

Comparison of the cleaning efficacy of conventional syringe irrigation, Endovac and Laser in removing smear layer from the root canal wall using scanning electron microscope: An in vitro study.

Shilpa Shrivastava¹, Pradnya Nikhade², Manoj Chandak³, Gaurav Tibdewal⁴

1. Post graduate student, department of conservative dentistry and endodontics, Sharad Pawar Dental College

2. Professor, department of conservative dentistry and endodontics, Sharad Pawar Dental College Sawangi

3. Professor and Head of the department, department of conservative dentistry and endodontics, Sharad Pawar Dental College, Sawangi,

4. Senior Lecturer, department of conservative dentistry and endodontics, Sharad Pawar Dental College

Abstract: Introduction-Debridement is the aim of and also a big challenge to endodontic treatment especially in the apical portion of the root canal. Because of the complexity of the root canal anatomy and the limitations of instrumentation, irrigation has gained increasing attention and one improvement in this respect is irrigant activation. The aim of this study is to compare the cleaning efficacy of conventional syringe irrigation, Endovac and Laser in removing smear layer from the root canal wall using scanning electron microscope. Material and method-30 single rooted premolar teeth with root length 17mm were decoronated and root canals were instrumented using crown-down technique and three groups were assigned. Group 1-Irrigation activation with conventional syringe, Group 2-Irrigation activation with LASER Device, Group 3 irrigation activation with Endovac. Results & Statistical Analysis,—data analysis was done by Kruskal-Wallis statistical test and Mann Whitney U-test at significance level of $P \leq 0.05$ which was found to be 0.04 at apical third. Conclusions It could be concluded that the apical negative pressure system (EndoVac) used in the study is significantly more effective than the Conventional syringe irrigation and Diode Laser in removal of smear layer in apical third.

Key words: Endovac, Irrigation Activation, Laser, smear layer, sodium hypochlorite

I. Introduction

Debridement is the aim of and also a big challenge to endodontic treatment especially in the apical portion of the root canal. Because of the complexity of the root canal anatomy and the limitations of instrumentation, irrigation has gained increasing attention and one improvement in this respect is irrigant activation.⁽¹⁾

There are various methods to activate the irrigant, ranging from moving gutta percha cones up and down in the root canal (MDA) to instruments energized by sonic or laser devices.⁽¹⁾

Conventional irrigation with syringes has been advocated as an efficient method of irrigant delivery before the advent of passive ultrasonic activation. This technique is still widely accepted by both general practitioners and endodontists. The technique involves dispensing of an irrigant into a canal through needles/cannulas of variable gauges either passively or with agitation. The latter is achieved by moving the needle up and down the canal space. Some of these needles are designed to dispense an irrigant through their most distal ends, whereas others are designed to deliver an irrigant laterally through closed-ended side vented channels.⁽²⁾

Combination of syringe irrigation to deliver the irrigant and various ways to activate it are applied mainly as final irrigation after root canal instrumentation is completed.⁽²⁾

The EndoVac system (Discus Dental, Culver City, CA) is a novel new irrigation system. A delivery/evacuation tip is attached to a syringe of irrigant and the high speed suction of the dental chair. A small tube attaches either a macro- or microcannula to the suction. The delivery/evacuation tip places irrigant in the chamber and siphons off the excess to prevent overflow. The macrocannula is plastic with an open end that measures International Standards Organization (ISO) size 55 with a .02 taper. The microcannula is stainless steel and has 12 small, laterally positioned, offset holes in 4 rows of 3, with a closed end measuring ISO size 32. As these cannulas are placed in the canal, negative pressure pulls irrigant from a fresh supply in the chamber, down the canal to the tip of the cannula, into the cannula, and out through the suction hose.⁽³⁾

With the introduction of lasers to the field of conservative dentistry, endodontic treatment was enriched by multitude of new treatment methods that improved the shown to be feasible and effective tools for cleaning and disinfecting the root canal system, particularly because they helped to overcome the problem of insufficient depth of penetration of commonly used disinfecting agents⁽⁴⁾. The effects of laser irradiation on dental hard

tissues may cause chemical, thermal, and / or mechanical changes. The latter effect is useful in removing carious dentin, while melting of dentin can seal the dentinal tubules and alleviate pain in cases of dentinal hypersensitivity⁽⁵⁻⁸⁾.

With the great progresses in the field of laser technology, semiconductor lasers such as diode laser are gaining increasing importance. The diode laser can achieve an output power of several watts and shown to be highly reliable and effective; the diode laser can be recommended for endodontic treatment because its wave length of 980nm which is within the infrared range, it is also have thin, flexible light-conductor fiber. Both Diode laser and Nd:YAG laser are equally effective and can be used as alternatives in medicine^(9,10).

Studies of the morphological changes of root canal wall after irradiation with diode laser proved that, the diode laser is useful for removing smear layer and debris from root canal walls, and reducing apical leakage after obturation in vitro and suggest that it would be useful for root canal treatment in clinic^(4,11,12).

The purpose of this study is to Compare the cleaning efficacy of conventional syringe irrigation ,Endovac and Laser in removing smear layer from the root canal wall using scanning electron microscope.

II. Methods and Materials

A sample of 30 single rooted premolar teeth extracted for periodontal and orthodontic reasons will be used in the study. Inclusion criteria was permanent teeth, with intact apices, no previous endodontic treatment and small restoration. Exclusion criteria was root length shorter than 17 mm, extensive restoration, root caries, cracks and fracture. Specimens were decoronated by diamond disc and working length was determined 1 mm short of apex. Root canals were instrumented using crown-down technique with Protaper nickel-titanium (NiTi) rotary (Dentsply — Tulsa Dental, York, PA) F2 to working length. During instrumentation, irrigation will be done with 1 ml of 5.0% NaOCl. Upon completion of canal preparation, apexes were sealed with wax to prevent extrusion during final irrigation. The groups were assigned as:

Group 1- Irrigation activation with conventional syringe-

Two milliliters of irrigant (6% NaOCl) was delivered by using a 10-mL syringe with a 30-gauge needle (Dispovan, India) placed 1 mm from Working Length in 20 seconds. This process was repeated thrice, resulting in a total irrigant volume of 6 mL and a total irrigant delivery time of 60 seconds. Needle was moved Up and down motion in the canal from 5mm short of Working Length to actual working length .The process was repeated thrice such that Total irrigant delivered is 6ml. Total irrigant delivery time 60 seconds. Total irrigant activation 30 seconds.

Group 2 - Irrigation activation with LASER Device

Irrigant was delivered inside the canal similar to group1. Endodontic fibre was inserted in canal and irrigant is activated such that Total irrigant delivered 6ml. Total irrigant delivery time 60 seconds .Total irrigant activation time 30 seconds .

Group 3 –Irrigation activation using ANP, EndoVac Group

6 ml 5.25 % NaOCl of solution is delivered using master delivery tip located at orifice ensuring continuous irrigant supply for 60 seconds. microcannula (#32/.00) was used at working length -1mm consecutively.

Sample preparation-Each root was longitudinally sectioned with diamond disk and number 15 blade into mesial and distal part and kept for 24 hrs in incubator. Only one part, i.e., either mesial or distal half was chosen for Scanning electron microscope analysis. The halved specimen was dried ,mounted on scanning electron microscopic stubs ,gold sputtered and evaluated in scanning electron microscope at low (x10 and x15) and high (x500 and x2000) magnifications at the apical ,middle coronal levels. The amounts of debris and smear layer on the canal walls were rated using the scoring criteria , as described by Mayer et al⁽¹³⁾

Score 1 - All dentinal tubules are open and no smear layer is present.

Score 2 - Some dentinal tubules are open and others covered by thin smear layer.

Score 3 - A few dentinal tubules are open and others covered by thin homogenous smear layer.

Score 4 - All dentinal tubules are covered by a homogenous smear layer without any open tubules visible.

Score 5 - Thick homogenous layer completely covering the canal walls.

Overall assessment was done involving coronal, middle and apical portion. When disagreement in scoring occurred, additional analysis was performed with three observers together until a consensus was reached.

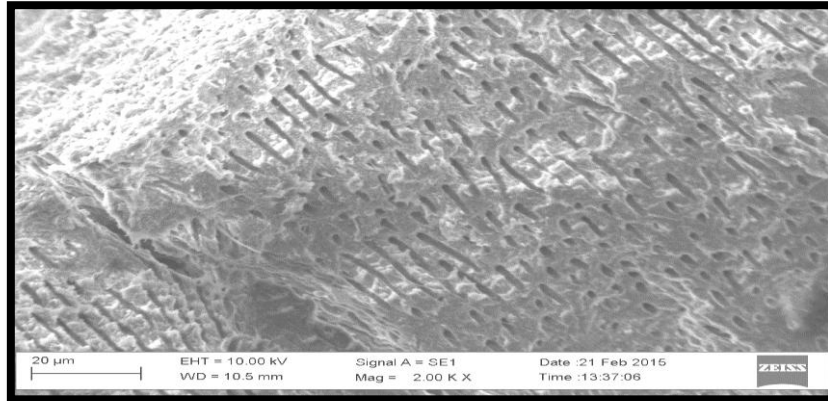
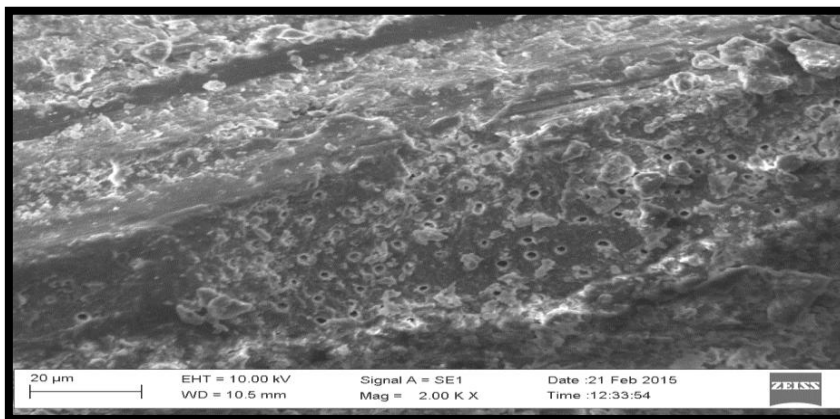
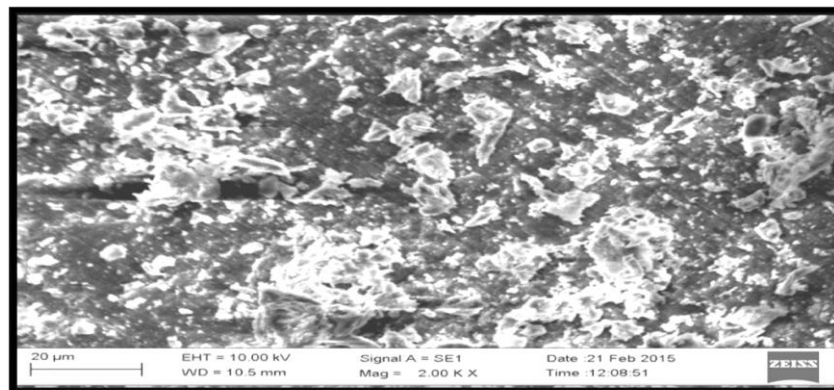


Figure 1 – Scanning electron microscope view of apical third with Endovac at 2000x



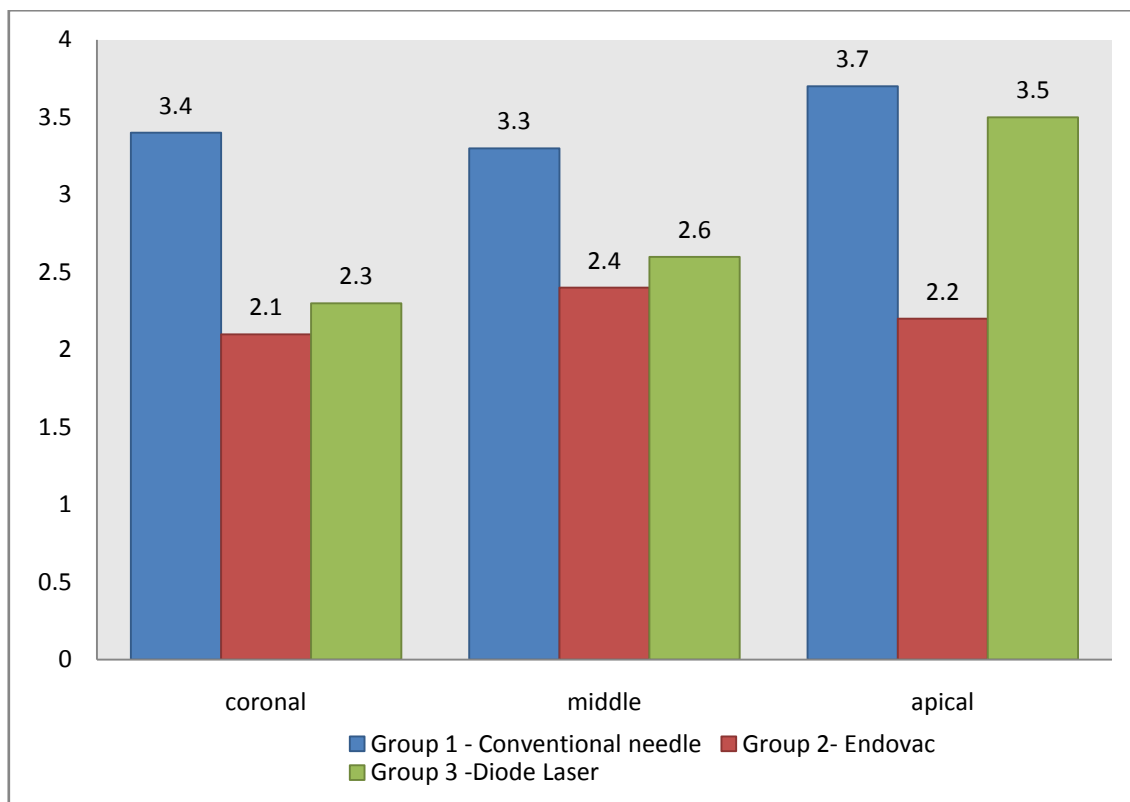
Scanning electron microscope view of apical third with Laser irrigation at 2000x



Scanning electron microscope view of apical third with Conventional syringe irrigation at 2000x

Statistical Analysis

Ordinal data was analysed by Kruskal-Wallis statistical test and Mann Whitney U-test at significance level of $P \leq 0.05$. Significant result was obtained at apical third which was 0.04



III. Results

Endovac provides the most successful results in dentin debris removal from the root canal wall, Laser and syringe irrigation were effective in coronal third, and middle third. The cleaning efficacy of Endovac was greater in apical third than Laser and Conventional syringe irrigation.

IV. Discussion

The smear layer is a combination of organic and inorganic debris present on the root canal after instrumentation; this layer has been described as being superficial on the dentinal surface and has been packed into the dentinal tubules. Biologically, the presence of

the smear layer has been postulated to be an avenue for leakage and a source of substrate for bacterial growth and ingress.

Sodium hypochlorite is the most widely used chemical solution in the biomechanical preparation of the root canal system^[14] However, despite its excellent antimicrobial activity

and capacity of dissolving organic materials, this solution alone does not effectively remove the smear layer^[14,15] The association of EDTA and NaOCl solutions has proven to be

effective in removing the smear layer^[16] EDTA acts upon the inorganic components of the smear layer while NaOCl dissolves the collagen, leaving the entrances to the dentinal

tubules more open and exposed. Studies have shown that the use of a high- volume final flush with 17% EDTA followed by NaOCl effectively removes the smear layer^[17] However, none of the irrigants with the conventional irrigation system are effective in cleaning the apical one- third of the root canal^[18]

Various irrigation systems have been developed that claim to work effectively in the apical third of the root canal^[19] In the current study, root canal instrumentation was performed with rotary nickel-titanium instruments that create a significant smear layer and hence are more challenging for irrigation systems. The results of this study showed that the EndoVac system produced significantly cleaner canals at 1 mm from working length compared with the conventional needle and syringe. This can be attributed to the design of the EndoVac microcannula and the placement of the 12 suction holes along the side of the last 0.07 mm of the microcannula. As the apical size increases, there are decreased chances of these holes contacting the root canal wall and becoming blocked. The larger area surrounding the microcannula also allows for increased volume of irrigant to the microcannula tip and a resulting increase in volume^[20] Another factor that supports the better cleaning efficacy of EndoVac in the apical 1 mm when compared with the conventional needle and syringe, is the vapor lock effect. The presence of apical vapor lock created by the organic decomposition of NaOCl into a bubble of carbon dioxide and ammonium adversely affects debridement efficacy when using a positive pressure system^[21] In the closed system, irrigant extrusion beyond 1-1.5 mm of a side- venting needle could generate a

liquid film along the air bubble–canal wall interface^[22] The fluid stagnation in this “dead water zone” (apical area where the solutions are not exchanged by irrigation) fails to provide adequate irrigant replacement, resulting in gross debris retention in this region. Also, irrigation with an acidic or calcium chelating agent creates a demineralized collagen matrix on the surface of the radicular dentin on removal of the smear layer

Lasers emitting wavelengths in the infrared region have been proposed for various dental hard tissue applications because Enamel, dentin, and cementum contain hydroxyapatite, which has absorption bands in the infrared region (9.0 through 11.0 μm) due to the presence

of phosphate, carbonate, and hydroxyl groups in the crystal structure^(23,24,25). The wave length of diode laser is within the infrared range, it is also have thin, flexible light- conductor

fiber so it can be recommended for endodontic treatment⁽²⁶⁾. It has the same effect as Nd:YAG laser and can be used as alternatives in medicine^(27,28).

EndoVac irrigation system showing better debridement than conventional needle irrigation at the apical level of root canal. Our study showed that the EndoVac irrigation system is an effective root canal irrigation system for the removal of intracanal smear layer in the apical area. Nevertheless, these *in vitro* results cannot be extrapolated to *in vivo* situations.

Hence, further research is required and more *in vivo* studies need to be performed to evaluate this method of irrigation.

V. Conclusion

Within the limitations of the present study, it could be concluded that the apical negative pressure system (EndoVac) used in the study is significantly more effective than the Conventional syringe irrigation and Diode Laser in removal of smear layer in apical third.

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