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Influence of Rotary File System and Obturating Technique on the Apical Microleakage of Root Canal Treated Tooth

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Abstract

Background: Root canal shaping with rotary or reciprocating files results in uniform conical tapered shape from apical foramen to the orifice which led to a path for single cone obturating technique. The present study aimed to compare the apical microleakage of lateral compaction and single cone obturating techniques in root canals prepared with different rotary file systems.

Material and Methods: 70 single rooted premolar teeth were selected for this study. The specimens were divided into three groups (n=22), and control group (n=4). In Group A, B and C the root canals were instumented with Protaper gold files, Hyflex EDM file, and WaveOne gold reciprocating file respectively. Each group was further subdivided into two subgroups (n=11) according to the method of obturation done i.e. Lateral Condensation technique and Single Cone technique. After obturation, all

experimental and control samples were stored in humidor at 98.6°F and 100% humidity for 48hours. Teeth were coated with two layers of nail varnish except at 2 mm area around the apical foramen. Each tooth sample was immersed in methylene blue dye for 3 days. After rinsing the samples with distilled water they were sectioned vertically along the long axis in the bucco-lingual direction. The samples were observed under strereomicroscope at10X magnification and the linear extent of the dye penetration was evaluated.

Results: The one-way ANOVA and Tukey HSD Multiple Post Hoc test showed no significant difference in the mean dye penetration betweenthe groups as well as within groups (p=0.938).

Conclusion: From the findings of the results, it was concluded that Single cone obturation group and cold lateral condensation group showed similar sealing effect and the canals prepared with different Ni-Ti rotary sytems showed similar level of dye penetration.

Keywords: Protaper gold system, Hyflex EDM file, Waveone gold reciprocating file, Single Cone technique.

Introduction

The success of root canal treatment depends on appropriate biomechanical preparation, disinfection, and three dimensional obturation.[1] Biomechanical preparation is done to accomplish aclean root canal system while maintaining the original canal configuration without creating any iatrogenic errors. According to Herbert Schilder, the root canal preparation should be a continuous tapering cone with narrowest diameter at the apex and widest at the orifice.[2]

Introduction of NiTi instruments is a leap forward in the evolution of endodontics. Advancements in the metallurgy of NiTi files with heat treatments such as blue or gold treatment and EDM technology notably improved their flexibility and fatigue resistance.[3]

ProTaper Gold (PTG; Dentsply, Tulsa Dental Specialties) and WaveOne Gold (WOG; Dentsply, Tulsa Dental Specialties) files aremanufactured by post machining gold treatment.[4] The gold process is a post manufacturing procedure in which the ground NiTi files are heat-treated and slowly cooled resulting in modified transformation temperatures (austenitic start and austenitic finish), thus enhancing instrument properties.[5]PTG rotary files feature the same exact geometries as ProTaper Universal (PU) (PU; Dentsply Maillefer, Ballaigues, Switzerland), but it has a shape memory effect. They exhibit a convex triangular cross-section and progressive taper.[6,7] WOG reciprocating single-file instrument has a unique parallelogram shaped cross-sectional design with one or two cutting edges depending on the location along the file. These edges significantly reduces torque, minimizes screwing effect on the cutting efficiency, and allowing better removal of debris.[5,6]

Another single-file system recently introduced to the market is HyFlex EDM (HEDM; Coltene/Whaledent AG, Altst€atten, Switzerland), manufactured using the technique of electrical discharge machining. This manufacturing process uses spark erosion to harden the surface of the NiTi file, resulting in superior fracture resistance and cutting efficiency. HEDM has control memory and the changing taper throughout the file.[8]

With the ameleorations in NiTi instrumentation technologies, the single cone obturation technique has gained superiority. The goal of obturation is to achieve a hemetic seal to prevent the remaining bacteria and their endotoxins from reaching the root apex.[9] In single cone obturating technique (SC), master cone with a larger taper which more closely matches the taper of the root canal space prepared by Ni-Ti instruments can provide a better three-dimensional seal of the prepared canal space. This simplified technique increases the amount of gutta-percha

within the canal, thereby reducing the amount of sealer between accessory cones.[10] Many studies showed single cone obturating technique was comparable to standard cold lateral condensation (LC) technique in terms of sealing efficiency, time constrain and operator fatigue.

Adequate apical seal of prepared canal depends on method of instrumentation and the obturating technique used. Hence, the purpose of this study was to compare and evaluate the apical microleakage in root canals prepared with rotary or reciprocating nickel titanium instruments (PTG, WOG and Hyflex EDM) and obturated with lateral compaction and tapered single cone gutta-percha techniques.

Material And Methods

Seventy freshly extracted human mandibular premolars with fully developed apex and straight root, free of caries, were selected for this study. The teeth were cleaned and stored in 10% formalin until further use.The samples were divided into three groups of 22 specimens each based on the files used for instrumentation and two control groups of 2 specimens each where,

Group A- Root canals were prepared with PTG file system

Group B- Root canals were prepared with HEDM file.

Group C- Root canals were prepared with WOGreciprocating file.

Again the three groups were subdivided into 2 subgroups of 11 specimens each, based on the technique used for obturation, such as

Subgroup 1- instrumented root canals were obturated with cold lateral condensation technique.

Subgroup 2 - instrumented root canals were obturated with single cone gutta-percha technique.

Positive Control: 2 teeth instrumented but not obturated were used to demonstrate dye leakage throughout the entire length of the canal.

Negative Control: 2 teeth were obturated and sealed completely using 2 layers of nail varnish externally.

Root Canal Preparation

Radiographs were taken to confirm the presence of single canal. Access opening was done and working length was determined by #15 size K file. Root canal preparation was done by crown-down technique. Between the instruments each canal was irrigated with 5 ml of 3% NaOCl and 17% EDTA alternatively.

Group A: The root canals wereinstrumented using PTG rotary instruments with X-Smart plus handpiece, the speed of rotation was maintained at 250 rpm. The sequence of instruments will be S1, followed by SX, to coronal two-thirds. There after a sequential apical instrumentation wasdone with S1, S2, F1, F2to the full working length.

Group B: The root canals were instrumented using Hyflex EDM system with the X-Smart plus handpiece and HEDM OneFile (25/.) NiTi file at 500 rpm and 2.5 Ncm torque to full working length.

Group C:The root canals were instrumented using WaveOne gold single file reciprocating system with the X-Smart Plus hand piece which works with reverse “balanced force” action using the pre-programmed motor to move the file in a back and forth in “reciprocal motion”. Primary file of tip size ISO 25 with an apical taper of 8% was used to prepare the root canal to full working length.The canals were dried with #30 paper points.

Root Canal Obturation

Subgroupsa1, B1, C1: Sample Preparation for Lateral Condensation Technique.

An ISO size#25 gutta-percha cone was fitted into the root canal at the working length and was checked for tug back. The master gutta-percha cone was then coated with AH Plus (Dentsply Maillefer, Ballaigues, Switzerland) sealer and placed into the root canal. Lateral compaction with

accessory gutta-percha cones was performed. Excess gutta-percha was removed with a heat source.

Subgroups A2, B2, C2: Sample Preparation For Single Cone Obturation Technique

A single cone of gutta-percha tapered with diameter and conicity corresponding to the final shaping instrument in each group was tried in the root canal. After visual and tug-back control, fit of the cone is checked with a periapical radiograph. Then canal walls were coated with AH Plus sealer using lentulospiral (Mani, Japan) followed by insertion of single cone till the working-length. The excess of gutta-percha was removed with a heated instrument.

After obturation, the access cavity was sealed with Glass ionomer cement (Fuji IX). All experimental and control groups were stored in a humidor at 98.6 F and 100% humidity for 48 hours.

Teeth were coated with two layers of nail varnish except for 2 mm area around the apical foramen. Specimens selected for positive (n = 10) and negative (n = 10) control groups were instrumented in the same way as other samples of experimental groups, but the root canals were obturated without sealer in the positive control groups to allow 100% leakage. The root surfaces of these teeth were also coated with 2 layers of nail varnish, except the apical 2 mm. The teeth in the negative control groups were obturated and the entire root surface was coated with two layers of nail varnish to ensure there was no leakage. All the samples were immersed in methylene blue dye for 3 days which engulfed two-third of the roots. After 3 days, the samples were removed from dye solution and rinsed with distilled water. Then the samples were sectioned vertically along the long axis in the bucco-lingual direction through the centre of the root.

The sectioned samples were observed under strereomicroscope at 10X magnification and the linear extent of the dye penetration was evaluated from the most apical part of the obturation material to its more coronal point of penetration using a metallic ruler. Positive and negative control groups were evaluated first to ensure that the microleakage was appropriate. After it was determined that the positive controls allowed free passage of dye material and negative control did not allow dye penetration, the rest of the samples were evaluated as shown in fig 1.

Results

Data collected was computerized and analysed using SPSS (STATISTICAL PACKAGE FOR SOCIAL SCIENCES) 13.0 version. Statistical Analysis was done using One-way Analysis of Variance (ANOVA) and Tukey HSD Post Hoc procedures as shown in tables 2,3 and graph 1. A p-value of <0.05 was considered statistically significant.

Table 1 shows Mean and Standard Deviation values of dye penetration. The mean apical microleakage values of PTG lateral condensation obturation group showed highest readings (2.4091) indicating more microleakage in this group. Mean microleakage values of HEDM single cone (2.0909) were least, indicating less microleakage but statistically not significant.

In intergroup and intragroup comparisons, statistically no significant difference observed in dye penetration among the different groups tested.

The readings showed that Single cone obturation group and Cold lateral condensation group showed similar sealing effect. Also, the canals treated with different Ni-Ti rotary sytems- PTG, HEDM & WOG showed similar level of dye penetration.

Discussion

Despite numerous innovations in obturating techniques and materials microleakage still persists as a major cause of treatment failure.Leakage through a filled root canal

may take place along the sealer-dentin and sealer-filling material interfaces or through voids within the sealer.[3,10] In the current study, the dye penetration or staining technique was employed which is a semi-quantitative method and it is simple and relatively economical.[11]

Instrumentation with NiTi rotary files produced a conical pathway allowing effortless entrance of obturating paste and therefore minimizing overfilling or underfilling and diminished odds of voids.[12] In this study, the three file system have not shown any significant difference in the apical microleakage with either of the obturating techniques. The reason may be attributed to surface treatment of these files which helped in maintaining the shaping ability of canals.

The heating process after the machining of the files such as gold treatment or electric discharge machining has been used to overcome surface defects, and to modify the crystalline phase structure imparting more flexibility and cyclic fatigue resistance.[13,14,15] Thus literature has shown these files have better canal centering abilty and provided improved shapes that are structurally appropriate for predictable canal disinfection, conefit, and obturation.[12] In an *in-vitro* study by Ozyurek *et al.* it was concluded that in simulated S-shaped canals lower level of resin removal was reported with the use of WOG and HEDM files as compared to the Reciproc NiTi files.[8] Jorge Rubio et al proved that Hyflex EDM and Wave One Gold showed similar shaping ability in the apical third of root canals.[16]Our results are also in corroboration with study by Al-Dhbaan AA et al. where no significant difference in the widths of S-shaped canals or in the curved portions of L-shaped canals prepared by the WOG and PTG systems.[6]

In the current study, mean microleakage with SC technique was found to be less than LC technique in all three instrument group but not statistically significant. This can be justified as the single cone and sealer combination results in a uniform mass which avoids the gaps observed between multiple cones as in LC.[17]However, the geometry of the gutta-percha cone and the rotary instruments must be well matched for an optimum adaptation.[3]Though SC technique is efficient, less time consuming than LC, porosities in large volumes of sealer, setting contraction and dissolution of the sealer are the main disadvantages of this technique as quoted by Whitworth.[18]

In a study by Holland et al. evaluated the influence of the type of endodontic cement and of the filling technique on the apical marginal microleakage. They found that the SC technique achieved the best sealing of the root canal than LC.[19]Inan et al. compared the apical sealing among the single-cone, thermafil and cold lateral condensation techniques, in mandibular premolars and concluded that the apical sealing that the use of single cone technique is comparable with both the lateral condensation and Thermafil techniques.[1]

On the other hand, Pommel and Camps reported that the single-cone technique had the highest leakage. Yucel and Ciftci concluded that the poor seal with single cone may be related to the technique itself, because the gutta-percha is not compacted but is only inserted to the working length with a substantial amount of sealer.[20] However, these obturations were done usually with zinc oxide eugenol based sealers. when large volumes of soluble sealer was used, dissolution of the sealer may had a negative effect on the outcome when compared to epoxy resin based sealer.AH Plus is an epoxy resin-based sealer, and provides a tight seal of the root canal system. These properties justified its choice and use in this study, corroborating the findings of Schafer and Zandbiglari (2003).[21]

Though both the obturating techniques showed similar results in this study, more research is required for the

evaluation of apical sealing ability of canals prepared with different file systems and filled with corresponding gutta-percha cones to apply them in regular clinical use.

Figures and Tables

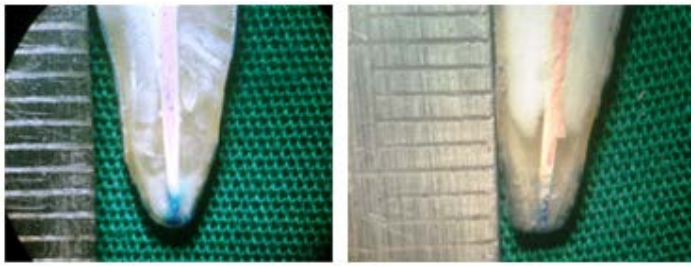


Fig 1: Stereomicroscopic image showing apical dye penetration in group A1 and A2

Table 1: Descriptive Values of Dye Penetration According To Study Groups

VALUES

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
A1_PLC	11	2.4091	.99544	.30014	1.7403	3.0778	1.50	4.50
A2_PSC	11	2.1364	.80904	.24393	1.5928	2.6799	1.00	4.00
B1_HLC	11	2.3636	.92442	.27872	1.7426	2.9847	1.00	4.50
B2_HSC	11	2.0909	.91701	.27649	1.4749	2.7070	1.00	4.00
C1_WLC	11	2.2727	.68424	.20631	1.8130	2.7324	1.50	3.50
C2_WSC	11	2.1818	.68091	.20530	1.7244	2.6393	1.00	3.00
Total	66	2.2424	.81920	.10084	2.0410	2.4438	1.00	4.50

Table 2: Comparison of Six Subgroups With Respect To Dye Penetration By One Way Anova

VALUES

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.894	5	.179	.251	.938
Within Groups	42.727	60	.712		
Total	43.621	65			

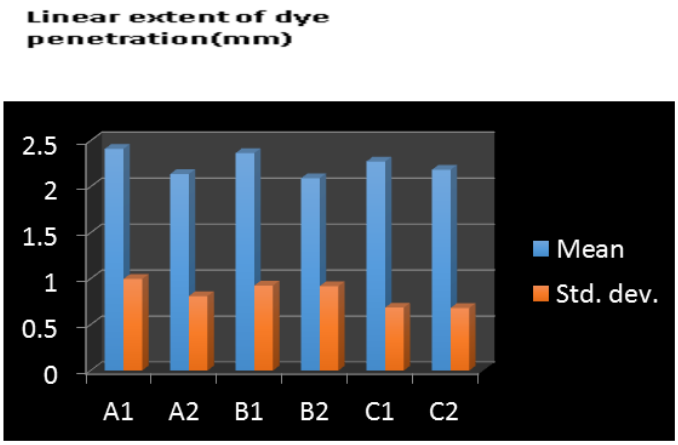
Table 3: Pair Wise Comparison of Six Subgroups with Respect To Dye Penetration by Tukey HSD Multiple Post Hoc Procedures

Multiple Comparisons

Dependent Variable: VALUES
Tukey HSD

(I) GROUPS	(J) GROUPS	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
A1_PLC	A2_PSC	.2727	.35983	.973	-.7865	1.3320
	B1_HLC	.0455	.35983	1.000	-1.0138	1.1047
	B2_HSC	.3182	.35983	.949	-.7411	1.3774
	C1_WLC	.1364	.35983	.999	-.9229	1.1956
	C2_WSC	.2273	.35983	.988	-.8320	1.2865
A2_PSC	A1_PLC	-.2727	.35983	.973	-1.3320	.7865
	B1_HLC	-.2273	.35983	.988	-1.2865	.8320
	B2_HSC	.0455	.35983	1.000	-1.0138	1.1047
	C1_WLC	-.1364	.35983	.999	-1.1956	.9229
	C2_WSC	-.0455	.35983	1.000	-1.1047	1.0138
B1_HLC	A1_PLC	-.0455	.35983	1.000	-1.1047	1.0138
	A2_PSC	.2273	.35983	.988	-.8320	1.2865
	B2_HSC	.2727	.35983	.973	-.7865	1.3320
	C1_WLC	.0909	.35983	1.000	-.9684	1.1502
	C2_WSC	.1818	.35983	.996	-.8774	1.2411
B2_HSC	A1_PLC	-.3182	.35983	.949	-1.3774	.7411
	A2_PSC	-.0455	.35983	1.000	-1.1047	1.0138
	B1_HLC	-.2727	.35983	.973	-1.3320	.7865
	C1_WLC	-.1818	.35983	.996	-1.2411	.8774
	C2_WSC	-.0909	.35983	1.000	-1.1502	.9684
C1_WLC	A1_PLC	-.1364	.35983	.999	-1.1956	.9229
	A2_PSC	.1364	.35983	.999	-.9229	1.1956
	B1_HLC	-.0909	.35983	1.000	-1.1502	.9684
	B2_HSC	.1818	.35983	.996	-.8774	1.2411
	C2_WSC	.0909	.35983	1.000	-.9684	1.1502
C2_WSC	A1_PLC	-.2273	.35983	.988	-1.2865	.8320
	A2_PSC	.0455	.35983	1.000	-1.0138	1.1047
	B1_HLC	-.1818	.35983	.996	-1.2411	.8774
	B2_HSC	.0909	.35983	1.000	-.9684	1.1502
	C1_WLC	-.0909	.35983	1.000	-1.1502	.9684

Graph 1: Comparison of Six Subgroups with Mean Values of Dye Penetration



Conclusion

Bio mechanical preparation and obturation plays a crucial role in success of root canal therapy. By using advanced rotary instruments, time of preparation was reduced with improved cleaning efficiency. Though SC obturating technique performed similar to LC in this study, the adequate match of master guttapercha with preparation of the canal and use of resin based sealer will improve the

efficacy of this technique providing astounding clinical results.

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