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Penetration depth of AH- plus Sealer in Dentinal Tubules following ErCr: YSGG Laser or EDTA application: A Confocal Laser Microscopic Study

Ali A. Shaheed[1, 2, 3], MSc, Hussien A. Jawad[1], PhD, Basima M.A. Hussain[1], PhD, Ahmed M. Said, DDS[3]
[1]Baghdad University/ Laser Institute for Postgraduate Studies
[2]Alkafeel University / College of Dentistry
[3]Shaheed Doctor Nawar Specialised Dental Center
Coresponding Author: Ali A. Shaheed
Email: Aluky1985@yahoo.com

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Abstract:
The aim of this study was to investigate the AHplus sealer penetration into dentinal tubule following smear layer removal by either use of ErCr:YSGG laser or EDTA. Thirty extracted human teeth with straight single roots were used. the teeth were decrownated, and the root canals were instrumented with ProTaper Next rotary instruments(DentsplyMaillefer, Ballagues, Switzerland) with copious irrigatant 2 mL 5% NaOCl. Smear layer removal was done for 20 of teeth either with ErCr:YSGG laser or with 17% EDTA, the remaining teeth used as controll. The canals were dried and obturated by using rhodamine B–labeledAHplus in combination with the carrier-based technique or the cold lateral compaction. After setting, the roots were sectioned horizontally at 3, 6, and 9-mm distances from the apical tip. On each section, sealer penetration in the dentinal tubules was measured by using confocal laser scanning microscopy. When groups were compared statistically, significant differences were found between laser/carrie-based group and all group (at P $\leq$. 01),and between laser/lateral compaction, EDTA/carrier-based groups and other groups. i it is obvious that using of ErCr: YSGG laser for smear layer removal with the carrier-baseed technique offers greater dentinal tubule penetration of the sealers.

Keywords:*Penetration depth, AH- Plus sealer, dentinal tunes.*

I INTRODUCATION

Endodontic treatment depend on the chemomechanical means. one of the drawbacks of the mechanical cleaning is the formation of smear layer. The presence of this layer may leads to diminsh dentin permeability, obstruct chemicals from pervading infected dentinal tubules, and restrict obturationmaterials adjustment to the root canal. Mechanical instrumentation of the root canal , in a period of two decades earlier, has been performed employing nickel-titanium (NiTi) files which a predictable shaping not seen with hand instrumentation. ProTaper Next is one of the recent systems that has highest cyclic fatigue resistance which may be belonged to the strengthened NiTi, M-Wire and off-centred cross section which brings about a swaggering movement during rotation thereby decreasing binding to the dentinal wall(1).

Among the used obturation techniques is cold lateral compaction which considerd as a reliable and simple way to fill the root canal very well with less complexity(2). Another obturationtechinique, carrier-based techniques, was used which is a warm gutta-percha on a cross-linked guttapercha core. For Example: Guttacore which achieved a better fill and adaptation in the critical apical third of working length than cold lateral or warm vertical techniques(3).

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There are a lot of didfferent composition root canal sealers which are aiding to close the voids or to fill irregularities in the root canal and to eqiuby the space between the gutta-percha cones and between the core material and the root canal. AH plus (DentsplyDeTrey, Konstanz, Germany) is an epoxy resin–based sealer. It is widely used selear and characterised by good handling and superior physical properties (4).

Endodontic cleaning procedures have been continuously advanced, laser at different wavelengths is one of these advancement proposed to supplement treatment. The erbium, chromium-doped yttrium, scandium, gallium and garnet (Er,Cr:YSGG) laser emits at a wavelength of 2,780 nm which is coninsided with the absorption peak of water. This high absorption in water give laser greater ability to cut or ablate tissue .photo-ablation occurs when the laser energy is absorbed in water which evaporates instantaneously, thereby ablating the surrounding tissue and removing smear layer. With this interaction , it is possible to achieve expansion and collapse of intratubular water of more than 1,000μm deapth. Inaddition, this micro-pulse-induced absorption could produce acoustic waves with sufficient strength to disrupt bacteria in intratubular dentine. (5–9).

The aim of this study was to investigate the AHplus sealer penetration into dentinal tubule following smear layer removal by either use of ErCr:YSGG laser or EDTA.

II MATERIALS AND METHODS

Preparation of the Teeth

Thirty single-rooted extracted human teeth were used in this study. After extraction, all teeth were stored in 0.1% thymol crystal solution until use. Then the samples were decrownated at the cementoenamel junction by using a high-speed fissure bur under water cooling.

The working length was estimated by using K-file #10 which introduced inside the canal and advanced until it was just seen at the apex and then this measurment was used after substracting 1 mm. the root canal was negotiated with size 08 or 10 K-files until apical patency is established. Then, they were shaped with ProTaper Next rotary instruments(DentsplyMaillefer, Ballagues, Switzerland).

The apical size of all the specimens were instrumented up to X4 (0.4 mm tip with 6 % taper). They were copiously irrigated between changing each file with 2 mL 5% NaOCl delivered by 27G needle with 3-mL syringe (Monoject, Sherwood Medical)

III EXPERIMENTAL DESIGN

The samples were divided into 3 groups of each group consist of 10 roots. The first one was irradiated by 2.796 μmEr,Cr:YSGG laser(Waterlasei plus; Biolase Technology, Inc, San Clement, CA) for smear layer removal with a redial firing tips RFT2 and RFT3 [diameter 200 μm for apical and middle third and 320 μm for coronal third respectivly]. The used parameters were: 1.25 W, 20Hz, H Mode; Air 30; Water 10 The RFT was inserted down to the root canal 1mm shorter than the working length. During laser application, the firing tip was withdrawan in a circular motion against the root canal walls. The procedure was repeated three times at a rate of 1-2mm/second.

Second group was irrigated with 17%EDTA (2 mL for 3minutes) for smear layer removal, then a final rinse with 2 mL NaOCl. Third group was used as control, so no smear layer was removed.

All specimen of all groups obturated with AH plus sealar. The sealer was mixed according to the manufacturers' instructions. However, in order to be investigated under confocal laser scanning microscopy, it was labeled by fluorescent dyes. Rhodamine B (Alfa Aesar, Karlsruhe, Germany) was added at an approximate ratio of 0.1% (weight). The sealer was introduced into the canal by using paper point. After that, the samples of

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each group were divided into 2 subgroups; first one was obturated with carrier-based technique and the other filled with cold lateral compactiontechnique.

In carrier-based technique , X4 GuttaCore was used with the GuttaCore oven Thermaprep (DentsplyMaillefer, Ballagues, Switzerland). After the heating period of the Thermaprep has ended, the Guttacore is thoughtfully withdrawn from the oven holder. Then, a locking cotton pliers was used to graspe the GuttaCore just above the calibration ring that marks the working length and inserted precisely into the orifice, and slip to length without stirring the axial walls.

While in the second group ,cold lateral technique group, the selected master cone was X4 (DentsplyMaillefer, Ballagues, Switzerland). After its insertion into the canal lumen, a finger spreader was used with labeled length 2–3 mm shorter than the working length. Then, the accessory cones with 0.02 tapering were implanted till the full length of the root canal was obturated.

For obturation assessment, radiographs were taken from two aspects buccally and mesially. Then, glass ionomer cement (Kavitan Plus; Spofa Dental, Prague, Czech Republic) was used to seal the access cavity. After that, The samples were conserved in an incubator at 37˚and 100% humidity for 2 days.

In summery, this study consist of six groups assembled by letter G from 1-6 as showed bellow where each group has five teeth :

G1: smear layer removed by Laser and obturated with carrier-based technique.

G2: smear layer removed by Laser and obturated with lateral compaction technique technique.

G3: smear layer removed by EDTA and obturated with carrier-based technique.

G4: smear layer removed by EDTA and obturated with lateral compaction technique technique.

G5: Root canals without smear layer removal and obtureated carrier-based technique.

G6: Root canals without smear layer removal and obturated with lateral compaction technique technique.

Roots Sectioning and Preparation for Confocal Laser Scanning Microscopic Analysis

The roots mounted in polyester resin. Then, horizontal sectioning was performed for each root at distances of 3, 6, and 9 mm from the apical end with a diamond saw spin at 500 rpm and under continual water cooling (Mecatome T210 A; Presi, Tavernoles, France). After that sandpaper discs(P 1000 mounted on Mecapol P230, Presi) were used to polish the surfaces of samples.

The sectioned root slices were inspected under a confocal laser scanning microscope (Leica DMi8; JH technology, Germany) at 532 nm wavelength, whereas the depth of sealer penetration measured at each slice on four distinct location (buccal, lingual, mesial, and distal). The used magnification was 10X and 40X. Visualized layers were selected 7.5 µm beneath the specimen surface. A dentin of 92.5 µm thickness was scanned at 7.5µm step sizes, and photographs with a resolution of 1,024_1,024 pixels were catched. Image analysis was done using Adobe Photoshop 7.0 (Adobe Systems, Inc, San Jose, CA). The maximum depth of sealer penetration in the dentinal tubules, starting from the canal wall , was measured and documented on 10 different lines in each sites.

Statistical Analysis was permormedusing SPSS version 21 to evaluate differences between studied groups by using ONE WAY ANOVA test , differences within groups were inspected by using multiple comparison method (L.S.D.). Differences between variables were setting as significant at 5% ($P \leq 0.05$) and highly significant at 1% ($P \leq 0.01$).

IV RESULTS

when all data were collected and the buccal, mesial, lingual, distal sites compared, the sealer

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penetration depth was significantly greater in the buccal and lingual direction (mean ± standard deviation,[max–min]: 752.5 ± 353.7, [1141.6-23.4]) compared with the mesial and distal directions (606.5 ± 322.4, [1075.2-10.8]) .
Regarding the means of sealer penetration in the coronal (771.02±262.75), middle (770.96±294.35), and apical sections (497.57±419.41), significant differences were found between the coronal and apical and between middle and apical sections) but not between the coronal and middle sections ($P < 0.01$ by using ONE WAY ANOVA). As shown in Figure 1

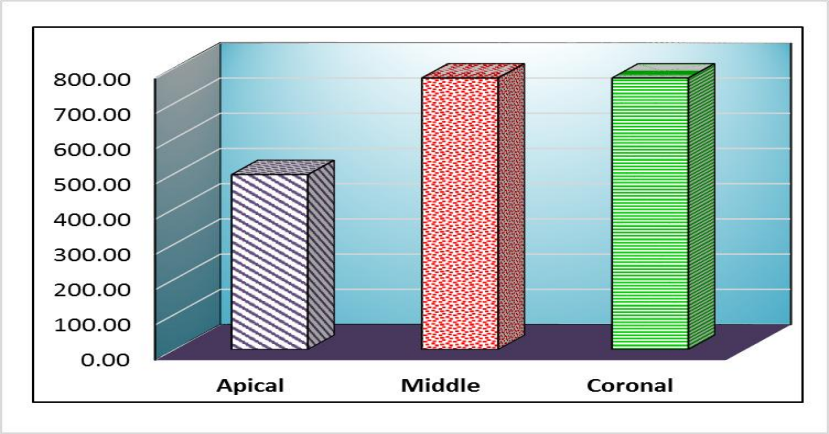

Fig.1. Overall comparison between studied groups in respect to location

When groups (overall values) were compared statistically (Table 1), significant differences were found between G1 and all group (at $P \leq .01$),and between G2 and G4,G5,G6, indicating that smear layer removal by laser , was associated with greater sealer penetration specially when used with carrier based technique. Significant differences were found also between groups G3,G4 and G5,G6, indicating that smear layer removal by EDTA , regardless the obturationtechnique,was associated with greater selearpentration as shown in Figure 2.

Table 1
Experimental Groups G 1-6 (µm, mean ± standard deviation) and Statistical Comparisons

Groups	Sections			
	Coronal	Middle	Apical	Overall
G1	938.77±154.48	1053.80±77.56	1001.27±143.36	997.95±136.96
G2	1060.91±60.65 a	934.16±144.73 a	478.62±313.59 A	824.56±321.47 a
G3	826.87±315.91 a,b	857.54±209.94 a	803.43±262.29 a,b	829.28±264.94 a
G4	757.51±114.44 a,b	775.79±146.96 a,b	624.85±280.17 a,b,c	719.38±204.10 a,b,c
G5	462.62±132.04 a.b.c.d	511.02±186.24 a,b,c,d	37.36±14.28 a,b,c,d	337.00±250.62 a,b,c,d

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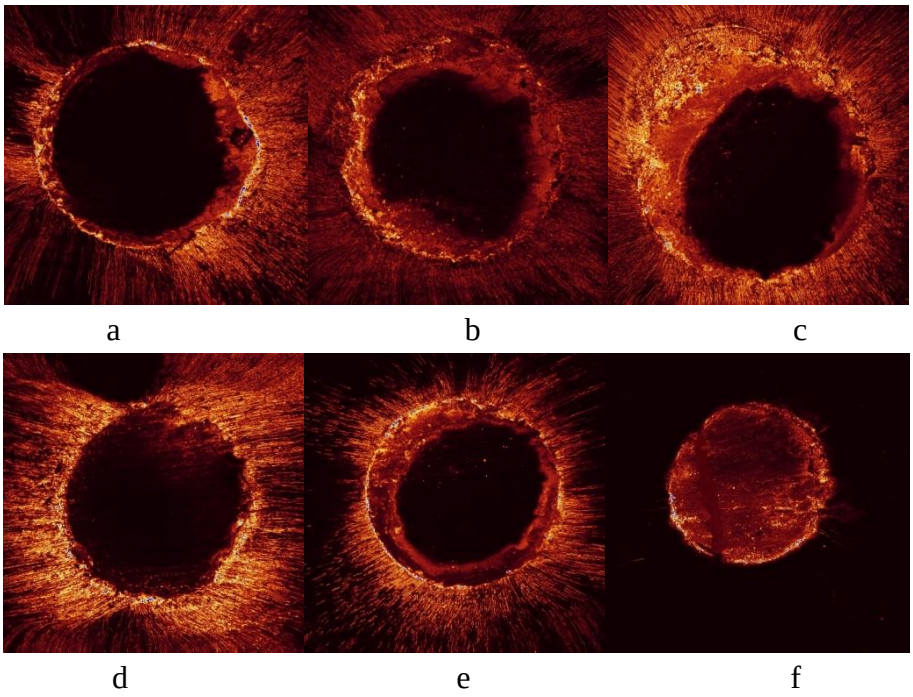
G6	579.45±107.65 a,b,c,d,e	493.46±371.87 a,b,c,d	33.88±26.27 a,b,c,d	368.93±327.40 a,b,c,d

Overall significant differences (P≤0.01) were observed between studied groups, however letter (a) referred to significant differences from group 1, letter (b) referred to significant differences from group 2, letter (c) referred to significant differences from group 3, letter (d) referred to significant differences from group 4, and letter (e) referred to significant differences from group 5 [25-29].



a b c

d e f

Fig. 2. Confocal laser scanning microscopic photograph showing the penetration of sealer in the dentinal tubules of an AHplus -filled canal (middle third). a) G1, b) G2, c) G3, d) G4, e) G5, f) G6. Magnification X10.

V DISCUSSION

It is noteworthy that the prime data of the present study was that higher selear penetration was established when the ErCr: YSGG laser was employed for smear layer removal with Carrier-based technique. Another meaningful data were that the removal of the smear layer in general and the obturation technique further enhanced the entrance of AH-plus selear into dentinal tubules.

The flow of a sealer and its pentration depth determine how good obturation will get,that fill inconsistency on the dentine walls, and distances among the core obturation materials. AH-plus selear was characterized as pseudoplastic material when subjected to compaction a decline in viscosity with a rise in flow will happened due to an increase in the shear rate (10,11). In the present study , the flowability of AH-plus is affected when exposed to a compaction pressure as a result of the wedging of the spreader or due to the hydraulic pressure of the Guttacore obturator.

In addition, the elevated temperatures accompanied the obturation of Guttacore leads to reduce in the viscosity of the AH-plus sealer. And that explaine the higher sealer penetration when used with the carrier-based technique. Beside that

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the obturators advance warm gutta-percha 3-dimensionally into the dentinal walls generate The hydraulic force bunched warm gutta-percha flowing uniformly in 3-dimensions which effect the pentration depth of the selear.

Many studies about the communication of the smear layer with the penetration depth of sealers into dentinal tubule have displayed controversy consequences; despite the fact a group of investigator have stated that no sealer penetration occurs in the presence of the smear layer (12, 13), others have found that the smear layer diminish the sealer penetration to a certain degree but does not absolutely cease it (14), and one in vivo study has disclosed that sealer penetration occurs notably even though a thick smear layer (15).

In the present study, the results are somewhat like-minded with the second group of studies (14) by reason of the smear layer removal by ErCr: YSGG laser as in (G1,G2) or by EDTA (G3,G4) expanded the the sealer penetration when compared with control groups(G5,G6).

The effect of smear layer removal by ErCr: YSGG laser is obviously clear over that by EDTA on selearpentration, this owing to the deeper clearness of dentinal tubules by laser as it can advance deeper into dentinal tubules (16) without being dicey to neighboring tissues(17) .In addition, the using of modified radial firing tips (RFT) boost the distribution of light in root canal system, and have been displaying to be a commodity tool for smear layer removal using water mutually to root canal disinfection in dry condition(18).

The pentration of selear was deeper, commonly, at the coronal and middle sections compared with the apical section. This in agree with results of preceding studies that have certified a collection of sealers and obturation techniques (19–21). That may be due to the size of dentinal tubule openings are denser and larger in the coronal and middle thirds in comparison with the apical third, and this permit smooth sealer penetration at these sections. Beside, higher compressive forces during obturation may have been exercised at the coronal and middle thirds.

Regarding the sites inside the canal wall, itsealer was noticed that the penetration depth of the selear is preeminent in the buccolingual oversight correlated with the mesiodistal, and this results in agree with that of a previous study (22). This may be related to the ‘‘butterfly effect,’’ which occure due to hike sclerosis along the tubules located on the mesial and distal sides of the root canal. This development is frequent in the single-rooted teeth of humans in a wide range of ages (23, 24).

To conclude, it is obvious that using of ErCr: YSGG laser for smear layer removal with the carrier-baseed technique bids larger dentinal tubule penetration of the Ah plus sealer.

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