatment cases [4]. During re-instrumentation process, inadequate cleaning and shaping may retain post-retreatment apical disease due to the remnants of the infected root-canal filling materials (RCFMs) in some cases [5, 6]. Some studies have suggested that clinician's priority when performing non-surgical root canal retreatments (NSRCRTs) is to reduce the bacterial population inside the root canal to a minimum level below the necessary to maintain a disease [7].

The remaining root-canal filling materials (RRCFMs) must be removed, allowing instruments and irrigants to penetrate well into the entire canal [8]. Therefore, different devices for irrigation activation have been advocated to increase the flow and distribution of irrigating solutions within the root canal [9]. Sonically and ultrasonically activated irrigations are used to agitate irrigant solution in the purpose of removal of the residual obturation material [10].

XP- Endo Finisher (XP-F) (FKG Dentaire, La Chaux-de-Fonds, Switerzerland) was invented as a final step instrument to clean the inner canal walls of all root canal morphologies and irregularities such as c-shaped canals, oval canals and improving the irrigants benefits due to its capacity to expand and its sickle shape that allows the instrument to scrape the dentin surface and/or the root filling material while preserving the canal anatomy [11]. It has a 25 tip size with non-tapered rotary Niti instrument that is made of a new alloy (MaxWire; Martensite-Austenic Electropolish Flew, FKG Dentaire). Depending on the temperature, the XPF changes its shape from martensitic phase (M-phase) to austenitic phase (A- phase) making a spoon shape that allows the XP-F to access and clean areas that were impossible to reach with standard instruments.

Recently, XP-endo finisher-R (XP-FR) (FKG Dentaire, La Chaux-de-Fonds, Switerzerland) was introduced to the market and dedicated for retreatment cases to eliminate gutta percha (GP)/sealer from the canal walls, and to improve irrigant benefits by creating turbulences of NaOCl and ethylenediaminetetraacetic acid (EDTA). According to the manufacturer, XP-FR has the ability to expand and contact the dentine surface with an improved reach of 6mm in diameter and clean areas that was previously impossible to reach. The new XP-FR varies than the XP-F with its larger core diameter tip size 30. It is designed to be used with irrigants after root canal retreatment with the aim of removing vital and/or necrotic tissues, and dentinal debris accumulated during instrumentation and smear layer [12].

Retreatment is indicated for the healing of peri-radicular lesions, in cases of unsuccessful root canal therapy and/or persistent apical lesion [13]. Healing rates of root canal retreatment range only between 74% and 98 % [14]. The important factors for achieving successful retreatment are thorough reshaping and cleaning of the canals to eliminate bacteria. The widely common used root filling material is gutta-percha (GP) in conjunction with a sealer, and their complete removal in endodontic retreatment is essential for a better outcome [15-17].

Nowadays, many techniques are used to remove root canal filling material and sealer from the canal system including the use of hand files or rotary nickel-titanium (NiTi) instruments with or without heat, solvent, and/or ultrasonic instruments [18]. However, all non-surgical retreatment techniques leave residual debris in the dentin walls after re-instrumentation [19].

The efficacy of the XP-F and XP-FR in removing residual materials from the canal walls might be referred to its metallurgy and elliptical movement in the canal. This movement allows the file to reach inaccessible parts of the canal. While XP-F rotates, a curved bulb is formed; which can expand its extent 6mm in diameter when the file tip squeezes or 100-times of corresponding sized file [20]. The XP-FR instrument differs also in the angulations of its tip compared to the XP-F file, which makes it potentially more aggressive for removing the filling material [21].

The purpose of the present study was to evaluate the efficacy of XP-Endo Finisher (XP-F) versus XP-Endo Finisher–R (XP-FR) instruments in removal of filling debris from root canal walls in comparison to the regular removal technique using only D-Race followed by traditional cleaning and shaping.

Methodology

Selection of teeth

This experimental in-vitro study was performed after approval of the Ethics Committee (Approval ID: 2018H-0060-D-M-0260). Twenty-four single rooted mandibular premolars were collected and stored in 0.2% thymol until further processing [22]. Soft tissue and calculus were mechanically removed from the root surfaces. Teeth were decoronated with a diamond fissure bur under water cooling, leaving a root segment with a length of 15mm in all teeth. The root canals were explored with a #10 K-file (Mani,Tochigi,Japan) until the tip of the file was visible from the apex. The working length (WL) was determined by subtracting 1mm from this length.

Initial root canal treatment

The root canals were enlarged with I Race files to size 30/04, and irrigated during root canal preparation with 10mL of NaOCl using 27 gauge needle

(Endo Eze; Ultradent, South Jordan, UT) [23]. Then the canals were dried using paper points (Meta Biomed Co., LTd., Cheongju City, Chungbuk, Korea). All the canals were filled using the warm vertical compaction (WVC) technique. Gutta-percha master cones (MCs), size #30/04, (Meta Biomed Co., LTd., Cheongju City, Chungbuk, Korea) were coated with resin root canal sealer (Adseal, Meta Biomed Co., LTd., Cheongju City, Chungbuk, Korea), and inserted into the root canal to the full working length. Down fill of the canals was done by EQ-V pen and back fill was done by EQ-V gun (Meta Biomed Co., LTd., Cheongju City, Chungbuk, Korea). Coronal access was sealed with MD-Temp (Meta Biomed Co., LTd., Cheongju City, Chungbuk, Korea). The specimens were then stored in 100% humidity for one week at 37° to allow complete setting [24].

Retreatment technique

Roots were randomly divided into three groups of eight (n=8). Penetration of root canal and bulk removal was done using D-Race files (FKG Dentaire SA, La Chaux-de-Fonds, Switzerland) as follows: The cervical third and the beginning of the middle third of the root canal filling were removed using a DR1 rotary file. A DR2 instrument was used in the middle and apical third to the working length. The files were used with 1000 rpm and a torque of 1.5 Ncm. Then, an apical enlargement with BT-Race, BT3 (35/0.04) at 800 rpm and a torque of 1.5 Ncm was achieved to minimize the amount of residual obturation materials. Solvents were not used in this study as they may create a fine layer of softened GP, which adheres to the root canal walls and make root canal filling material removal more challengeable [25].

Following initial gutta-percha removal and canal shaping with BT Race, samples were assigned into three groups according to the cleaning approach with a final irrigation protocol of 1mL 17% EDTA followed by 5 ml 5.25% NaOCl.

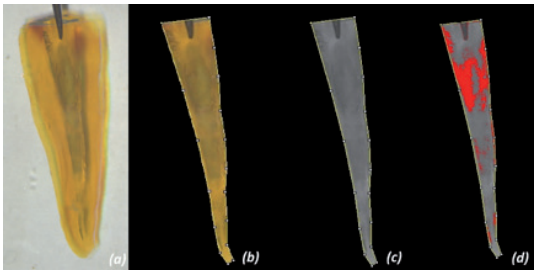

Fig. 1: (a) Dental operating microscope image of transparent specimen under 16x magnification. (b): View of specimen demonstrating canal. (c): Specimen changed to 8-bit gray scale. (d): Schematic representation of measurement of area covered by GP/Sealer remnants.

Group A: No further procedure after syringe irrigation with NaOCl and EDTA.

Group B: XP-Endo Finisher (XP-F)

As recommended by the manufacturer, XP-Endo Finisher (XP-F) was placed in a contra-angle hand-piece endo motor (Silver, VDW, Munich, Germany), cooled (Endo Frost; Roeko, Langenau, Germany) and was removed from the plastic tube in rotational mode by a lateral movement. Each canal was filled with 5.25% NaOCl and the XP-Endo Finsiher was inserted into it without rotation. Then, instrument was initialized (800 rpm and 1 Ncm), and was activated for 1 minute using slow and gentle 7-8mm lengthwise movements up to the WL. Finally, root canals received 1mL Of EDTA 17% and then flushed with 5mL of 5.25% NaOCl using syringe/needle 1mm short of the WL. Each XP-F instrument was used in 4 canals and was then discarded. Retreatment was deemed complete when there was no gutta-percha/sealer covering the instruments. No solvent was used to facilitate the removal of the root filling.

Group C: XP-Endo Finisher-R (XP-FR)

The XP-Endo Finisher-R was used in the same manner as XP- Finisher.

Evaluation

Each root canal was prepared, filled and retreated by the same operator to reduce inter-operator variability.

All specimens were rendered transparent according to the technique described by Robertson [26] as follows: Samples were demineralized using 5% nitric acid (HNO3) for 72 hours. The solution was changed every 8 hours. The teeth were then washed under running water for 4 hours. After that dehydration of samples using ascending grades of ethanol was done as follows: 60% for 8 hours, 80% for 4 hours and 96.6% for 2 hours. Finally, samples were placed in xylene for 2 hours to harden them prior to their immersion in methyl salicylate to render them transparent.

After clearing, the GP/sealer remnants on the canal wall were imaged on a white background in bucco-lingual (B-L) and mesio-distal (M-D) directions using a dental operating microscope DOM (Leica, M320, Germany) at 16 x magnifications. Evaluation of GP remnants was carried out by a second examiner who was blind to group assignment. The Images were then transferred to computer to be subjected to morphometric analysis of the root canal area covered by root filling remnants using Image J software (National Institutes of Health, Bethesda, MD ,USA) (Figs. 1 a & b). Images were changed using Image J software to 8-bit gray scale (Fig. 1c). The threshold was adjusted until the required area was automatically shaded red (Fig. 1d). Finally, the area of fraction was measured using Image J software.

Groups	Retreatment Tech.	N	B-L (Mean ± SD)	M-D (Mean ± SD)
Group A	**D-Race**	8	16.18 ± 8.27	15.75 ± 8.18
Group B	**D-Race + XP-F**	8	11.87 ± 6.26	12.33 ± 6.81
Group C	D-Race + XP-FR	8	9.85 ± 9.94	8.9 ± 6.63

Table 1: Area of root canal wall covered by GP/sealer remnants after retreatment in B-L and M-D directions.

Statistical analysis

The quantitative data were presented as mean ± standard deviation. Analysis of variance (Kruskal-Wallis) was adopted because one of the variables was not normally distributed according to Shapiro-Wilk test to analyze the differences in the mean of GP/ Sealer remnants covered area among the three groups. All analysis was performed with 0.05 level of set significance using the statistical software SPSS 24.0 for Windows (SPSS Inc, Chicago, IL).

Results

All retreatment techniques used in this study left some filling material inside the root canal (Table 1). Images in buccolingual and mesiodistal directions showed no significant differences between the groups ($p>0.05$). The mean values of the remaining filling materials of the three groups respectively, from the lowest to highest, were group C (XP-FR), group B (XP-F) and group A (D-Race).

Discussion

Complete removal of old filling material from canal is the ultimate goal for a successful non-surgical root canal retreatment since residual filling material negatively affects the antimicrobial feature on the infected walls. Remaining filling material has been assessed by different methodologies: radiography, splitting teeth longitudinally or making teeth clear. Among them, clearing [27] appears to be cost-effective and can easily identify small area of residual GP/ sealer on the canal walls [28]. In the present study, teeth were made transparent after retreatment to allow measurement of the residual root canal filling material.

The present study was conducted to test the efficacy of XP Finisher files in removing the residual filling material from root canals during root canal retreatment. Both Files were effective in the removal of additional filling material, but there was no significant differences between the groups ($p>0.05$). Residual filling material remained in all samples, irrespective of the XP-endo instrument used, even though FKG changed the core diameter and the angulations to make the file stiffer than XP-endo finisher. This finding is consistent with a previous study by Silva et al. [21] who found no differences between XP-FR and XP-F in removal of the root canal filling material remnants during retreatment. Although our results were similar to the results of a previous study, it is important to highlight that there are differences in the methodology. In the former study, the authors used Micro CT Scan to evaluate the volume of the remaining root canal material in the three thirds of the canals, whilst the present study used image J software (National Institutes of Health, Bethesda, MD,USA) to evaluate the remaining material in the whole canal.

Reviews of the literature revealed that it is very difficult to remove all traces of GP/sealer from root canals with any retreatment technique, regardless of single or supplemental instruments used [29, 30]. And this was demonstrated in the present study, as none of the samples were free of GP/ sealer remnants under dental operating microscope examination. It might be noted that larger diameter of XP-FR should clean better in the root canals. However, in the present study, the apex was enlarged from an initial size 30 to 35 before using the XP-Endo Finishers. Thus, the possible benefit of the larger instrument was not detected. However, FKG manufacturer's instructions for using XP-FR should be used following any retreatment case with a diameter of 30 or more [2]. No instrument fractures occurred during root canal filling material removal. Speed of the rotary instruments was adjusted according to the manufacturer's recommendation. Each instrument was used to prepare maximum 4 root canals.

Conclusion

Within the limitation of the present study, none of the used finishers were able to completely remove the root canal filling material from the root canal walls.

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