Original Article ISSN (O):2395-2822; ISSN (P):2395-2814

Comparison of Diode Laser with Maleic Acid and Ethylenediaminetetraacetic Acid on Smear Layer Removal from Root Canals: A Scanning Electron Microscope Study.

Shahnaz Nabi[1], Ajaz Masoodi[1], Riyaz Farooq[1], Aamir Rashid[1], Fayaz Ahmed[1]
[1]Department of Conservative Dentistry & Endodontics, Govt. Dental College and Hospital, Shireen Bagh, Srinagar, India.

Received: September 2018
Accepted: October 2018

ABSTRACT

Background: Aim: To evaluate the effect of diode laser with maleic acid and ethylenediaminetetraacetic acid (EDTA) on the smear layer removal from root canals. **Methods**: A total of 160 mandibular premolars were decoronated to working the length of 12 mm and prepared with protaper gold rotary files up to size F3. Group 1 canals irrigated with 1 ml 17% EDTA followed by 3 ml of 3% NaOCl. Group 2 canals were initially irrigated with 0.8 ml of 17% EDTA the remaining 0.2 ml was used to fill the root canals, and diode laser application was done. Group 3 canals were irrigated with 1 ml of 7 % maleic acid followed by 3 ml of 3% NaOCl. Group 4 canals were irrigated with .8 ml of maleic acid and remaining .2 ml was used to fill canal and activated by diode laser followed by 3% NaOCl. Scanning electron microscope examination of canals was done for remaining smear layer at coronal middle and apical third levels. **Results**: Maleic acid with and without diode laser had the least smear layer scores. **Conclusion**: Diode laser with maleic acid performed significantly better than EDTA.

Keywords: Diode laser, ethylenediaminetetraacetic acid, maleic acid, root canal irrigants, scanning electron microscope.

INTRODUCTION

The basic aim of root canal treatment is to clean and disinfect the root canals as thoroughly as possible and to eliminate debris and microorganisms to achieve perfect obturation and hermetic seal without leakage. However, during preparation and instrumentation of the root canals, an amorphous, irregular layer is formed on the root canal walls smear layer. Various chemicals, ultrasonics, and lasers, in combination or alone, have been evaluated for the removal of the smear layer with varying results.[1-3] Sodium hypochlorite (NaOCl), 1–5.25% concentration as an irrigant is widely used in root canal treatment as it is bactericidal and has the ability to dissolve organic tissues but noneffective in removing the smear layer.[4,5] Decalcifying solutions used for removing the smear layer include phosphoric acid, citric acid, maleic acid, ethylenediaminetetraacetic acid (EDTA), and MTAD (a mixture of tetracycline isomer, an acid, and a detergent).[6,7] Lasers have also been used to remove the smear layer such as argon laser,[8] neodymium doped yttrium aluminum garnet,[9] CO2 laser,[10] erbium doped yttrium aluminum garnet,[3] and diode.[11] Maleic acid is used as an acid conditioner in adhesive dentistry.[12] This mild organic acid is found to remove smear layer from the surface of teeth.[13] Ballal et al. have shown that smear layer removal from the apical third of the root canal was performed better using 7% maleic acid than EDTA.[14] Currently, a final irrigation sequence with a chelating agent EDTA and NaOCl is being used to remove the inorganic and organic components of the smear layer.[15] This study evaluates the efficacy of smear layer removal from the root canals using diode laser with EDTA and maleic acid during endodontic therapy.

Name & Address of Corresponding Author
Dr. Shahnaz Nabi
Department of Conservative Dentistry & Endodontics, Govt. Dental College and Hospital, Shireen Bagh, Srinagar, India

MATERIALS AND METHODS

A total of 160 adult human noncarious mandibular premolars were taken for the study. Inclusion criteria included single rooted teeth with straight, patent roots, and fully formed apices. Extraction for periodontal or orthodontic reasons. Standard radiographs were taken in a buccolingual and

mesiodistal direction of each tooth after being held in a custom made jig to determine whether or not the sampled tooth conforms to the selection criteria adopted for the study.

Sample preparation

The teeth were stored in 10% formalin solution till they were used for the study. The root surfaces were cleaned and then decoronated using a diamond disc under water irrigation to obtain a standardized root length of 12 mm. After standardization, the working length of specimens was determined by deducting 1 mm from the length of the #10/#15 K-file after it was passively placed in the canal until the tip of the instrument visibly penetrated the apical foramen. Apices of the roots were sealed with sticky wax to simulate the clinical conditions and root canal instrumentation was initiated with ISO hand files up to #20 followed by ProTaper gold rotary files up to size F3(Dentsply/Tulsa Dental, Tulsa, OK, USA). Two milliliter of 3% NaOCl(KMC Pharmacy, Manipal, Karnataka, India) was used as an irrigant after every instrument change. The irrigants were delivered with a disposable syringe and a 30-gauge Max-I-Probe needle placed 1 mm short of the working length. Finally, 3 ml of 3% NaOCl was used to flush out the debris from the root canals followed by a rinse with 3 ml of distilled water to terminate any action of the solvents remaining in the canal. A constant total volume of 15 ml of NaOCl was used as irrigant for each root canal during the study.

Grouping of samples

After biomechanical preparation, the samples were divided into six different groups of twenty specimens each.

Group 1 [EDTA] – Root canals were irrigated with a final flush of 1 ml of 17% EDTA for 1 min followed by 3 ml of 3% NaOCl

Group 2 [diode + EDTA] – The root canals were initially irrigated with 0.8 ml of 17% EDTA for 40 s; the remaining 0.2 ml was used to fill the root canals, and diode laser application was done for 20s

Group 4 [maleic acid] – The root canals were irrigated with 1 ml of 7% maleic acid, followed by 3 ml of 3% NaOCl

Group 5 [diode + maleic acid] - The root canals were irrigated with a final flush of .8 ml of maleic acid and remaining .2 ml was kept in canal and activated by diode laser, followed by 3 ml of 3% NaOCl. The root canals were finally flushed with 5 ml of distilled water to terminate the action of the irrigating solutions dried and prepared for scanning electron microscope (SEM) examination.

Scanning microscope examination

The teeth were grooved along the buccal and lingual planes by using a diamond disc at low speed. The roots were then split longitudinally with a bi-beveled chisel and a mallet. One-half of each root was selected depicting the entire root canal length and prepared for SEM examination. The selected samples were progressively dehydrated using graded concentrations of aqueous ethanol (70%, 80%, 90%, and 100%) for 24 h at each concentration. After dehydration, samples were placed in a vacuum chamber and sputter coated with a 30 nm gold layer. The dentinal wall of the root canals was examined at coronal, middle, and apical thirds at a magnification of ×1000 for the presence or absence of smear layer and patency of dentinal tubules. Photomicrographs of the root canals were taken at coronal, middle, and apical level for scoring individually in a calibrated single blind manner according to the rating system developed by Gutmann et al.[16]

Score Criteria	Gutmann rating system for remaining smear layer scores
1	Little or no smear layer; covering<25% of the specimen; most tubules were visible and patent, or almost complete laser melting
2	2 Little to moderate or patchy mounts of smear layer; covering 25–50% of the specimen; many tubules visible and patent, or laser melting
3	Moderate amounts of scattered of aggregated smear layer; covering 50–75% of the specimen; minimal to no tubule visibility or patency, or scattered laser melting
4	Heavy smear layer covering>75% of the specimen; no tubule orifices were visible or patent; or no visible laser melting

Data were analyzed using one-way analysis of variance using the SPSS version 20 (IBM Corp, Armonk, NY, USA) and post hoc tests ($P < 0.05$).

RESULTS

At the coronal third level: Group 3 followed by Group 4 had the least smear layer scores with no significant difference between them. This was followed by Group 2 and Group 1 with significant difference between group 3 and group 1. At the middle third level: Group 3 followed by Group 4 had the least smear layer scores with significant difference between group 3 and group 1. This was followed by Group 2 and Group 1 with significant difference between them. The highest smear layer scores were for Group 1 and Group 2, respectively [Table 1]. At the apical third level: The lowest smear layer scores were for Group 3 followed by Group 4, Group 2, and Group 1, respectively, with significant difference between them [Table 2].

DISCUSSION

The outcome of this research revealed that 7% maleic acid was better in the removal of smear layer than 17% EDTA and diode laser combination in the coronal, middle and apical thirds of the root

canal with a significant difference. In the middle third, both maleic acid and EDTA diode combination were equally effective without any statistical difference between them. This is in agreement with other studies.[17,18] A larger canal diameter in the coronal and middle third exposes the dentin to a higher volume of irrigants, allowing a better flow of the solution and hence, improving the efficacy of smear layer removal.[19] In Group 2 and group 4, the choice for the power 1.5 watts in CW parameter settings used in this study was based on the results of study by Alfredo et al.,[20] who demonstrated that these parameters yielded a temperature rise approximately 10°C, which does not exceed the limit supported by the periapical tissues.[21] Twenty seconds time application was used according to the study by Marchesan et al.[22] In Group 2 and group 4, the smear layer was removed from the root canals; the dentinal tubules were obliterated mostly at the middle and apical level. The results were similar to the study of Faria et al.[23] who found absence of smear layer and partially obliterated dentinal tubules after application of 980 nm diode laser on root canals irrigated with 1% NaOCl plus 17% EDTA.

In Group 1, the root canal surfaces were clean and free of smear layer in the coronal and middle third, whereas the apical third showed scattered areas with smear layer. No significant difference in smear layer scores was recorded at the coronal and middle levels; however, higher smear layer scores were recorded at the apical level which was not significant in comparison to coronal third. The results were statistically non significant in comparison to Group 3 and Group 4.[24] The combination of diode and EDTA and diode maleic acid performed better than EDTA, alone in removing smear layer suggesting that the incorporation of diode laser with EDTA might prove beneficial in increasing the ability of EDTA to remove the smear layer by enhancing its interaction with the root canal walls particularly in the apical regions. The diode laser used alone proved to be effective than EDTA in the apical regions in removing the smear layer; however, the difference was not significant. The outcome of this research revealed that 7% maleic acid was better in the removal of smear layer than 17% EDTA and diode laser combination. This might be related to the differences in surface tension between 17% EDTA (0.0783 N/m) and 7% maleic acid (0.06345 N/m).[23] EDTA is a chelating agent effective. At a neutral pH and thus is independent of a high hydrogen ion concentration to cause decalcification. A decrease in pH in dentin is due to the exchange of calcium by hydrogen which is responsible for a reduced efficacy of EDTA over time.[25] Maleic acid has a better demineralizing effect within a shorter period as it is highly acidic.

CONCLUSION

The removal of smear layer is deemed as an important area for the complete disinfection of the root canal system. Within the limitations of the current study, all the tested groups were able to remove the smear layer from the prepared root canals to different degrees. Maleic acid alone or with diode laser showed significantly better smear layer removal than ethlenediaminetetraacetic acid alone. Diode laser could be a good addition to the armamentarium used for smear layer removal and along with its bactericidal effects on the root canal microbes could increase the success rate of endodontic therapy. 7% maleic acid as a final irrigant is highly efficacious for the removal of smear layer when used in the apical third of the root canal system.

REFERENCES

1. Baumgartner JC, Mader CL. A scanning electron microscopic evaluation of four root canal irrigation regimens. J Endod 1987;13:147-57.
2. Cameron JA. The use of ultrasonics in the removal of the smear layer: A scanning electron microscope study. J Endod 1983;9:289-92.
3. Takeda FH, Harashima T, Kimura Y, Matsumoto K. Efficacy of Er:YAG laser irradiation in removing debris and smear layer on root canal walls. J Endod 1998;24:548-51.
4. Yamada RS, Armas A, Goldman M, Lin PS. A scanning electron microscopic comparison of a high volume final flush with several irrigating solutions: Part 3. J Endod 1983;9:137-42.
5. Prati C, Selighini M, Ferrieri P, Mongiorgi R. Scanning electron microscopic evaluation of different endodontic procedures on dentin morphology of human teeth. J Endod 1994;20:174-9.
6. Wayman BE, Kopp WM, Pinero GJ, Lazzari EP. Citric and lactic acids as root canal irrigants in vitro. J Endod 1979;5:258-65.
7. Aktener BO, Bilkay U. Smear layer removal with different concentrations of EDTA-ethylenediamine mixtures. J Endod 1993;19:228-31.
8. Harashima T, Takeda FH, Zhang C, Kimura Y, Matsumoto K. Effect of argon laser irradiation on instrumented root canal walls. Endod Dent Traumatol 1998;14:26-30.
9. Dederich D, Zakariasen K, Tulip J. Scanning electron microscopic analysis of root canal wall dentin following neodymium-yttrium aluminium-garnet laser. J Endod 1984;10:428-31.
10. Onal B, Ertl T, Siebert G, Müller G. Preliminary report on the application of pulsed CO2 laser radiation on root canals with AgCl fibers: A scanning and transmission electron microscopic study. J Endod 1993;19:272-6.
11. Wang X, Sun Y, Kimura Y, Kinoshita J, Ishizaki NT, Matsumoto K. Effects of diode laser irradiation on smear layer removal from root canal walls and apical leakage after obturation. Photomed Laser Surg 2005;23:575-81.
12. Wieczkowski G Jr., Yu XY, Davis EL, Joynt RB. Microleakage in various dentin bonding agent/composite resin systems. Oper Dent 1992;5:62-7.
13. Ballal NV, Mala K, Bhat KS. Evaluation of decalcifying effect of maleic acid and EDTA on root canal dentin using energy dispersive spectrometer. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011;112:e78-84.

14. Ballal NV, Kandian S, Mala K, Bhat KS, Acharya S. Comparison of the efficacy of maleic acid and ethylenediaminetetraacetic acid in smear layer removal from instrumented human root canal: A scanning electron microscopic study. J Endod 2009;35:1573-6.
15. Hülsmann M, Heckendorff M, Lennon A. Chelating agents in root canal treatment: Mode of action and indications for their use. Int Endod J 2003;36:810-30.
16. Gutmann JL, Saunders WP, Nguyen L, Guo IY, Saunders EM. Ultrasonic root-end preparation. Part 1. SEM analysis. Int Endod J 1994;27:318-24.
17. Torabinejad M, Khademi AA, Babagoli J, Cho Y, Johnson WB, Bozhilov K, et al. A new solution for the removal of the smear layer. J Endod 2003;29:170-5.
18. Mancini M, Armellin E, Casaglia A, Cerroni L, Cianconi L. A comparative study of smear layer removal and erosion in apical intraradicular dentine with three irrigating solutions: A scanning electron microscopy evaluation. J Endod 2009;35:900-3.
19. Teixeira CS, Felippe MC, Felippe WT. The effect of application time of EDTA and NaOCl on intracanal smear layer removal: An SEM analysis. Int Endod J 2005;38:285-90.
20. Alfredo E, Silva SR, Ozório JE, Sousa-Neto MD, Brugnera-Junior A, Silva-Sousa YT. Bond strength of AH plus and epiphany sealers on root dentine irradiated with 980 nm diode laser. Int Endod J 2008;41:733-40.
21. Eriksson AR, Albrektsson T. Temperature threshold levels for heat-induced bone tissue injury: A vital-microscopic study in the rabbit. J Prosthet Dent 1983;50:101-7.
22. Marchesan MA, Junior AB, Gabriel AE, Silva SR, Neto MD. Ultrastructural analysis of root canal dentine irradiated with 980-nm diode laser energy at different parameters. Photomed Laser Surg 2008;26:235-40.
23. Faria MI, Souza-Gabriel AE, Alfredo E, Messias DC, Silva-Sousa YT. Apical microleakage and SEM analysis of dentin surface after 980 nm diode laser irradiation. Braz Dent J 2011;22:382-7.
24. Walmsley AD, Williams AR. Effects of constraint on the oscillatory pattern of endosonic files. J Endod 1989;15:189-94.
25. Abbott PV, Heijkoop PS, Cardaci SC, Hume WR, Heithersay GS. An SEM study of the effects of different irrigation sequences and ultrasonics. Int Endod J 1991;24:308-16.

How to cite this article: Nabi S, Masoodi A, Farooq R, Rashid A, Ahmed F. Comparison of Diode Laser With Maleic Acid and Ethylenediaminetetraacetic Acid on Smear Layer Removal From Root Canals: A Scanning Electron Microscope Study. Ann. Int. Med. Den. Res. 2018; 4(6):DE12-DE15.

Source of Support: Nil, **Conflict of Interest:** None declared