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EFFECT OF ROOT CANAL PRETREATMENTS USING ER: YAG LASER AND CHLORHEXIDINE ON MICROLEAKAGE OF FIBER POSTS

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ABSTRACT

Background and aim: Adhesion between resin and dentin is considered to be a weak point in luting a fiber post. This study evaluated the effect of different root canal pretreatments on microleakge of cemented fiber posts.

Materials and Methods: Thirty-two extracted human maxillary central incisors were randomly assigned to 4 groups after post space preparation: control group (root canal irrigation with normal saline) and experimental groups (chlorhexidine (CHX), Er: YAG laser, CHX+ Er:YAG laser). Fiber posts were cemented with Panavia F2. After being immersed in a 0.5 % aqueous solutions of basic fuchsin, the roots were sectioned vertically and microleakage was examined by stereomicroscope. Microleakage means were statistically analyzed by one-way ANOVA. Results: The differences between root canal pretreatment methods were not statistically significant ($p>0.05$). The specimens treated with CHX leaked less than other groups and the highest microleakage mean value was found in the laser-prepared group. Conclusion: Root canal pretreatments with CHX, Er: YAG laser and CHX+ Er: YAG laserdid not effectively decrease the leakage of cemented fiber post .

Keywords: Fiber post, Chlorhexidine, Er:YAG laser, Microleakage

1- INTRODUCTION

In recent years, restoration of endodontically treated teeth with fiber-reinforced composites (FRCs) posts has become increasingly popular (1).FRC posts are chair side ready-to-use posts and can be made from carbon fiber, glass fiber, polyethylen or quartz fiber and come in variety of shapes and designs(2). Fiber posts have some advantages in comparison with traditional cast posts such as higher flexural strength and lower elastic modulus closer to those of dentin decreasing the possibility of root fracture due to better stress distribution. Also, gingival color and the root surface is not affected by corrosive products improving aesthetics particularly at the anterior region (3). Furthermore the teeth immediately restored with fiber posts and composite cores have no risk of coronal leakage between treatment visits (4, 5). However, FRC posts have some disadvantages. The first drawback is preparation of the root canal to fit the shape of the post leading to loss of dentin (1) and the other is debonding at the adhesive resin-dentin interface which is the most common failure mode related to fiber posts (3). Imperfections along the bonded interface can be an inducement for microleakage (5). Studies have shown that loss of resin-dentin bond integrity happens over the time due to hydrolysis of hydrophilic resin components and degradation of exposed collagen fibrils in hybrid layers by the endogenous proteolytic mechanism of matrixmetalloproteinases(MMPs)(6).

MMPs also known as matrixins are a cell-derived endopeptidase family with 26 members that involve in destruction of proteins. The following MMPs are found in the coronal and radicular dentin: MMP_2 (Gelatinase A), MMP8 (Neutrophil Collagenase), MMP9 (Gelatinase B) (7). In addition recent studies has revealed the presence of cysteine cathepsins in dentin which can play a role in collagen breakdown (8, 9). Both MMPs and cysteine cathepsins can degrade sub-optimally infiltrated collagen fibers once they have been activated during bonding procedures (8). It has been indicated that the bond integrity can also be compromised by occlusal forces and shrinkage stress in the resin layer (5,6). Obviously, dentin hybridization is very important in resin – dentin bond and can be affected by different types of dentin pretreatments (3).Adhesive interface may be hindered by the smear layer covers dentin walls after post space preparation and remnants of sealer. In order to decrease the risk of de bonding, post-space treatments that effectively remove the smear layer are of clinical interest (10). Chlorhexidine (CHX) is a broad spectrum antimicrobial agent with a high substantivity and does not alter the collagen present in the dentin organic matrix; thus, it is expected not to adversely affect the resin-dentin bond strength (3, 8, 11). However, previous studies showed conflicting results. Some studies reported that chlorhexidine adversely affected bonding efficacy(12,13)while others reported that CHX had no detrimental effects on bond strength and microleakage (3,11).In many researches it has been demonstrated that CHX preserve the longevity of resin-dentin bond by acting as an unspecific inhibitor of MMPs and cysteine cathepsins (3,8,6,11,14,15).This inhibitory effect is not influenced by concentration of CHX solution and duration of its application. It is capable to inactivate MMPs at a concentration of only 0.02% and at a short period of time i.e. 30 seconds (8,15). Nevertheless in most of the studies the concentration of 2% has been used in which microbial load of the root canal can be decreased effectively (11,16).

Erbium: yttrium-aluminum-garnet (Er: YAG) laser is the other dentin conditioning investigated in many studies. Inconsistent findings have been reported about laser- irradiated dentin. Some studies have reported lower bond strength to laser-prepared dentin, others have represented higher bond strength and a few have shown no statistical difference between laser groups and controls (17). Laser radiation is absorbed by water molecules and in dentin substrate leading to water vaporization that causes an internal pressure and consequent microexplosions especially in the intertubular dentin which contains more water components. In theory, irradiated dentin with rough surface and open tubules can be infiltrated better by adhesive resin (17, 18, 19). On the other hand, there are some reports of weaker adhesion by laser irradiation through decreasing organic matrix at the dentin surface and so hampering the hybrid layer formation(17,19).The objective of this in-vitro study was to assess the impact of three different root canal pretreatments (CHX, Er:YAG laser,CHX+ Er:YAG laser) on the microleakge of cemented fiber posts. We hypothesized that the method of dentin pretreatment would not significantly affect the microeakage.

2-MATERIALS AND METHODS

Thirty-two extracted human maxillary central incisors with no cervical lesions, root cracks, craze lines, external resorptions or open apices were selected and kept in saline solution. All external debris was removed with an ultrasonic scaler (Juya Electronic Co., Tehran, Iran). Then the teeth were stored in 0.5% chloramine T solution as a surface disinfectant for one week. The crowns of the teeth were removed below the CEJ using a diamond disc (Tizkavan, Tehran, Iran) and a high-speed handpiece (NSK, Tokyo, Japan) with water coolant perpendicular to the long axis.

Root canal preparation

The root canals were instrumented using step- back technique and #40 master file (Maillefer, Dentsply, Ballaigues, Switzerland) at a working length of 1 mm from the apex.

The middle and the coronal third were enlarged by using size 2 and 3 Gates Glidden (Mani Inc, Tochigi, Japan). The canals were irrigated with normal saline solution after every change in the file size throughout the instrumentation, then dried with paper cone (Ariadent; Asia Chemi Teb Co, Tehran, Iran). Each canal was obturated with gutta-percha ((Meta Biomed Co., Chung-Ju, Korea) and AH26 (DENTSPLY International, York, PA, USA) using lateral condensation technique.

The access cavities were temporized with a non- eugenole provisional material (Cavisol, Golchai Co., Tehran, Iran).The roots were stored in normal saline at 37°C for one week for full sealer setting. Gutta-percha fillings were removed to a depth of 9 mm with No.3 Gates Glidden (Mani Inc, Tochigi, Japan) and post space preparation up to 9 mm was carried out with #2 white post system drills (WhitePost, FGM, Joinville, SC, Brazil).The specimens were randomly allocated into 4 groups (n =8) according to the dentin conditioning. Group 1 was the Control group in which fiber posts No.2 (20mm, 1.8mm, 1.05mm) with no additional canal pretreatment after post space preparation were cemented with Panavia F2 half kit (light) (Kuraray, Osaka, Japan) .A mixture of one drop of each ED primer A and B was applied onto the root canal surfaces for 30 seconds and after gentle air dry, excess was removed with absorbent paper points. Then equal amounts of paste A and paste B of the cement were mixed for 20 seconds and placed in the post space with the aid of a lentulo drill (Maillefer, Dentsply, Ballaigues, Switzerland) .The fiber post was covered with cement and seated inside the root canal under finger pressure and the excess cement was removed with a brush.The cement was light-polymerized for 40 seconds on each side with Valo LED light curing unit (Valo; Ultradent, South Jordan,UT, USA)at 1000 mW/ cm2 and a distance of 1.0mm. The outpus of the device was controlled with a radiometer(LED Radiometer, sds/Kerr, Orange, CA, USA).Then second group after post space preparation root canals were filled with CHX 2% (Clorhexidina S, FGM, Joinville, SC, Brazil) for 30 secondsand then dried with paper points and posts were cemented as explained in group 1. In the third group root canals were irradiated with Er:YAG laser (Doctor Smile erbium and diode laser, Lambda Scientifica Srl, Vicenza,Italy).Laser parameters were set at output power1.5W; wavelength 2940 nm, pulse frequency 25Hz; air pressure of 65% and water pressure of 100% in an irradiation of 5 s for 3 times at 10 s intervals using H4 fiber tip with a diameter of 400 µm.Fiber posts were then cemented similar to group1 into root canals. In the last group prior to fiber post cementation, the post spaces were initially treated with CHX 2% for 30seconds andthen dried, subsequently irradiated with laser with the same method mentioned in group 3. After cementation the posts were cut using a fissure diamond bur (Tizkavan, Tehran, Iran) and the specimens were stored in saline for 24h.

Microleakage measurement

The roots were thermocycled in distilled water for 1500 cycles between temperatures 5±5°C and 55±5°C (dwell time of 30 s, transfer time of 10 s). Root apices were sealed with sticky wax and the entire external surface of teeth except for 1mm around the adhesive dentin interface site was covered with two coats of nail polish.

All specimens were immersed in a 0.5 % aqueous solution of basic fuchsin at 37°cfor 72 hours and then rinsed under running tap water.

After air dryingeach sample was embedded in the clear epoxy resin with in an acrylic mold. The samples were sectionedvertically in the buccolingual plane with a cutting devise and diamond covered disk (Nemo, Mashhad, Iran) dividing the roots into halves. The corresponding sectioned splits were examined under a stereomicroscope at 40X(Motic Smz-143 SERIES, Micro-optic industrial group Co, Xiamen, China). The depth of dye penetration for each sample was measured in µm at the cement – dentin interfacefrom the orifice on both mesial and distal surfacesusing motic image plus 2 ML software. The data were analyzed using SPSS v.22 by one-way

ANNOVA test .The accepted level of error was set at $P<0.05$.

3-RESULTS

The mean microleakage and standard deviation values in the 4 groups are presented in Table1. The specimens treated with CHX leaked less than other groups.The highest microleakage mean value was found in laser-treated group. In the last group with supplementary laser pretreatment after CHX application, the amount of dye penetration was more than control and CHX groups but less than laser-treated specimens.(Figure1)One-way ANOVA revealed no significant differences between the groups ($p>0.05$).

Table 1. The mean microleakage and standard deviation values in the 4 groups.

Microleakage (μm)	N	Mean	Std. Deviation
control	16	1211.19	700.921
CHX	16	934.75	532.497
Laser	16	1502.75	798.907
CHX + Laser	16	1337.63	786.589
Total	64	1246.58	726.327

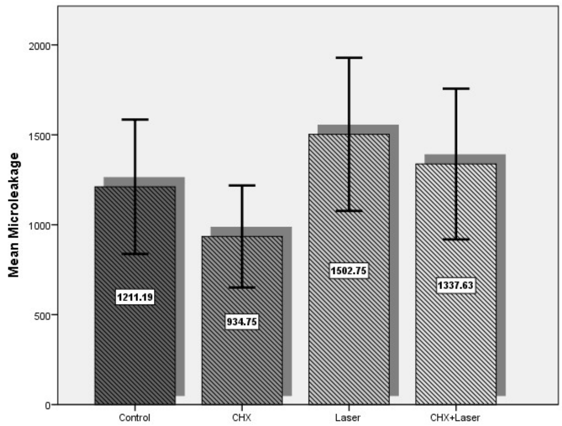

Figure 1: The mean microleakage and standard deviation values in the 4 groups

4-DISCUSSION

Clinically, it is important to improve the adhesion between a resin cement and tooth structure to reduce the extent of microleakage at resin- dentin interface (20). Integrity of adhesion and also quality of hybrid layer which plays an important role in the bonding process can be evaluated by microleakage tests(21). In the present study the effect of different pretreatment techniques on microleakage of cemented fiber posts was investigated.

Our results indicated that the use of 2% CHX prior to the application of self-etch cement did not increase the microleakage compared to the control group. Lower amount of dye penetration was even observed in CHX- treated group even though the differences were not significant with other groups.

CHX is a commonly used antimicrobial agent, as well as for disinfecting the dentin after root canal preparation (22). CHX is an amphiphilic molecule that binds to several proteins and acts as an inhibitor of matrix metalloproteinases by cation-chelating mechanism. It inactivates MMPs by depleting them of metal ions (Ca^{+2} and Zn^{+2}) and in this way prevents the cleavage of exposed collagen in the hybrid layer; hence the integrity of resin-dentin bond will be secured during the time (7, 15). Since CHX acts unspecifically it can also interfere with the proteolytic activity of cysteine cathepsins (15). However, controversial findings have been reported about CHX effects on the adhesion. Some studies have concluded that CHX interacts in a material-specific manner with different adhesive systems. In the present study we used Panavia F2 as a self –etch cement. Our results are in agreement with the findings of Shafiei et al that reported CHX application with Panavia F2.0 cement did not lead to a significant difference in the microleakage (21). Similar to our results, Arslan et al showed no significant differences in microleakage of class V restorations treated with Er,Cr:YSGG laser or CHX disinfectant when used with self-etch adhesive(23). Our findings are in accordance with the results of Geraldo-Martins et al in which no significant differences were found in the microleakage of class V cavities treated with CHX 2% ,Er:YAG laser and CHX plus Er:YAG laser and restored using a self-etch adhesive (24). Most previous studies evaluated the effect of different treatments on bond strength and many of them have found that CHX cavity disinfectants do not have an adverse effect on bond strength (3, 8, 5, 14, 23). Contrary to our results few studies showed that 2% CHX adversely affected the bond strength (12, 13) In a study by Hiraishi et al, the use of CHX before Panavia F2.0 adversely affected bond strength and increased nanoleakage. They attributed this to the residual moisture of the CHX solution, which might interfere with the functioning of the ED primer II. However,in the present study the post space was dried with paper point after the application of CHX (13).

According to our findings, even though the highest mean value of microleakage was observed in the Er:YAG laser-pretreated specimens but the differences were not significant with other groups. Er:YAG laser can be used for caries removal, cavity preparation, disinfection of root canal and also conditioning of dental hard tissue (25,26).

Similar to CHX, researches about the efficacy of bonding between self-etch adhesive and lased-dentin reflect some controversies.

To the best of our knowledge, this is the first study that evaluated the effect of laser treatment on microleakage of fiber posts. Previous studies assessed the bond strength of cemented fiber posts to laser-treated dentin;therefore, direct comparison of our results with those studies is difficult.

In this matter, Bitter et al (27) showed that there were no significant differences between the push out bond strength of fiber posts cemented with Panavia F2 cement in the Er:YAG treated group and the controls irrigated with chlorhexidine . Kirmali et al (28) found that Er, Cr:YSGG laser irradiation with different intensities did not increase the bond strength of the fiber posts to the root canal dentin walls. On the other hand, Mohammadi et al (29) presented that Er, Cr:YSGG laser increased the push-out bond strength of fiber posts cemented to root canal dentin using a self-adhesive cement. The differences in the findings can be due to the type and power of laser used in these studies. In a study by Arslan et al, Er:YAG laser irradiation enhanced the bond strength of fiber posts to root canal walls. The power setting and type of laser used in their study was the same as ours; however, they used 5 % NaOCl and 17 % EDTA irrigants during instrumentation of root canals which could have removed the smear layer (30).

A few studies have investigated the effect of laser irradiation on microleakage of coronal restorations. We should take this fact into account that bonding to radicular dentin is different from coronal dentin, since, smear layer and remnants of sealer cover dentin walls after post space preparation. AFM and SEM analysis revealed that consequent to laser irradiation of the root canal, smear layer is removed, producing a clean and rougher surface with completely open dentinal tubules (31). In accordance to our finding Muhammed et al (20) and Navarro et al (32) represented that the amount of microleakage was not influenced with Er:YAG laser irradiation in Cl V restorations. Contrary to our results, somestudies have stated increased values of microleakage with preparation or pretreatment by Er:YAG laser (33, 34).In a study by Yaman et al laser-treated cl V cavities showed higher amount of microleakage than those of bur-prepared teeth, especially for the specimens with self-etch adhesive application in comparison to etch and rinse bonding materials (35). They attributed this to decomposition of the dentin organic matrix and denaturing or micro rupturing of collagen fibers after laser irradiation (19). Based on SEM analysis another impact of Er:YAG laser on the adhesive protocol is creating several subsurface micro fissures which would not fully be reinforced with adhesive resin creating a weak zone just below the hybrid layer (19, 36).

This diversity in the findings can be due to different laser parameters used in the studies and also different adhesive systems. Bitter et al concluded that bond of fiber posts are depended on the type of luting agents (27).

The data obtained in the present study revealed that microleakage in specimens treated with CHX and supplementary Er:YAG laser irradiation was not reduced compared to the controls .Likewise, Geraldo-Martins reported that CHX irrigant combined with Er:YAG irradiation did not affect the amount of microleakage compared to other groups that were treated with either laser or CHX(24). Martinho *et al* revealed that dentin pretreatment with Nd:YAG laser irradiation and CHX irrigant showed no improvement in bond strength (3). It can be interpreted that laser irradiation could somewhat obscure the slight favorable impact of CHX on the microleakage.

Considering the limitation of this invitro study and divergent results of previous researches, further investigation is certainly required to determine proper radicular dentin pretreatments for each types of adhesive cements and also to assess applicability of Er:YAG laser in root canals.

5-CONCLUSION

Our observations suggest that none of the pretreatment methods completely eliminated the microleakage. Among the study groups CHX revealed the lowest microleakage and Er: YAG laser showed the highest amount. Therefore, it can concluded that post space conditioning with Er: YAG laser due to technique sensitivity and high cost is not recommended.

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