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Efficacy of R-endo® and Protaper® Re-treatment Systems in Removal of Realseal™

Afaf.Y. AL-Haddad, Zeti A. Che Ab Aziz, Eshamsul Sulaiman

Department of Conservative Dentistry Faculty of Dentistry, University of Malaya Kuala Lumpur, Malaysia

Abstract: Aim: to evaluate (1) the efficacy of R-Endo® and ProTaper® re-treatment rotary systems compared to Hedström files for removal of laterally and vertically compacted RealSeal™ from the root canal and (2) the effect of cold lateral compaction and warm vertical compaction obturation techniques during re-treatment. Materials and Methods: seventy eight extracted premolars were prepared and filled with RealSeal™ using either cold lateral compaction or warm vertical compaction technique (39 roots each). Each group was subgrouped into 3 groups. Re-treatment was done with one of the following: Hedström files, R-Endo® and ProTaper® re-treatment files (13 roots each). After clearing the roots, the area of the remaining material in coronal, middle and apical thirds was calculated using image analyzer software. Statistical analysis was performed using Multiple Analysis Of Variance and Mann-Whitney tests. Results: No significant difference between used files during removal cold laterally compacted RealSeal™ ($P>0.05$). However, the two rotary re-treatment files left significantly less remnants than Hedström files in the middle third of the root canal ($P<0.05$) during removal warm vertically compacted RealSeal™. The removal of warm vertically compacted RealSeal™ left significantly more remnants than cold laterally compacted in coronal and middle third of root canal with use of Hedström files ($P<0.05$). No effect to the obturation technique on RealSeal™ removal with two rotary re-treatment files ($P<0.05$). Conclusions: None of the used systems was able to completely remove of RealSeal™ and use of warm vertical compaction technique needs more effort to remove RealSeal during re-treatment.

Key words: Endodontic re-treatment, ProTaper, RealSeal, R-Endo.

INTRODUCTION

Orthograde re-treatment is the treatment of choice to treat the periapical inflammatory lesions that persist or develop after endodontic treatment (Roda S, 2006). The main goal of orthograde re-treatment is to gain access to apical foramen through complete removal of any mechanical barrier, thereby facilitating sufficient cleaning and shaping of the root canal (Stabholz A., 1988). Several methods can be used to remove root canal filling materials. These methods include using of hand files in combination with: different chemical solvents (Tamse A, Unger U, 1986; Wong R., 2004), Gates Glidden or heat pluggers (Friedman S, Stabholz A, 1990), and the ultrasonic technique which enhances the removal of obturation material (Jeng HW, 1987; Wilcox LR., 1989). Additionally, rotary instruments had also been used, such as the inflexible GPX burs (Hülsmann M., S. Stotz, 1997), the canal finder (Imura N., Zuolo M.L., 1996), or one of the recent flexible rotary nickel-titanium (NiTi) files which commonly used in endodontic treatment for cleaning and shaping of root canals (Masiero A.V., 2005; Saad A.Y., 2007). Recently two NiTi rotary have been designed to remove obturation material from the root canal, ProTaper® Universal re-treatment system (DentsplyMaillefer, Ballaigues, Switzerland) and R-Endo® (Micro-Mega, Besancon, France) system. The ProTaper® universal re-treatment system was found to be efficient in removal of GP compared to Hedström files and Gates-Glidden (Gu L-S., Ling J-Q., 2008). Whereas R-Endo system were found to be not efficient to complete removal of GP in curved canals (Gergi R., 2007).

Although gutta-percha has been the standard obturation material used in endodontic with a variety of sealers, the recent studies have demonstrated microleakage in canals filled with these materials (Khayat A, 1993; Friedman S., 1997). Many researchers correlated the endodontic failure with leakage through root filling materials (Lin L.M., 1997; Saunders W.P., 1994). In response to the shortcomings of GP and conventional sealers, the new resin-based endodontic obturation material (Resilon™ or RealSeal™) has been introduced. This material is expected to form a monoblock within the canal space which has been suggested to reduce the

Corresponding Author: Afaf.Y. AL-Haddad, Department of Conservative Dentistry Faculty of Dentistry, University of Malaya Kuala Lumpur, Malaysia

microleakage. The manufacturer of Resilon™ claimed that it is retreatable. In literature review, removal of vertically compacted Resilon™ was more efficient than that for GP during re-treatment (Schirrmeister JF, 2006).

Controversially, removal of laterally compacted Resilon™ compared to GP was less efficacious and long time required completing re-treatment and more material residue was present in the apical third of canals. The removal was enhanced by apical enlargement beyond the diameter of the canal before re-treatment (Hassanloo A., 2007). Such enlargement may be associated with a risk of transportation. However, until now, there is no study was conducted to compare efficacy of these two systems in removal of new resin based obturation material (RealSeal™).

MATERIALS AND METHODS

Specimen Preparation:

Seventy eight extracted single-rooted premolars disinfected in 0.5% chloramines T trihydrate. After removing the soft tissues and hard deposits, the teeth were stored in distilled water until used. The teeth were radiographed buccolingually and mesiodistally. The teeth with single straight root canal, completely formed apex with patent foramina, no internal and/ or external resorption, no obstruction within canal system, and no pulp stones were selected. The selected teeth were decoronated at the level of 16 mm from the apex to standardize the length for all specimens.

Root Canal Preparation:

After removal of the pulp tissue, A K-file size10 was introduced into the canal until it appeared at the apical foramen. The true working length was established by subtracting 1.0 mm from this measurement. Root canal preparation was achieved with modified step-down technique (Goerig A.C., 1981). The coronal two-third was flared up with size 2-4 Gates-Glidden drills. The apical third was then prepared with K-files to master apical file size 25 and step-back in 1mm increment to a file size 55. Apical patency was maintained with size 10 K-file. Canals were regularly irrigated between changes of files with 5.25%NaOCl. The final irrigation was done with 17% EDTA followed by distilled water to ensure complete removal of the NaOCl from the root canal.

Root Canal Obturation:

The specimens were randomly assigned into two groups (39 roots each). The roots were obturated according to the assigned group using either cold lateral compaction (CLC) or warm vertical compaction technique (WVC).

Clc Group:

A size 25 master cone was fitted in each canal with tug-back at the working length. The root canal was conditioned with RealSeal self etching Primer. The RealSeal sealer was applied with paper point. The root canals were laterally compacted with accessory cones using medium-fine finger spreader. The system B side of the Elements™ Obturation Unit (SybronEndo, Orange, USA) was used to sear off the cores at the canal orifice.

Wvc Group:

A medium-fine size non-standardized RealSeal core was fitted into the root canal until tug-back at the working length. After conditioning the canal and applying the sealer. The selected core was coated lightly with sealer and inserted to the working length and then down packed with the selected Buchanan plugger using the System B side of the Elements™ Obturation Unit. Backfill of the canal was achieved by warm vertical compaction of the injected RealSeal™ (Elements RealSeal™ Obturation Cartridge, SybronEndo, Orange, USA) using the Extruder side of the Elements™ Obturation Unit which was set at 150 C. The coronal surface of all specimens was light cured for 40 seconds to produce an immediate coronal seal. After canal obturation, radiographs were taken to assess the quality of the root canal filling. The filling was considered satisfactory if it appeared to be dense without voids and if it extended within 1mm from the root end. The canal coronal to the root filling was restored with IRM. All specimens were then kept in an incubator at 37 C for 8 weeks in 100% humidity. AnaeroPack®Anaero (Mitsubishi Gas Chemical Co., INC. Tokyo, Japan) was used to create anaerobic environment as the sealer set more completely in this environment.

Re-treatment Techniques:

Prior to the re-treatment the temporary filling was removed and the Gates-Glidden drill was used to remove 2-3mm of the obturation material to create a reservoir to the solvent during re-treatment procedures. The 39 specimens in each group were further subdivided into three subgroups (each 13 roots).

The re-treatment was performed using 2 drops of chloroform solvent that were incrementally delivered to each root, and one of the following instruments:

Group 1 & 4:

A sequence of hand Hedström files from #55coronal to #25 apical was used in a crown-down technique in a circumferential quarter-turn push-pull filing motion.

All instruments of the ProTaper and R-Endo was performed using rotary engine driven motor X-Smart™ (Dentsply Maillefer, Ballaigues, Switzerland) with constant speed of 500 r.p.m, torque control of 2NCm $^{-1}$, and a 16:1 reduction gear contra angle hand piece.

Group 2 & 5:

ProTaper re-treatment rotary system was used as recommended by manufacturer in crown-down technique and brushing motion circumferentially. D1, D2 and D3 were used respectively to remove the root filling material from the coronal, middle and apical thirds.

Group 3 & 6:

R-Endo rotary system was used as recommended by manufacturer in crown-down technique and push-and-retain motion circumferentially. R1, R2 and R3 were used respectively to remove the root filling material from the coronal, middle and apical thirds.

The removal of the obturation material was considered complete when the working length was reached, no material was observed between the flutes of the files, and the walls of the canal were smooth and free of visible debris. All instruments were used to re-treat 5 root canals and then discarded.

Evaluation:

The specimens were decalcified according to the previous study (18) in 5% nitric acid for 72 hour, washed for 4 h and dehydrated in increasing concentrations of alcohol (70% for 12 h, 95% for 1 h and 99% for 3 h).

The roots were cleared subsequently using methylsalicylate. Each specimen was imaged in a standardized way on a black background in buccolingual and mesiodistal directions using a SZ40 stereomicroscope (Olympus, Japan) at ×6.7 magnifications that connected integrated 3.0 M pixel Moticam camera with 2.0 USB output. The photographs were coded, computed and saved. The area of the remaining filling material in each third and the area of the canal thirds were traced and then measured automatically using an image analysis system (Motic image plus 2.0 ML, China). The percentages of the residues to each third were measured and computed.

Statistical Analysis:

Multivariate analysis of variance (MANOVA) to compare the percentage of remnants in coronal, middle and apical third of the root canal was employed amongst different types of re-treatment systems. Non-parametric Mann-Whitney test was achieved to compare between two obturation techniques.

Results:

For WVC, there was a significant difference between the two rotary systems and Hedström files in term of remnants in middle third (P=0.038 and P=0.017) and no significant difference between the two rotary re-treatment systems (P=1.00). No significant difference between used files in the coronal and apical thirds (P>0.05). For CLC, no significant difference was found between used files in three thirds of root canal (P>0.05). By using hand Hedström files, the mean percentages of remnants left after removal of vertically compacted RealSeal™ was higher than that of laterally compacted. Statistical significant differences were found between two techniques on coronal and middle third (P<0.05). However there was no significant difference between two obturation techniques in the remnants of apical third (P>0.05). By using ProTaper® and R-Endo® re-treatment systems, the mean percentages of remnants in each third of root canal (especially middle third) were higher after removal of warm vertically compacted RealSeal™ than that of cold laterally compacted one.

Even so no significant difference was found in the percentages of remnants (for each third of root canal)

between two obturation techniques after removal of RealSeal™.

Table 1: MANOVA analysis to the root canal thirds covered with remnants after removal of warm vertically compacted RealSeal™

	Re-treatmentsystems	n	CoronalMean(SD)	MiddleMean(SD)	ApicalMean(SD)	P value*
	Hedstrom	13	8.60(5.31)	37.27(11.56)	36.61(23.35)	0.015?
MD	ProTaper	13	4.34(3.24)	19.29(17.59)	35.21(19.36)	
	R-Endo	13	6.72(4.66)	21.29(16.79)	26.04(16.51)	
BL	Hedstrom	13	8.33(4.43)	37.48(13.38)	35.40(22.07)	0.017?
	ProTaper	13	4.41(3.47)	19.15(17.17)	37.92(20.29)	
	R-Endo	13	6.86(4.33)	21.74(16.87)	26.73(18.32)	

a- Multivariate test (*level of significant set at P<0.05).

b- The three univariate analysis of variance between files showed the significant difference occurred in mean percentage of the remnants of the middle third in mesiodistal (MD) and buccolingual (BL) assessments P value= 0.010 and 0.012 respectively .

Table 2: MANOVA analysis to the root canal thirds covered with remnants after removal of cold laterally compacted RealSeal

	Re-treatment system	n	Coronal Mean(SD)	Middle Mean(SD)	Apical Mean(SD)	*P* value*
	Hedstrom	13	4.50(3.47)	15.05(14.86)	25.75(24.84)	0.607
MD	ProTaper	13	4.87(4.46)	9.17(7.36)	27.62(14.92)	
	R-Endo	13	4.06(2.85)	11.32(9.70)	26.09(22.64)	
	Hedstrom	13	4.57(3.55)	15.96(14.65)	25.56(23.11)	0.220
BL	ProTaper	13	5.07(4.34)	8.53(7.47)	28.87(16.07)	
	R-Endo	13	4.35(2.97)	11.24(10.07)	24.47(21.09)	

Multivariate test (*level of significant set at *P*<0.05).

Discussion:

Root filling material act as a mechanical barrier against reaching the apex of the root during endodontic re-treatment and any remnants of this material could hide the bacteria that may be responsible for failure of re-treatment (Schirrmeister J.F., 2006). Complete removal of these residues may increase the success of endodontic re-treatment. Removal of the root canal filling in this study followed current re-treatment strategies. Gate-Glidden drills were used for removal of the root filling materials at the coronal 2-3mm of the canals. The chloroform was used in limited amount (0.1 ml) in each root canal in order to leave the effectiveness in removal RealSeal™ to the experimental files without interference by the effect of solvent.

Different methods have been used to assess the cleaning of the root canals after re-treatment. The most common method used was the longitudinal sectioning of the roots (Kosti E., 2006; Zmener O, 2006), radiographical assessment (Ferreira J.J., 2004), teeth clearing technique (Schirrmeister J.F., K.M. Meyer, 2006) and computed tomography scan (Barletta F.B., 2007). Each of used techniques has its limitation. Teeth-Clearing technique was found to be sensitive enough to detect the residues in root canal after re-treatment (Schirrmeister J.F., P. Hermanns, 2006).

CLC and WVC techniques were used to fill the root canals before re-treatment, as these techniques were the most commonly used in the clinical practice and in previous studies concerning re-treatment efficacy of Resilon™ (Schirrmeister J.F., 2006; Hassanloo A., 2007; Somma F., G. Cammarota, 2008; Ta?demir T., 2008).

The result of this study for removing the cold laterally compacted RealSeal was in agreement with previous studies that used same obturation technique with different files to remove GP during re-treatment (Ta?demir T., 2008) and that used same re-treatment system as R-Endo (Gergi R., C. Sabbagh, 2007; T. Ta?demir, 2008) or ProTaper re-treatment (Hammad M., 2008). Unlike the present study, ProTaper® re-treatment system was found to be more effective in removal of laterally compacted GP than hand Hedström files (Gu L-S., 2008; Somma F., 2008). The disagreement could be referred to the different procedures of re-treatment, as the following:

1. Removal of root filling material was followed by re-instrumentation of the root canal with ProTaper preparation files and GP was used as the root canal filling material (Gu L-S., 2008).
2. The different size of master apical file (MAF) used during re-treatment which was size 40 for Hedström file and size 20 for ProTaper® re-treatment (Somma F., 2008) whereas comparable MAF sizes (25 size, 0.02 taper) Hedström file and (20 size, 0.07 taper) ProTaper® re-treatment file were used in the current study.

The highly significant amount of remaining debris were left after removal of warm vertical compacted RealSeal with Hedström files especially in middle third of root canal compared to rotary re-treatment system could be referred to the limited amount of solvent used and confining it only to the coronal third which was not enough to dissolve the highly compacted material in the lingual and buccal extensions of the premolar oval canals (Wu M.K., P.R. Wesselink, 2001). In addition, the frictional heat produced during rotation of the rotary re-treatment files may have softening effect on the root canal filling material (RealSeal™). These could explain

why highly significant amount of remaining debris were left after re-treatment with Hedström files compared to rotary re-treatment system.

For the apical third no significant difference was detected between the three methods used. It could be referred to equivalent of MAF of the three re-treatment systems used. The amount of residues was higher in the apical third. This is in agreement with the most of previous studies that concerning endodontic re-treatment (Saad AY, 2007; Kosti E, 2006; Zmener O., 2006; Ezzie E., 2006).

Conclusion:

None of the used systems was able to completely remove of RealSeal™ and use of warm vertical compaction technique required more effort to remove RealSeal during re-treatment.

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