Original Article

Dentin Sealing Versus Erbium

Immediate Dentin Sealing Versus Erbium (Er): YAG laser Dentin Ablation Prior to Composite Inlay Luting Procedures

Ola Mohamed Sakr[1,2]

ABSTRACT

Objective: The aim of the study was evaluation of the effect of different dentintreatment using immediate dentin sealing or Er: YAG laser on adhesion of prefabricated resin composite inlay.
Study Design: Comparative Study
Place and Duration of Study: This study was conducted at the College of Dentistry, Qassim University, Kingdom of Saudi Arabia from November 2018 till December 2020.
Materials and Methods: The study teeth comprised 45caries free molars which were divided into three equal groups. The occlusal third of the crowns were cut with a slow-speed diamond saw. The groups were classified as follows: group A, dentin etched with 35% phosphoric acid for 10 s directly prior to luting procedures. Group B, immediate dentin sealing is done directly after cavity preparation. Group C, dentin surface treated with 100 mjEr: YAG laser directly prior to luting procedures. The resin composite inlays were adhered to different treated dentin surface using adhesive resin cement. The specimens with their adhered inlays of each group were subjected to shear bond strength testing. Analysis of the recorded shear bond strength values (Mpa) were done using one-way analysis of variance and Tukey post hoc test. Statistical analysis was performed using Graph pad Prism-6 statistics software for Windows P values ≤ 0.05 are considered to be statistically significant in all tests.
Results: Shear bond strength mean values for Group B>Group C >Group A.
Conclusion: IDS and Er:YAG laser improve the shear bond strength of composite inlays to dentin
Key Words: Immediate dentin sealing -Er: YAG laser - Delayed dentin sealing Composite inlay.

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INTRODUCTION

Laboratory fabricated indirect restorations are need at least two appointments:
First appointment for tooth preparation and impression taking ended with temporary restoration fabrication and luting and second appointment for final restoration luting procedure[1].
Two appointment inlay technique or delayed dentin sealing (DDS), dentin sealing and hybridization is applied after removal of temporary cement. Immediately after tooth preparation, the exposed essential dentin is susceptible to insult from bacterial infiltration and micro-leakage during the temporalization process. Penetration of bacteria and fluids through the exposed dentinal tubules can result in microorganism colonization, post-operative sensitivity, and the potential for subsequent pulp irritation. Residual temporary cement can remain on the surface of the tooth even after mechanical surface cleaning, and the tooth surface is possibly penetrated by certain cement ingredients, altering features such as touch angle and permeability of dentin. In this manner, the definitive restoration is not related to freshly prepared dentin, but rather to contaminated dentin, which can result in failure of hybridization and decreased bond strength[2,3].
In order to prevent these potential sequelae, local application of a dentin bonding agent is suggested when a large accessible area of dentin has been exposed during tooth preparation for indirect bonding restorations[4]. Since the early 1990s, this immediate dentin bonding application prior to the temporalization stage for indirect bonded restorations was proposed[5-8]
There have been comprehensive so-called immediate dentin sealing IDS[8].
IDS Studied and greatly enhanced over the years with good findings with regard to the strength of bonds, void formations, bacterial leakage, and post cementation hypersensitivity. In this step a dentin bonding agent is

[1.] College of Dentistry, Qassim University, Kingdom of Saudi Arabia.
[2.] College of Dentistry, Misr University for Science and Technology (Egypt).

Correspondence: Associate Prof of Conservative Dentistry, College of Dentistry, Qassim University, Kingdom of Saudi Arabia / Professor of Operative Dentistry, College of Dentistry, Misr University for Science and Technology (Egypt).
Contact No: 201223649456
Email: olasakr2004@hotmail.com

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applied to the freshly prepared dentin before the placement of the temporary cement. Immediate dentin sealing requires hybridization of the exposed dentin surface immediately after tooth preparation and during final cementation procedures.[8,9]

Many advantages of IDS technique as it prevents the dentin sensitivity and bacterial invasion during the temporalization stage with subsequent increased bond strength, the dentin bonding agent thickness is considered before tooth preparation Impression[10].

Erbium-YAG (Er-YAG) lasers emit a 2.94 µm wave length which coincides with the major water absorption band. Hydroxyapatite absorbs this emitted energy well and has been shown to remove dental hard tissue more effectively than other laser systems[11 -13]. Many studies reported dental tissue little thermal damage especially when laser is irradiated in conjunction with a water spray.[14,15]

The Er-YAG laser has been used clinically for dental hard ablation, caries removal and cavity preparation.[16]

Lased dentin showed many specific characters which as advantageous for resin bonding. It showed the formation of a microscopically rough substrate surface without surface demineralization, open dentinal tubules with no smear layer formation, and sterile dentin surface[17,18].

Er-YAG laser dentin ablation showed improved hard dental tissues bond strength results[19,20].

The aim of this study was to investigate the effect of immediate dentin sealing and Er-YAG laser dentin ablation prior to composite inlay luting procedures.

MATERIALS AND METHODS

I-Preparation of the teeth specimens: Forty five specimens of caries-free human molars which were extracted for periodontal reasons. Any residual soft tissue on the tooth surfaces was removed, and the teeth were preserved at room temperature in distilled water. In auto polymerizing acrylic resin (Meliodent; Bayer Dental, Newbury, UK), the teeth specimens were mounted vertically. The occlusal enamel was removed using a slow-speed diamond saw sectioning machine under water cooling(Isomet; Buehler, Lake Bluff, IL). Randomly teeth samples were divided into three groups. Guided grooves were made to a depth sufficient to expose 0.5 mm dentin depth below dentinoenamel junction. Under water-cooling, the dentin surfaces were abraded with decreasing grits of silicon carbide (SiC) paper (from #800 to #1200) for 30 seconds per paper. A standard superficial dentin surface of about 0.5 mm from the dentinoenamel was formed, along with a standard smear layer.

An adhesive tape punched with a modified Ainsworth rubber-dam punch to provide 3 mm diameter holes was used to determine the dentin surface area for testing. Finally, each group received fifteen dentin samples.

Before the luting techniques, all perpetrated teeth specimens were placed in water at 37°C for five days.

The treatment groups were as follows:

Group A: Dentin etched with 35% phosphoric acid for 10 s directly prior to luting procedures.

Group B:Immediate dentin sealing is applied directly after cavity preparation.

Group C: Dentin ablated with Er: YAG Laser at100 mJ for 12.5 secdirectly prior to luting procedures.

The treatments of dentin were as follows:

Group A-Acid etching: using colored gel of35% phosphoric acid (Scotchbond etchant gel,3M,USA) was applied for 10 sto the dentin surface, followed by copious rinse with water for 10 s and gentle indirect air drying 5 s, followed by luting cement.

Group B-immediate dentin sealing:

Immediately following tooth preparation, the IDS was achieved.

With 35% H3PO4 (Scotchbond etchant gel,3M, USA) for 10 s, Dentin was washed with copious amount of water for30 seconds.

Primer and adhesive resin are then applied (Optibond FL, Kerr, USA), indirect air-thinned then 10 s photopolymerized using halogen curing light (3 M ESPE, St Paul, USA) with a light output of 1000 mW / cm2.Thin layer of Glycerin gel was applied and, the surface was photopolymerized for 40s.

Group C- Laser pretreatment:

Er: YAG dental laser (BURANE XLER: YAG laser 1243, Germany). Its wavelength, in infra-red region, was 2.94 µm . Spot size was 3 mm and pulse duration 250µ m. The beam was applied perpendicularly to the specimens at 100 mJ. A pulserepetition rate was 4 HZ**.** The number of pulses delivered for each specimen was constant 50 pulses as the duration was 12.5 sec.

II-Preparation of the composite inlays: Resin composite discs with 4 mm thickness and 5mmin diameter were prepared by layering 2-mm-thick per increment of a nanohybrid resin composite ((Filtek Z350XT, 3 M ESPE, St Paul, USA) into a silicone mold. Eachincrement was photopolymerized using halogen curing light (3 M ESPE, St Paul, USA) with a light output of 1000 mW / cm2 for 40 seconds.

Fitting side of the resin composite discs was abraded ,underwater cooling system, with 600-grit SiC paper to standardize the surface roughness.

III: Luting Procedures: Before starting luting procedures, ultrasonic cleaning, for 10 minutes, of theresin compositediscs with distilled water. Discs were dried with air, and silanated with (Scotchbond, Universal Adhesive, 3M ESPE) for 20 sec., air dried foe 5 sec.

Dentin Specimens were gently dried using cotton pellets. Laser ablation for group C. Acid etching with 35% phosphoric acid gel (Scotchbond etchant gel, 3M, USA) was applied for 10 s to the dentin surface, followed by water rinsing for 10 s and 5 s gentle

indirect air drying. Dentin specimens were rubbed with (Scotch bond, Universal Adhesive, 3M ESPE) for 20 sec. According to the manufacturer's instructions, luting agents (RelyX, Ultimate Adhesive Resin Cement, 3M ESPE)were applied. Digital pressure was used to press resin composite discs onto the cement, which was persist until20 s/surface, light curing was applied from the buccal, lingual, and occlusal sides. For 24 hours, cemented specimens were maintained in distilled water.

IV- Measurement of shear bond strength: The specimens of each group were subjected to shear bond strength testing. The cemented specimens were clamped to a universal testing machine (LLOYD Universal Testing Machine LR5R series UK) . Each specimen in its resin block was hold in the lower jaw of the testing machine. In the upper jaw, a knife edge chisel was attached and allowed force application on interface between the test material and the dentin surface, the test machine was run at a constant speed of 0.5 mm/min and until the inlays separated. Shear bond strength values were registered in Newton and transformed into Mpa by dividing the maximum load by the surface area. One-way study of variance and the Tukey post hoc test were used to examine the shear bond strength values (Mpa). Statistical analysis was performed using Graph pad Prism-6 statistics software for Windows P values ≤ 0.05 are considered to be statistically significant in all tests.

RESULTS

Mean shear bond strength values are presented in Table1: The shear bond strength values (Mpa) were analyzed using one-way analysis of variance and Turkey post hoc test and were revealed a significant influence of the Main groups type tested ($p=0.0001 < 0.05$) on shear bond strength mean values (Group B> group C > group A).

Table No.1: Shear bond strength results (Mean ± SD) for all groups with different surface treatment of the dentin

	Shear bond strength	P value
Group A	3.89±0.72	0.0001*
Group B	6.198±1.15	0.0277*
Group C	5.06±1.1	0.0001*

Different letters indicating statistical significances P≤ (0.05) *; significant (P≤0.05)

DISCUSSION

Dentin preparation technique plays a major role in success of adhesive procedure of indirect bonded restorations.[8,9]

A contaminant-free substrate, such as that obtained at the time of preparation when dentin is freshly cut and clean, is a primary prerequisite for optimum bonding[2, 21]. The conventional method of tooth-colored inlays luting procedures is performed after a period of temporary restoration with possibility of the dentin surface contamination with remaining of temporary restorative material[22].

The results of this study showed that immediate dentin sealing specimens had the highest bond strength. In order to decrease bacterial infection and tooth sensitivity during the provisionalization process, the immediate dentin sealing protocol was proposed as an effective technique of sealing the dentinal tubules. The application of dentin bonding agent to freshly prepared dentinled to influence of the retention and placement of the indirect inlay restoration.[8,9,23]

The optimum conditions were presented by the delayed dentin sealing procedure even on contaminated dentin surfaces. The primary issue of decreased shear bond strength correlated with provisional treatment. The creation of an effective bond between the existing resin coating and the new luting resincement is a key element of IDS[8,9].

Suggesting that bond strength can begin to decrease after 7 days after the IDS procedure.[24]

The Er:YAG laser was chosen for the study as many researchers believe it is a promising form of laser for treating hard dental tissues with minimal pain and thermal impact. This was presumed as its wave length 2.94 µm matching with the absorption peak of the collagen fibrils, hydroxyaptite crystals and water which are the major components of dentin[25,26]. Also, some researches have shown that its wave length stimulated reparative dentin formation[27].

In this study the Er: YAG laser dentinablated showed significantly high bond strength than total acid etched dentin surface. Many studies explained that t the low-energy Er: YAG laser can modify the dentin surface. The recommended Er: YAG laser output for conditioning is inferior to 200 mJ[28].

It was found that the Er: YAG dentin ablation produces microexplosions within the dentin. Dentin organic and inorganic tissue particles are ejected as a result of these microexplosions. Surface irregularities created on the ablated dentin surface without smear layer[29].

CONCLUSION

1. Immediate dentin sealing improved the shear bond strength of composite inlays to dentin.
2. Er: YAG laser with low intensity pulses modify dentin surface with subsequent positive response of shear bond strength records of composite inlays to dentin.

Author's Contribution:

Concept & Design of Study:	Ola Mohamed Sakr
Drafting:	Ola Mohamed Sakr
Data Analysis:	Ola Mohamed Sakr
Revisiting Critically:	Ola Mohamed Sakr
Final Approval of version:	Ola Mohamed Sakr

Conflict of Interest: The study has no conflict of interest to declare by any author.

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