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COMPARATIVE EVALUATION OF THE EFFECT OF SMEAR LAYER REMOVAL WITH EDTA AND ND: YAG LASER ON THE APICAL MICRO LEAKAGE OF TWO EPOXY RESIN BASED ROOT CANAL SEALERS - AN INVITRO STUDY.

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ABSTRACT:

Aim: To compare the effect of smear layer removal with 17% EDTA and Nd:YAG laser on the apical microleakage of two resin based sealers.

Materials and Methods: Sixty freshly extracted maxillary central incisor teeth with patent canals were selected. The teeth were debrided and stored in saline for 24 hours before use. The teeth were sectioned at CEJ & cleaning and shaping were done upto 50 size by step back technique. The following groups were analyzed.

GROUP 1: Gutta percha (GP) + AH plus sealer without smear layer removal.

GROUP 2: GP + RC seal sealer without smear layer removal.

GROUP 3: GP + AH plus treated with 17% EDTA.

GROUP 4: GP + RC seal treated with 17% EDTA.

GROUP 5: GP + AH plus treated with Nd:YAG laser. GROUP 6: GP + RC seal treated with Nd:YAG laser.

8 samples were subjected to dye penetration study for apical microleakage & 2 samples were subjected to SEM in each group to show the effect of smear layer removal by EDTA and laser.

The data were analyzed by using ANOVA and TUKEY-HSD test.

Results: Groups 1 and 2 showed maximum microleakage , other groups showed lesser microleakage but there was no statistically significant difference between laser and EDTA treated Groups.

Conclusion: EDTA and Nd:YAG laser can be effectively used to remove smear layer and showed less apical microleakage compared to non-treated groups.

Keywords: 17% EDTA, Nd:YAG LASER , AH plus , RC sealer , Smear layer.

Introduction

The prime objective of root canal therapy is to remove the organic, inorganic substances and microorganisms to achieve a perfect seal to the periapical region. The necessity to provide a perfect seal at the apical region and filling of

accessory canals had brought many changes in materials used as sealers. A smear layer which is formed during instrumentation consists of inorganic debris , organic components such as pulp tissue remnants, odontoblastic processes, saliva , blood cells and microorganisms5.

During obturation , a root canal sealer is necessary for the GP to bind with the canal walls. Several studies have shown that the penetration of root canal sealers into the dentinal tubules and its adhesion to the canal walls is prevented by the smear layer and affects the efficacy of obturation14,18 . So, it becomes important to use an effective chelating agent like 17% EDTA to remove the smear layer for better adhesion of filling materials to the canal walls18,20,21.

The advent of laser irradiation has been used to remove smear layer. Laser light is monochromatic, coherent and collimated. When laser energy strips the tissue , it may be absorbed by it, scattered within it or reflected The laser beam can be adjusted to vary the power , the size of the focal point enabling the beam to cut vaporize or coagulate the tissue. It may be pulsed, incrementally activated for a micro second or act continously13.

The purpose of this study is to evaluate the effect of smear layer removal with EDTA and Nd: YAG laser on the apical micro leakage of two resin based sealers.

MATERIALS AND METHODS:

Sixty freshly extracted maxillary central incisors with patent canals devoid of any deformity confirmed by the radio graphs were selected for the study . The teeth were kept in 5.25% sodium hypochlorite for 30 minutes to remove soft debris , organic tissue and stored in normal saline for 24 hours before use.

METHODOLOGY:

The teeth were sectioned at the CEJ and patency of the canals were confirmed by passing a 10 K-file. The working length was determined and coronal portion flared with gates glidden burs and canals were prepared with K-files using step back technique upto 50size. The canals were irrigated thoroughly with 5.25% Sodium hypochlorite during instrumentation.

The teeth were randomly categorized into six groups of 10 each.

GROUP 1: Obturation with GP and AH plus sealer without treatment for smear layer removal (control group).
GROUP 2: Obturation with GP and RC seal sealer without treatment for smear layer removal (control group).
GROUP 3: Smear layer removal with EDTA and Obturation with GP and AH plus.
GROUP 4: Smear layer removal with EDTA and obturation with GP and RC seal. GROUP 5: Smear layer removal with Nd:YAG laser and obturation with GP and AH plus.
GROUP 6: Smear layer removal with Nd:YAG laser and obturation with GP and RC seal.

In Groups 1 and 2 which were used as a control group, the respective sealers were mixed according to manufacturers instructions and canals were obturated without removal of smear layer.

In Groups 3 and 4 , the canals were irrigated with 17% EDTA for 3 minutes to remove the smear layer. The canals were obturated with respective sealers.

Radiographs were taken to check for homogenous obturation. The coronal 1mm was sealed with IRM. Out of 10 samples, 8 were selected for stereo microscopic evaluation and 2 for scanning electron microscopic (SEM) evaluation.

The root samples selected for stereo microscopic study were coated with nail varnish except at apical foramen. After 24 hours drying period, a second coat of nail varnish was applied followed by a third coat 3 hours later.

DYE PENETRATION STUDY:

After the nail varnish has dried, the teeth were suspended with sticky wax from inside of the beaker lid. So that only the root tip was immersed in 2% aqueous methylene blue dye and stored for 48 hours. After that the roots were washed with running water and kept in acetone to remove the nail varnish. The specimen were split longitudinally and the linear penetration of the dye was measured with stereo microscope(Carl Zeiss, Germany) at 20X magnification.

Scoring criteria for degree of microleakage :

Score 0 - No leakage detected Score 1- Leakage < 0.5mm
Score 2- Leakage between 0.5 and 1mm Score 3 - Leakage > 1mm

SCANNING ELECTRON MICROSCOPE:

Two specimens from each group were subjected to scanning electron microscopic study. The samples were cut into longitudinal sections. The samples were dehydrated with ascending gradations of ethanol.

The samples were mounted on aluminium studs and they were placed in the JEOl-JSM- 1100 ION sputtering device. The instrument deposits a thin coating of gold evenly on the sample. The coating is essential to enhance the number of secondary electrons emitted from the surface of the sample.

The specimens were examined under a SEM (JOEL-JSM-5610LV Japan) and photomicrographs were taken at 20X magnification.

RESULT:

Based on ANOVA, there is highly significant difference between all groups.
Based on multiple range test (TUKEY HSD test), Group 1 and 2 showed significant difference with Group 3,4,5and 6.
There is no significant difference between Groups 1 and 2 and also between Groups 3, 4,5and 6. But there is significant difference between Groups 1 and 2 with Group 3, 4, 5 and 6.
The mean microleakage value for Group 1 (1.40±0.64) and Group 2 (1.67±0.49) based on ANOVA, highly significant difference was present. But, Tukey-HSD showed no significance.
The mean microleakage values for Group 3(0.43±0.29) and Group 4 (0.64±0.33) . Based on ANOVA highly significant difference was present. But Tukey-HSD showed no significance.
The mean microleakage for Group 5 (0.21±0.16) and Group 6 (0.34±0.27) . There was no significant difference between these groups, but apical leakage is very less compared to control groups.
Comparing between EDTA and laser treated groups based on ANOVA , there was statistical significance. But, Tukey-HSD proved no significance.

SCANNING ELECTRON MICROSCOPIC PHOTOGRAPHS

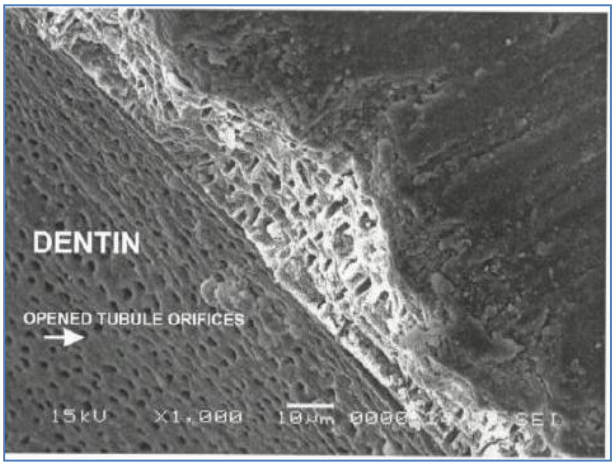

Figure 1: EDTA TREATED

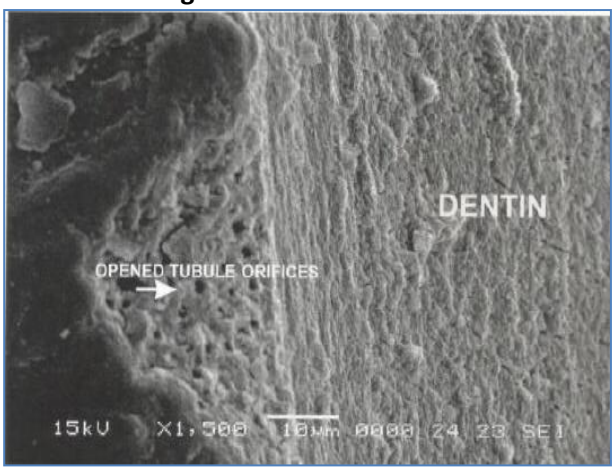

Figure 2: LASER TREATED

DISCUSSION:

A thorough debridement of the entire root canal space, obliteration of the root canal space with an inert filling material, creation of a hermetic seal and elimination of any portal of entry or exit to periapical tissues have been proposed as goals for successful endodontic treatment. The major cause for endodontic failure is inadequate obturation12 . Root canal sealers play an important role for proper binding of GP with root canal walls and to prevent apical microleakage12.

Instrumentation of the root canal produces microcrystalline debris that coats and clogs the dentinal tubules which is termed as smear layer. This was first described by McComb & Smith2. It consists of dentinal shavings, tissue debris including pulpal remnants, microbial elements and endotoxins.

Several studies have shown that smear layer is composed of two distinct layers:The first layer

covering the canal walls is thin, loosely adherent and easy to remove. The second intra dentinal layer occludes the dentinal tubules and strongly adheres to the canal walls. The thickness of smear layer varies from 10-15µm.

Michelich et al (1980) and DIAMOND and CARREL (1984) established that smear layer acts as a physical barrier to bacteria and its product. Brannstorm and Nyborg (1974) showed that bacteria and smear layer multiplies and produces toxins that damage pulp. Goldberg and Abramovich (1977) stated that smear layer prevents the penetration of intracanal disinfectants and sealers into the dentinal tubules. Gengoglu et al (1993) showed that removing the smear layer significantly reduces apical leakage obturated with GP. For these reasons, smear layer is deleterious and it should be removed for better adhesion of sealers and root canal filling materials to dentin1,20,21.

Materials used for smear layer removal are organic acids like 50% citric acid and 40% polyacrylic acid . Chelating agents are disodium ethylene diamine tetra acetic acid followed by 3 - 5% NaOCl. Nygard-Ostby was the first to suggest the use of EDTA for cleaning and widening the canals. The optimum pH for demineralization of dentine is 5 to 6. The optional working time for EDTA is 15 minutes after which the chelating effect ceases. So, EDTA solution should be renewed every 15 minutes. EDTA reacts with calcium ions in hydroxyappetite crystals, removing calcium ions from dentine, produces softening and denaturation of collagen fibres. EDTA can be used in various concentration and combinations in RCT17.

The Nd:YAG laser was developed in 1964 by Guesic and is referred to as Neodimium:Yttrium Aluminum - Garnet. These lasers are in the infrared range, a wavelength of 1.064µm and can be delivered in contact or non contact mode. The laser energy can penetrate 0.5-4mm in the oral tissue. The effect of lasing on root canal results from no effects to disruption of smear layer to actual melting and recrystallization of dentin depending on the power level, duration of exposure and colour of the dentin. The recrystallized canal wall appeared to be non porous and continuous in nature7.

Harishima in 1977 showed that when Nd:YAG laser was used for debridement , it caused melting of internal structure on instrumented root canals. The smear layer fused onto the dentinal tubules15.

The removal of smear layer reduced apical microleakage due to mechanical locking of sealer into the dentinal tubules, better adhesion to canal walls and greater surface area for canal wall sealing.

The present study is to evaluate the effect of EDTA and Nd:YAG laser used for smear layer removal and effect of smear layer removal on apical microleakage of two resin based root canal sealers.

Studies have shown that obturation without a sealer did not produce a proper apical seal , so obturation with a sealer is necessary to provide a good apical seal9. Epoxy resin sealers (AH plus and RC seal) are used in the study as they are dimensionally stable , insoluble in oral fluids, bacteriostatic, tolerated by periapical tissue, good adhesion to dentin, radio opaque and non carcinogenic.

The combination of 17% EDTA and 5.25% NaOCl is chosen as an effective irrigating solution for smear layer removal. Final rinsing with 10ml of saline is used to remove the residual NaOCl which may affect the bonding of sealer. The teeth were obturated with GP and two sealers by lateral condensation as it is widely recommended technique and considered as a standard with which others can be compared. Lasers were used in the study for removal of smear layer to compare its effect with EDTA.

Here, 2% methylene blue was used for dye penetration study because 1) the methodology was convenient 2) allows direct inspection of dye penetration visually and stereo microscopically 3) do not require special precautions like radio isotopes and provides a high degree of penetrability.

The results were subjected to one way analysis of variance (ANOVA) demonstrated a statistically significant difference in microleakage between the control groups and smear layer treated groups. There was no significant difference between Group 1 and 2 and no significant difference between EDTA and laser treated groups.

The increased microleakage in Group 1 & 2 may be due to presence of smear layer which alters the

sealing ability of sealers which coincided with the study observed by Economides et al in 19998.

The decrease in apical leakage in Group 3 and 4 may be due smear layer removal and better adhesion of sealer to dentine, improved mechanical locking of sealer into patent dentinal tubules and greater surface area for canal wall sealing which coincides with studies conducted by Timpawat et al (2001) and Funda Cort Cobankara(2004)10.

The decrease in apical leakage in Group 5 & 6 may be due to removal of smear layer by Nd:YAG laser as substantiated by the study done by Park et al(2001)15 and Goya et al (2000)11.

The leakage value between the two groups with different sealers did not show any statistical significance. This reveals that both EDTA and Nd:YAG laser were effective for smear layer removal and reduces apical microleakage and both the sealers have good adhesion on the canal wall after smear layer removal.

Samples examined under SEM , EDTA treated group showed complete removal of smear layer with open tubule orifices and erosion of dentinal surfaces. This may be due to dissolution of peritubular and intertubular dentin due to alternative effects of NaOCl which would have dissolved organic portion and EDTA which brought about dissolution of inorganic portion similar to studies done by Baumgartner and Maden3. The laser treated groups showed open tubule orifices and root canal surfaces were melted, fused and in some areas smear layer melted and fused onto the dentinal tubules. This result is close to the study conducted by Harashima in 199715. In Groups 1 and 2, there was interface gap between sealer and dentine due to intact smear layer.

CONCLUSION:

Within the limitations of the study, it can be concluded that both EDTA and laser can be effectively used to remove smear layer and the adhesion of resin sealers were better with EDTA and laser treated Groups. Hence, in the present results, it will be more appropriate to carry out further study on Nd:YAG laser, EDTA and physical and chemical properties of AH plus and RC seal. The true effectiveness of the sealer and Nd:YAG laser should be evaluated for application in clinical procedures.

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