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Comparative evaluation for removal of gutta-percha and bio-ceramic sealers from oval root canals with reciprocating and rotary retreatment file systems: A micro-computed tomography study

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Abstract---Context: Residual filling material can impair the prognosis in endodontic retreatment cases. A variety of file systems have been used in both rotary and reciprocating motion. Aims: To evaluate and

compare the ability of ProTaper Universal Retreatment systems, GPR Mani Retreatment systems and, V Blue Reciproc systems in removal of gutta percha and bioceramic sealer from oval root canals using micro-computed tomography. **Materials and Methods:** Sixty extracted human mandibular premolar with oval canals standardised with cone beam computed tomography (CBCT). Following preparation with ProTaper Next files and obturation with gutta-percha and I Root SP sealer all specimens were randomly assigned to three groups ProTaper Universal retreatment system (PTUR), GPR Mani Retreatment system and V-Blue files, (n=20). Quality of obturation was confirmed with CBCT. After 1 month, retreatment was carried out and the percentage of remaining obturating material was evaluated before and after retreatment through micro-CT imaging. Two sample means and Kolmogorov-Smirnov test were used to analyse data. **Results:** The V-Blue files removed 97.27% of residual filling material whereas PTUR and GPR Mani removed 85% and 79.33% respectively and the difference between V-Blue and other two files tested was statistically significant ($P < 0.05$). **Conclusion:** No system was able to completely remove the filling material but V-Blue files performed insignificantly better than PTUR and GPR Mani file systems.

Keywords---bioceramic sealer, cone-beam computed tomography, micro-computed tomography (micro-CT).

Introduction

Post-treatment disease after root canal treatment is caused mainly by persistent and secondary intra-radicular infection. The success rate is 62% to 85.9% for well-performed retreatment procedure¹. Removal of obturating material from root canal system is mandatory as it may act as mechanical barrier for irrigating solution and intracanal medicament to reach the root canal wall and apex.² Various rotary, reciprocating, ultrasonic or hand instruments have been introduced for retreatment procedures. Fruchi et al.³ reported that reciprocating instruments were more efficient than rotary instrument for retreatment in case of curved and straight canals. In contrast Monquilhott Crozeta et al.⁴ stated that the efficacy of rotary files were more in comparison with reciprocating instruments in removal of residual filling material. R€odig et al.⁵ compared rotary and reciprocating instruments and found that both have similar efficacies for removal of apical filling material.

Gutta-percha and sealers are the most commonly used root canal filling material.⁶ Bioceramic sealers are next generation and revolutionary material in endodontics. Shortcoming of these materials is in the difficulty of removing them from root canal during retreatment procedures.⁷ ProTaper Universal Retreatment system comprises 3 flexible instruments. D1 (30/9%) was used in preparation of coronal third, D2 (25/8%) in the middle third, and D3 (20 /7%) in the apical third.⁸ Mani GPR (gutta percha removal) system contains 4-file. The first file 1S (70/0.04) and 2S (50/0.04) was used in the canal orifice and coronal third, followed by 3N (40/0.04) and 4N (30/0.04) in the middle third, and 4N apical

third.⁹ V-Blue files belongs to single-file reciprocating system. Files were small (25/8%), medium (40/6%), large (50/5%).¹⁰

To the best of our knowledge there is no studies which compared the efficacy of ProTaper Universal Retreatment systems, GPR Mani Retreatment systems and, V Blue files in removal of gutta percha and iRoot SP sealer from straight root canals using micro computed tomography (micro-CT). Therefore, this in-vitro study was undertaken. The null hypothesis stated that there was no difference in the removal of residual filling material among three groups.

Materials and Methods

Approval of this in-vitro study was obtained from the Institutional Ethics Committee(IEC) with protocol no. IEC297022021.

Selection of Samples

Sixty freshly extracted caries free human mandibular premolars with oval and straight canals were selected on basis of cone beam computed tomography (CBCT)(Kodak CS 9000).Teeth were considered oval only when bucco-lingual diameter was 2.5 times than mesio-distal diameter of teeth.¹¹Teeth with previous root canal treatment, calcifications in canal, caries, dilacerated roots, external resorption and/or internal resorption were excluded from the study. They were disinfected with 0.1% thymol solution at 37°C and stored in normal saline until use.The tooth crown was sectioned with diamond disks-C12/190 (0.2mm) to maintain uniform working length of 15 mm.

Samples preparation

Initial exploration of canal was carried out by the size 10 k file (Mani, Japan). The specimens were prepared using the ProTaper Next (Dentsply Mallifer, Switzerland) rotary system up to X3(size 30,.07 taper). Root canal were irrigated with a total of 10 ml of 5.2% sodium hypochlorite (NaOCl) (Prime Dental, India) using 30-gauge side vented needle (Ultradent) followed by 1 ml of 17% ethylenediamine tetra-acetic acid (EDTA) (Prime Dental, India) for 1min. Then canals were dried with paper points (Dentsply Mallifer, Switzerland). ProTaper Next gutta percha cones (Dentsply Mallifer, Switzerland) were used in accordance with master apical file size of prepared canals and were evaluated by checking the tug back sensation.iRoot SP sealer (IBC, Canada) was injected into the canal using an intracanal tip up to the middle third of root canal and gutta-percha master cone was placed. Obturation was done using the cold lateral compaction technique. Root canal was obturated 0.5mm short of the apex. The access cavities were temporary sealed with Cavit (3M ESPE, Germany)and stored at 37°C for 1 month in 100% relative humidity.The status of Obturation was confirmed with CBCT imaging.

Root canal retreatment procedure

The prepared samples were coded and randomly divided into 3 groups (n=20).

- Group 1-ProTaper Universal retreatment system. (Dentsply Mallifer, Switzerland)
ProTaper retreatment files were used in crown-down manner in a brushing motion at minimum speed of 500 rpm.
- Group 2: GPR Mani Retreatment system (Mani, Japan)
These instruments were operated at 1000 rpm and according to manufacturer's recommendation.
- Group 3: V BLUE FILES (NIC Superline Technology)
These files were used in back and forth pecking motion with gentle inward pressure. Files were operated with 150CCW/30CW motion, according to manufacturer's recommendations.

15 ml of NaOCl was constantly used after using each file. Every file was used for only three root canals. When each instrument reached up to working length, retreatment was considered to be concluded. Root canals were flushed with 1 ml of 5.2% NaOCl after retreatment, using 30 gaugeside vented needlefilled with 17% EDTA in the canal for 3 min, followed by rinse with 1 ml of 5.2% NaOCl and were dried with paper points.

Laboratory micro-CT imaging for measurement of filling material and remaining filling material

All specimens before and after retreatment procedures was scanned by Xradia 520 Versa 3D micro-CT. Samples were measured at 75 kV and 55 μ A using 400 projections. The geometrical magnification was kept at 80. The same procedure was repeated for all specimens in order to maintain uniformity. The percentage of the remaining filling material was calculated and subjected to statistical analysis.

Statistical analysis

The percentage of volume of residual filling material was analysed using a two-sample test for independent means and $P < 0.05$ was considered statistically significant. Data analysis was done using Windows based 'MedCalc Statistical Software' version 19.1. Data for mean resistance was analyzed for normality using the Kolmogorov-Smirnov test.

Results

Data of all the samples from the micro-CT evaluation indicated that there was no significant difference in the mean volume of the initial filling material among samples of three different groups($P > 0.05$). [Table 1] shows the initial volume of the filling material (in mm^3) and the remaining volume after the retreatment protocols.

Table 1: Volume of the filling material (mm^3) after the filling and the retreatment procedures: ProTaper Universal, GPR Mani, V Blue files

Groups	n	Minimum	Maximum	Mean
Baseline volume				

ProTaper Universal	20	1.300	8.700	3.643
GPR Mani	20	1.000	5.600	3.671
V Blue files	20	2.200	6.700	4.071
Retreatment volume				
ProTaper Universal	20	0.01000	0.08000	0.04286
GPR Mani	20	0.03000	0.09000	0.06429
V Blue files	20	0.007000	0.01000	0.009286

Table 2: Rate of decrease (%) in the filling material volume after retreatment with the ProTaper Universal, GPR Mani, V Blue files

Percentiles (%)								Kolmogorov-Smirnov ^a
Groups	N	Mean (%)	Minimum (%)	Maximum (%)	25th	50th (Median)	75th	P value
ProTaper Universal	20	85.21	69.23	97.70	80.16	94.41	97.18	0.8470
GPR Mani	20	79.33	68.00	89.36	71.25	87.93	89.22	0.5227
V Blue files	20	97.27	95.45	98.51	95.97	98.18	98.45	0.0290

[Table 2] represents the mean percentage rate of decrease in volume of filling material after retreatment with the ProTaper Universal, GPR Mani, V Blue files was 85% , 79.33%, 97.27% respectively. The V Blue file system removed the filling material more effectively than the ProTaper Universal and GPR Mani, with the latter two systems showing no significant differences ($P > 0.05$).

Discussion

Root canal retreatment was accomplished with thorough removal of previous filling materials from root canals in-order to facilitate 3D obturation. The residual filling material act as a mechanical barrier between intracanal medicament and microorganisms which may result in periapical pathosis. It may also affect the adhesion between dentin and new sealer.¹² Hence success of secondary root canal treatment depends on complete removal of residual filling materials from root canals.¹³

In this study, the standardization of the specimens was done by using CBCT. According to De Dues¹¹ criteria the canals were classified oval if the buccolingual diameter was more than 2.5 times larger than the mesiodistal diameter using following parameter field of view, 20×20 mm; 54µm; 75 kV; through CBCT. ProTaper Universal Retreatment system comprises 3 flexible instruments (D1, D2 and D3). These instruments have an internal angle of approximately 60° at the cutting edge and a convex triangular cross-section which, facilitates removal of obturating material from root canal system in retreatment procedures.¹⁴ Ma J et al found that manual Hedstrom file and ProTaper Universal Retreatment systems were equally effective in removal of bioceramic sealers during retreatment procedures.¹⁵ Mani GPR system contains 4-files (1S, 2S, 3N, 4N). Cross-section of all files are teardrop in shaped and tapering is .04. They have a positive rake

angle with wide radial land and higher cutting ability. It reduces stress and eliminates the screwing in effect.¹⁶

The efficacy of V Blue files were more in the removal of obturating materials although none of the systems completely removed the filling material. Apparently, V Blue file (size 24, .08 taper) system shows decrease rate of 97.27 % volume of residual filling material and was the most successful retreatment system. ProTaper Universal and GPR Mani retreatment system shows 85.21% and 79.33% decrease rate of residual filling material respectively. Bernardes et al. reported that reciprocating systems were more effective than rotary systems for removal of residual filling material.¹¹ Plotino et al. and Bu€rklein et al stated that S shaped cross-section of V blue files have more superior cutting efficacy than triangular and tear shaped cross-section.¹² In reciprocating motion the instrument rotates counter-clockwise and clockwise with 120 degree of difference between two movements. They travels to shorter angular distance compared to rotary instruments which results in lower stress and increase in resistance to cyclic fatigue. There is reduction in compression force, screwing effect and bending fatigue due to kinematic motion. Pedulla et al stated that there was 62% reduction in preparation time with reciproc systems as compared to other rotary systems.¹³ In the present study oval shaped canals were selected particularly, as obturating material fills the polar areas of canal hampering its removal and may end in perforation.

In the current study solvent were not used as it dissolve gutta-percha and push it into canal irregularities and dentinal tubules which hampers disinfection, cleaning and re-treatment procedures.¹⁴ Generally in retreatment procedures softening of gutta-percha can be done by chloroform, xylene, halothane, eucalyptol oil, and turpentine oil. These solvents are toxic to the periapical tissue.¹⁵ Hess et al stated that addition of chloroform solvents did not improve the removal of bioceramic sealers.¹⁶

Irrigation protocol followed in the present study was in accordance with Bernardes RA et al.¹⁷ The results of our study was in accordance with study conducted by Bernardes et al. as they concluded that the amount of residual filling material after re-treatment with reciprocating system is less as compared with rotary system. In contrast study conducted by Nevares et al stated that rotary and reciprocating file system are equally effective in removal of obturating material and this can be attributed to the size of retreatment instruments used.¹⁸

iRoot SP sealer, recently introduced bioceramic sealer was used in the present study.¹⁹ It is highly biocompatible, non-toxic, aluminium-free, anti-bacterial, hydrophilic and provides outstanding sealing properties. They exhibit zero shrinkage and expands on setting. It utilizes the moisture naturally present in the dentinal tubules to initiate and complete its reaction.¹⁹ Oltra E²⁰ et al concluded that bioceramic sealers were difficult to remove than epoxy based resin sealer after retreatment procedure. Zhang W et al¹² found that iRoot SP sealer has capability to induce biomineralization as well as proliferation and differentiation of dental papilla stems cells into odontoblast like cells.

Various methods such as digital radiography, confocal microscopy, optical microscopy, scanning electron microscope and microcomputed tomography have been used for the assessment of the amount of residual sealers in the root canal.¹⁷ The advent of micro-CT has propelled the endodontic field to a greater heights. In the present study micro-CT was used to evaluate residual filling material in a root canal before and after retreatment.²¹ It was used to generate multi slice image without requiring the sectioning of samples. The micro-CT is a non- destructive and non- invasive method to obtain two- and three-dimensional images.²²The volumetric pixels provide by micro-CT is in range of 5-50 μ m.

The limitation of this study was that it was done in oval shaped canals of mandibular premolar teeth. In clinical conditions we have to come across different anatomical complexity which may interfere with the results obtained thorough micro-CT evaluations. In this study only ProTaper Universal retreatment systems, GPR Mani retreatment system and V-Blue file was used for the removal of gutta-percha and iRoot SP sealer so further studies are required to compare other endodontic retreatment file system and sealers.

Conclusion

From this study it was concluded that thereciprocating system (V-Blue files) was more effective than the rotary file systems (ProTaper Universal retreatment and GPR Mani retreatment system) in the removal of gutta-percha and iRoot SP sealer during the retreatment of oval and straight root canals in extracted human mandibular premolar teeth.

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