The Effects Of Diode Laser Irradiation On Shear Bond Strength Of 7th Generation Self-Etch Adhesive System To Human Dentin–An In Vitro Study

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Abstract: Composite bonding to teeth structure can be influenced using laser irradiation by increasing penetration depth of bonding adhesive forming modified hybrid layer. The effect of 940 nm diode laser on shear bond strength of self-etch adhesive to dentin has not been studied extensively in literature.

Aim: Aim of this study is to evaluate in vitro the effect of diode laser irradiation on shear bond strength of 7th generation self-etch adhesive system to human dentin.

Methodology: Ten therapeutically extracted non-carious, unrestored human premolars were collected (n = 10). The buccal and lingual surfaces of the teeth were ground with the help of a diamond disc under continuous water coolant until dentin was exposed. The specimens were divided in to two groups (05/ group). In group A (without laser), 7th generation dentin bonding adhesive (Beauti Bond) was applied on both buccal and lingual surfaces of specimens and light cured. In group B (with laser), 7th generation dentin bonding adhesive (Beauti Bond) was applied on both buccal and lingual surfaces followed by laser irradiation before light curing. After respective treatment for both the groups, composite build up was done in rectangular cylinder form. Shear bond strength was measured using Instron universal testing machine at cross head speed 0.5 mm/min.

Result: Level of significance was set at p value < 0.05. According to the results, it was found that the mean shear bond strength value in group with laser (11.56+0.27) was higher than the group without laser (6.25+0.47), but difference was statistically not significant.

Conclusion: Based on the results and within the limitation of this study, it may be concluded that irradiation with 940 nm diode laser after self-etch adhesive application can increase the bond strength of composite to dentin.

Keywords: diode laser, self-etch adhesive, Beauti Bond, shear bond strength, human premolars

Introduction

A two-fold bonding mechanism, namely micro-mechanical interlocking and chemical bonding has been extensively studied in the context of self-etch adhesive systems. This type of bonding appears to have advantages when it comes to the durability of restorations. While the chemical interaction lessens hydrolytic degradation and prolongs the marginal sealing of restorations and the micro-mechanical bonding helps to provide strength against mechanical stress.[1]

Self-etch adhesive systems are promising materials, easy to use, bond chemically to tooth structure while maintaining the dentin hydroxyapatite, important for the durability of the bonding.[1]

Prior to applying adhesive resin, the phosphoric acid etch-and-rinse method has become the accepted practice for surface conditioning enamel and dentin: Resin tags are created when adhesive resin seeps into the porous zone, providing micromechanical retention to etched enamel and dentin. Demineralization and infiltration happen concurrently in the self-etch technique, albeit not exactly at the same time. It is suggested that these streamlined systems shorten clinical procedures and lessen technique sensitivity. The self-etch adhesives can be classified as two-step systems (requiring a separate bonding step) or one-step systems (combining all bonding procedures in a single application) based on the number of bonding procedures needed. Based on the quantity and makeup of polymerizable acids and/or acid resin monomers, the self-etch adhesives are also categorized into three groups according to their initial pH values: mild (pH of 2.5 or higher), moderate (pH of approximately 1), and strong (pH < 1). Their interaction with enamel is known as nano retentive interlocking; in this process, additional monomer permeates between and within the crystallites while the central and periphery of the crystallites dissolve. Disagreeably, some writers have written about the adhesive systems ability to adhere to dentin and enamel at varying pH levels. A morphological study by Moura et al. revealed that using a self-etch primer did not produce a deep enamel etching pattern, in contrast to applying phosphoric acid.[2]

Because of the necessity to increase the bond strength of self-etch adhesives, laser activation is taken into account in this investigation. Dr. Shimoe's group first suggested using laser engraving technology in 2012 to produce micro-mechanical retention in order to increase the shear bond strength (SBS) of porcelain fused to zirconia (Zr). Consequently, numerous investigations have demonstrated that by cutting micro-slits before bonding, which raises the surface area, laser engraving can dramatically raise the SBS of Zr to DBRs or ICRs.[3] We have used a diode laser to determine its effect on the shear bond strength of self-etch adhesives.

Methodology

Ten therapeutically extracted non-carious, unrestored human premolars were collected (n = 10). All teeth were kept in 3% sodium hypochlorite solution for 10 minutes after scraping the remaining tissues, if any and then rinsed with running tap water for 15 minutes. After cleaning with pumice, they were stored in normal saline at 4°C until use.

The buccal and lingual surfaces of the teeth were ground with the help of a diamond disc under continuous water coolant until dentin was exposed. Rectangular molds were prepared using modelling wax in cube form, later modelling wax was replaced with cold cure acrylic resin in all the 10 teeth till cementoenamel junction. The test area was delimited to a circle of 3mm x 3 mm in diameter with the help of nail varnish on both buccal and lingual surfaces of all the specimens.

The specimens were divided in to two groups (05 teeth each group) (fig.1&2).

Group A (without laser)- 7th generation dentin bonding adhesive (Beauti Bond, SHOFU)

Group B (with laser) - 7th generation dentin bonding adhesive (Beauti Bond) + laser irradiation

Figure 1. group A

Figure 2- group B

Sample preparation:

Group A (n=10) – application of 7th generation dentin bonding adhesive (Beauti Bond) according to manufacturer's instructions on both buccal and lingual surfaces of the specimens and then polymerization with LED curing light unit for 20 s (fig 3).

Group B (n =10) - application of 7th generation dentin bonding adhesive (Beauti Bond) according to manufacturer's instructions on both buccal and lingual surfaces of the specimens followed by irradiation with diode laser in non-contact mode for 60 s and then polymerization with LED curing light unit for 20 s (fig 4).

Diode laser unit (Epic 10, Biolase) with a wavelength of 940 nm, power of 1W, Pulse rate 1.5 pulses/s with a non-contact tip of 200-µm diameter was used in this study. Laser was applied freehand in non-contact mode for 60 s. During laser application, laser tip was held perpendicular to the specimen's buccal and lingual surfaces at distance of 1mm. later polymerization was done with LED cutting unit for 20 s.

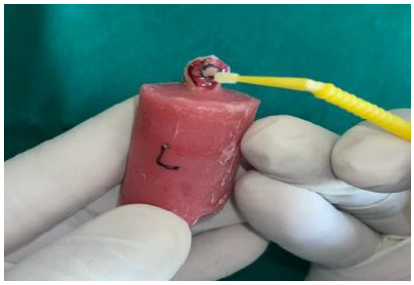

Figure 3- bonding agent application

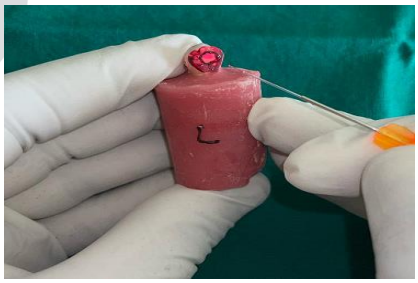

figure 4 – laser irradiation

After respective treatment mentioned above for both the groups, 3mm x 3mm plastic straw was used to place composite resin (3M™ Filtek™ Z 350 XT) on buccal and lingual surfaces of the specimens. Composite built up was done in

increments with each increment being cured for 20 s with LED curing unit. Later, straw was incised and removed leaving composite cylinder bonded to the treated specimen surface which was cured for additional 60 s (fig 5&6).

Figure 5 – group A

figure 6 – group B

The specimens were then mounted individually on Instron universal testing machine for debonding at cross head speed of 0.5 mm/min (fig 7&8). All shear bond strength values obtained were then subjected to statistical analysis.

Figure 7

figure 8- testing on Instron machine

Results

IBM's SPSS version 18, a statistical package for social sciences, was used for all of the analysis. Independent t test was used to compare values between surfaces treated with and without laser. Level of significance was set at p value < 0.05. The mean value of shear bond strength in group A (without laser) was 6.25+0.47 and in group B (with laser) was 11.56+0.27. Although the mean shear bond strength in group B (with laser) was greater than group A (without laser) but difference was statistically not significant (p>0.1) (table 1).

Table No 1: comparison of mean shear bond strength

Group	N	Mean	Std. Deviation	F-Value	p-Value
Group A (without laser)	10	6.25	0.47	2.61	0.12
Group B (With laser)	10	11.56	0.277		

Test applied independent t test; Level of significance set at p≤0.05

Discussion

The restoration is subject to various forces. Resin contraction creates tension in the bonded area during composite polymerization, causing it to pull away from the cavity walls. The quality of the bond can be impacted by chewing related stresses as well as thermal and chemicals. Tests for bond strength assess an adhesive's capacity to withstand these stresses while providing services. [4]

Bonding to dentin is more difficult because of higher water content, dentin tubular pattern, presence of smear layer, and pathophysiological changes such as presence of hyper-mineralized and sclerotic dentin. [5]
Performance of the adhesive system depends on penetration of hydrophilic monomers into the porosities and around the collagen fibrils exposed by acid. The efficacy of the adhesive system depends on the formation of hybrid layer interface. [6,7]
By demineralizing the smear layer and underlying dentin and simultaneously allowing resin monomers to penetrate into the demineralized zone, self-etch adhesive can improve marginal integrity and alleviate patient symptoms by forming hybrid layer within the dentin's collagen network. [8]
According to research, primary teeth's SBS to enamel is lower than that of permanent teeth. The permanent teeth exhibit higher densities, more regular enamel structure, the presence of specific directions, a greater number of enamel prisms and higher crystal densities than the primary teeth.[4]
Franke et al. speculate that the heat produced directly by laser irradiation may have contributed to the instantaneous increase in bond strength by promoting penetration of adhesive and evaporation of solvent. Furthermore, it was found that bond strength values can be immediately increased by a warm air stream, which could explain the laser irradiation technique's successful results.[9]
Based on studies on the effects of two single bottle adhesive systems and a self-etching primer on the bond strength to dentin, Ramos et al. concluded that the adhesive system being used determines how much the erbium-doped yttrium aluminium garnet laser (Er:YAG) negatively affects bond strength.[10]
The impact of the Er:Cr: YSGG laser on the adhesive strength and microleakage of dentin-bonded to resin composite was investigated by Vohra et al. In this study, 40 third molars were prepared using a traditional diamond wheel bur, and the remaining 40 were prepared by phototherapy with an Er, Cr:YSGG laser (erbium, chromium-doped yttrium, scandium, gallium, and garnet). Following their subgrouping, the third molars received SE and total etch treatment. The study found that the combination of the Er: Cr: YSGG phototherapy dentin treatment and the etch and rinse dentin bonding regime showed promise for clinical application when compared to conventional conditioning techniques. Even though the laser was utilised in the previously mentioned study to prepare the dentin, not much was known about how the Er: Cr:YSGG laser affected the dentin after the bonding agent was applied.[11]
From the present study we can infer that the laser activation does increase the shear bond strength of the self-etch bonding agent. Even though the increase in the bond strength is not significant statistically, further research in this field should be conducted to increase the understanding of the effect of laser on the shear bond strength of self-etch bonding agents.
One of the most important aspects of any restoration is its bond strength. The laser has made improvements possible in a number of dental fields. Before being used commercially, the impact of diode lasers on important teeth should be assessed in clinical trials. This study is a further step in that direction.

Conclusion:

Laser activation increases the shear bond strength of self-etch bonding agents, although the increase is not statistically significant.

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