International Journal of Applied Dental Sciences

ISSN Print: 2394-7489
ISSN Online: 2394-7497
IJADS 2020; 6(1): 05-08

www.oraljournal.com
Received: 04-11-2019
Accepted: 08-12-2019

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Evaluation of effect of removing smear layer by two ways on the quality of apical sealing of root canals obturated using ADSEAL sealer: An *in vitro* study

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Abstract
The Aim of this Study is to evaluate the effect of the method of the removing of smear layer on the Quality of Apical Sealing of Root Canals.
Materials and Methods: The sample included 60 single teeth with single canal which were divided into 3 experimental groups (n = 20 teeth each) according to the smear layer removal method as following: (group 1: ER –YAG, group 2: XP–Endo Finisher File System, group 3: control group).
The teeth were obturated using Gutta Percha and AD SEAL Sealer, The apical sealing was measured by endoscope after making longitudinal sections.
The data obtained was statistically analyzed using One-Way ANOVA and Bonferroni.
The results show that the teeth that we removed smear layer in it with ER-YAG achieved The same apical sealing as the teeth in which we used XP Endo Finisher while both methods showed better apical sealing than teeth with smear layer not removed.

Keywords: ER –YAG, XP Endo finisher file, smear layer, apical sealing

1. Introduction

Apical sealing of the root canal system is of fundamental importance for the success of endodontic treatment. For adequate apical sealing, the presence of smear layer and the sealer to be used must be considered, among other factors [1].

During mechanical preparation, the use of hand or rotary files for instrumentation will result in the production of considerable amount of mineralized debris what is called smear layer [2].

The smear layer consists of both; organic and inorganic components. The organic component is usually a collection of pulpal and bacterial debris whereas the inorganic componentis mainly made of dentinal debris [3].

There are however various limitations to a successful root canal treatment including anatomic complexities, lateral canals, apical ramifications and the failure of the current protocols to properly disinfect these. Olivi, Crippa *et al*. found intricate anatomical structures in 75% of the teeth analyzed. They also found residual pulp after biomechanical preparation both in the lateral canals and in the apical areas in vital and necrotic teeth [4].

Hence, there is a need for new materials, techniques, and technologies that can improve the cleaning and decontamination of these anatomical areas [4].

The FKG Dentaire SA Company in Switzerland recently introduced the XP-Endo finisher, a new NiTi file, into the market. The manufacturer claims that this file can effectively clean the root canals with complex morphology or very narrow straight or highly curved canals. These properties are attributed to the small size of the central core (ISO 25 diameter), 0% taper, MaxWire NiTi alloy, molecular phase transformation of the file in body temperature, high flexibility of the file, and its ability to access the surrounding environment by 6 mm or 100 times it's primary volume [5].

The file is straight in its martensitic phase (M phase) at room temperature (25 °C). When the file is exposed to the body temperature (37°C inside the canal), it changes its shape due to its molecular memory to the austenitic phase (A-phase), expanding within the root canal and assuming a convex shape with a 1.5 mm depth in the final 10 mm of its length [6].

Maiman in 1960 developed the ruby laser, and since then Dental researchers began investigating the potential uses of lasers in dentistry. It was Stern and Sognnaes in 1965 that reported that a ruby laser could vaporize enamel [7].

"LASER" stands for Light amplification by stimulated emission of radiation. Built on the principles of quantum mechanics, this device creates a beam of light where all of the photons are in a coherent state - usually with the same frequency and phase. This causes the light from a laser to be tightly focused, not diverging much, resulting in the traditional laser beam [8].

In various laser systems used in dentistry, the emitted energy can be delivered into the root canal system by a thin optical fiber (Nd: YAG, erbium, chromium: yttrium-scandium-gallium-garnet [Er, Cr: YSGG], argon, and diode) or by a hollow tube (CO_2 and Er: YAG). Thus, the bactericidal effect of laser irradiation can be used for additional disinfecting the root canal system following instrumentation with the tradiotional methods. It also has been proven in various studies that CO_2, Nd: YAG argon, Er, Cr: YSGG and Er: YAG laser irradiation can remove debris and the smear layer from the root canal walls following biomechanical instrumentation [9, 10, 11].

2. Materials and Methods

For this study, sixty single rooted human teeth were were washed with distilled water and then soft tissue remnants were removed using ultrasonic scalar and polished cautiously with pumice, and finally, samples were put in an ultrasonic bath for 5 minutes and stored in distilled water containing 0.1% thymol. Access was made with round and endo–z burs. The teeth were filed 1mm on the side of the apex with k-file (Maillefer, Ballaigues, Switzerland) and The teeth were prepared using Revo-S (Micro-Mega) with an X-Smart (Dentsply Maillefer) torque- limited electric motor.

Revo-S instruments were used in a crown-down manner at a speed of 350 rpm. The operating sequence was as follows: a 10, K-File was used to create a glide path; a 6% taper instrument (SC1) was used with slow and unique downward movement in a free progression and with out pressure to 2/3 of the WL; a 4% taper, instrument (SC2) was used with up and doen movement to the full WL; a 6% taper, size-25 instrument (SU) was used to the full WL in a slow and unique downward movement, we finish the preparation by using AS30. Copious irrigation with 5,25% sodium hypochlorite solution were performed between each file.

After biomechanical preparation of canals the specimens were dried with paper point and divided into three experimental groups (n = 20 teeth each) according to the smear layer removal method as following: (group 1: ER: YAG laser, group 2: XP–Endo Finisher File System, group 3: control group).

G1 (n=20) The teeth were irradiated with ER: YAG Laser (*key laser III 1234)*, 2.940 qm wavelength, 250 ms pulse width, through handpiece number 2062, with an optic fiber of 375 qm diameter under air cooling. The parameters used were: 120 mj, 15 HZ, 1.8 W.

Each canal was irradiated 3 times with 10 s intervals. The irradiations (2 mm of root canal per second) were performed with rotational movement in the apical – coronal direction according to manufacturer's instructions.

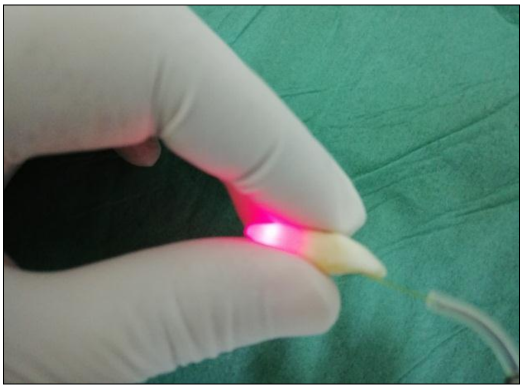

Fig 1: Removing of smear layer using ER: YAG Laser

G2 (n= 20): XP-endo Finisher file, 5 mL NaOcl 5.25% and agitated with XP-endo Finisher file that set on speed 800 rpm and torque 1, inserted 1 mm from the working length for 1 min, then canals were prepare mechanically by After agitation procedure, specimens of all groups were irrigated with 5 mL distilled water and dried with paper point.

G3 (n=20) we don't remove the smear layer and the teeth were only irrigated by 5 mL NaOcl 5.25% then we dried the canals with paper point.

The teeth were obturated using gutta percha and AD SEAL Sealer, and then left in wet environment until hardened. The external root surface was painted with two layers of nail polish except the most apical 2mm. The apical part was immersed in methylene blue for 24 hours. The apical sealing was measured by endoscope after making longitudinal sections.

Fig 2: Painted the external root surface with two layers of nail polish except the most apical 2mm

The experimental teeth were sectioned longitudinally using a low-speed Isomet diamond saw (Buehler Ltd., Lake Bluff, NY) in a direction approximately parallel to the long axis of the tooth and through the apex. After cutting, the specimens were examined under a endoscope (x15) magnification. The distance from the end of the root filling to the end point of dye penetration was measured and recorded in millimeters according to the following standard.

1. No penetration of the dye
2. Penetration of the dye toward the coronal direction for 0.5 mm.
3. Penetration of the dye toward the coronal direction for 1mm.
4. Penetration of the dye toward to coronal direction for 2mm.
5. Penetration of the dye toward to coronal direction more than 2mm.

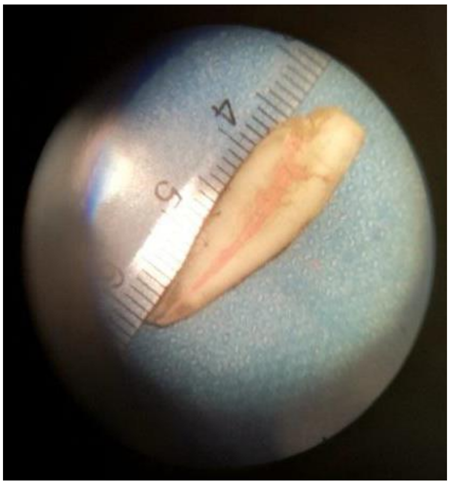

Fig 3: Sample from Group 1 (ER: YAG Laser) exhibiting no evidence of apical microleakage

Fig 4: Sample from Group 2 (Xp Endo Finisher) exhibiting apical microleakage

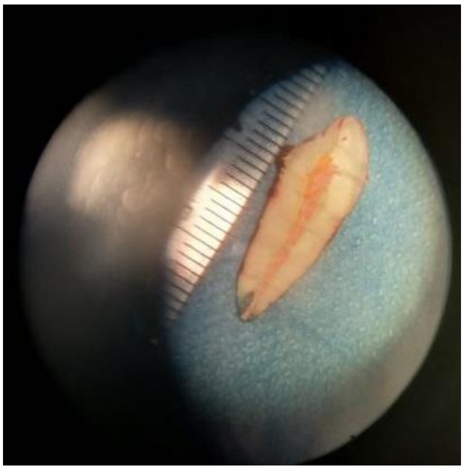

Fig 5: Sample from Group3 (control group) exhibiting apical microleakage

3. Discussion

The main goal of endodontic treatment is cleaning and preparation of root canal walls to ensure removal of necrotic and vital pulp tissue, bacteria, debris, and smear layer and prevent re- contamination of the canal [12].

The removal of smear layer is extremely important because it causes a series of undesirable effects, i.e., obstructs dentinal tubules, shelters microorganisms and does not allow close contact between the canal walls and the sealer [3].

After mechanical preparation of root canal, an amorphous, irregular layer known as the smear layer is formed on root canal walls. Possible harmful effects may occur if the smear layer is not removed during root canal treatment. The smear layer may act as a harbour for microorganisms after the instrumentation of an infected root canal space, so bacteria and bacterial by products can survive and infect the canal again [13].

Er: YAG laser was selected for this study because it promotes clean dentinal walls, no smear surfaces and open dentinal tubules [14, 15].

The helicoidal movements that were employed permitted the irradiation of the entire surface without great temperature increase [16].

The manufactures of XP-endo Finisher files are dependent on the shape-memory principles of the NiTi alloy. The file is straight in its martensitic phase which is formed when it is cooled. When the file is subjected to the body temperature (the canal) it will convert its shape because of its shape-memory to the austenitic phase. It has been claimed by the manufacturer that the austenitic phase shape in the rotation mode permits the file to contact and clean areas that are otherwise difficult to reach with regular instruments. Even though neither the smear layer was not completely removed nor the dentinal tubules opened clearly compared with cavitation effect formed by laser activated irrigation [17].

The findings There was no statistical difference between the Xp Endo Finisher file system (group 2) and the ER: YAG Laser (group 1) And the teeth that we removed smear layer in it with ER: YAG (group 1) and XP Endo Finisher (group 2) achieved better apical sealing than teeth with smear layer not removed (group 3) Can be attributed to high efficiency of both Er: YAG laser and Xp Endo Finisher file system in removing of smear layer wich cause best adaptation of gutta perca and sealer with root canal walls and that in Agreement with Živković, Nešković *et al*. Bao, Shen *et al*. and Ihab, Roshdy *et al*. Who found XP-endo Finisher is rotary NiTi file without taper which with efficient irrigation in instrumented canals can remove smear layer and dentin debris from inaccessible areas [18, 19, 20].

And with Grinkevičiūtė, Povilaitytė *et al*. and Reza, Mohsen *et al*. Who found that laser systems can have a positive effect on the ability of irrigation solutions to remove the smear layer [21, 22].

Our findings disagreement with the results of Azimian, Bakhtiar *et al*. study who showed that Xp Endo Finisher combined with NaOCl solution alone had lower efficacy for smear layer removal [5].

This difference may be due to the volume, concentration or frequency of use of irrigating solutions.

And we disagreement with Medina, Souza-Neto *et al*. who found The Er: YAG laser irradiation applied to the root canal walls was not able to prevent apical microleakage [23].

4. Conclusion

According to the outcomes of the study both XP-endo Finisher and ER-YAG Laser achieved better apical sealing and showed promising results regarding removal of smear layer and dentin debris.

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