

The Effect of Laser Irradiation on Shear Bond Strength of GI to Dentin After CPP-ACP Treatment

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Abstract

Background: Dentin sensitivity is one of the most important problems in dentistry. Enamel loss due to root exposure is serious issue and common exposure is one of the reasons for dentin hypersensitivity. There are different methods for solving this problem. One of the most conservative and least expensive methods is use of casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) paste.

Objectives: The aim of this study was to evaluate shear bond strength of GIC to dentin, with or without laser, CPP-ACP paste and polyacrylic acid treatments.

Materials and Methods: Fifty sound human third molars were bisected in a mesiodistal direction using a diamond disk. Using 400, 600 and 800 grit silicon carbide paper, dentin surfaces were exposed. The teeth were divided into five groups. In groups A, B, D and H, CPP-ACP (GC tooth mousse Itabashi-Ku, Tokyo, Japan) was applied for one hour the first day and repeated at the same time of day for a total of five days. In groups B, C, D and E, the specimens were subjected to laser for 10 seconds using Er, Cr: YSGG laser. In groups B, C, H and G, specimens were treated with 10% polyacrylic acid for 20 seconds. A plastic tube containing GI was positioned over the tooth. Samples were loaded in shear bond using a Universal Testing Machine (Zwick/Roell, Germany), at a 0.5 mm/minute crosshead speed.

Results: Despite the failing of groups A and D, group analysis showed that there were no significant differences between the groups. The predominant type of fracture in all groups was adhesive.

Conclusions: Application of CPP-ACP, without preconditioning with polyacrylic acid, can decrease shear bond strength. Laser irradiation has no effect on shear bond strength of GIC to dentin in this condition.

Keywords: CPP-ACP, Laser, Glass Ionomer, Shear Strength, Tooth Mousse

1. Background

The unique chemistry of glass ionomer (GI) has led to its broad clinical application as a mean to protect teeth from caries. GI can be used to provide a marginal seal and surface protection, as well as fluoride release (1). Yet, the longevity of restoration is crucial because of the marginal seal to reduce secondary caries (2). One of the main factors that improves marginal seal is high bond strength.

The exchange of ions between GI and the tooth structure stabilizes GI chemical bond to tooth minerals. Calcium (or strontium, in some products) and fluoride in the GI material, and calcium and phosphate in the tooth structure, migrate and form an intermediate layer that enables the GI to bond to the dentin (3). Both ultra-structural and analytical evidence is available on the existence of an intermediate layer along the GIC-dentin/enamel interfaces that is caused by ion exchange.

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lems in dentistry. Enamel loss due to root exposure is a serious issue, and common exposure is one of the reasons for dentin hypersensitivity.

There are different methods for solving this problem. One of the most conservative and least expensive methods is use of casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) paste. CPP-ACP delivers additional calcium and phosphate ions to the oral environment for enhancement of remineralization. The proposed mechanism of CPP-ACP is to stabilize calcium phosphate in solution and to increase the level of calcium phosphate ions to maintain a state of super saturation (4), thereby, facilitating ion exchange and remineralization.

When no reduction in dentin sensitivity after use of CPP-ACP paste occurs, the next conservative treatment would be GI application. McLean and Wilson first used the term 'surface conditioning' for cavity pretreatment in order to differentiate it from acid etching. Conditioning

is done to eliminate the debris formed on the tooth surface following cutting (5). There are different approaches for conditioning the tooth surface such as polyacrylic acid application and laser irradiation. The surface treatment, however, is still controversial. Several studies (6-12) have focused on the efficiency of the laser on the removal of carious tooth structures, surface pretreatment and cavity preparation. As laser irradiation produces a disorganized, indiscriminate destruction of organic and inorganic components (9, 13) and influences the availability of calcium ions on the tooth structure (14, 15), the mechanical and chemical adhesion of GIC is inherently affected (16). However, studies on the application of Er, Cr: YSGG laser, along with CPP [U+2011] ACP, are lacking.

2. Objectives

The aim of this study was to evaluate shear bond strength of GIC to dentin, with or without laser, CPP-ACP paste and polyacrylic acid treatments.

3. Materials and Methods

Fifty sound human extracted third molars were selected and cleaned with a scaler and pumice/water slurry with dental prophylactic cups and stored in 1% chloramine-T for two weeks. The teeth were bisected in a mesiodistal direction at low speed by diamond disk under water cooling, providing 100 halves. Using 400, 600 and 800-grit silicon carbide paper as (Matdor, Germany) dentin surfaces were exposed. The selected teeth were then embedded in cylindrical blocks in a manner that only the occlusal surfaces of the teeth were exposed. These teeth were divided into eight groups (Table 1).

In groups A, B, D and H, CPP [U+2011] ACP tooth mousse (GC International, Itabashi [U+2011] Ku, Tokyo, Japan) was applied on the dentin surface for the first hour on the first day and repeated at the same time of the day for a total of five days.

In groups B, C, D and E, the occlusal surface of the specimens was subjected to laser for 10 seconds using an Er, Cr: YSGG laser (Waterlase® Biolase, USA) in noncontact mode, at a distance of 1-2 mm at 1 W energy and 20 Hz frequency.

In groups B, C, H and G, specimens were treated with 10% polyacrylic acid for 20 seconds. After thorough washing with distilled water for 15 seconds, the samples were dried.

A plastic tube was positioned over the tooth, resulting in a cylindrical cavity with the diameter coincident with the 3 mm delimited bonding area. A standard power/liquid ratio was then mixed as specified by each manufacturer.

The resultant mixture was injected into the matrix and polymerized for 20 seconds. After storage in distilled water at 37°C for 24 hours, the matrix was opened and separated, leaving a Fuji Ortho LC (GC Corp., Tokyo, Japan) cylinder (3 mm in diameter × 4 mm height) that adhered to the surface. Samples were loaded in the Universal Testing Machine (Z010, software: TestXpert II V3.0, Zwick/Roell, Germany), at a 0.5 mm/minute crosshead speed. Shear bond strength values were registered in Kgf and converted into MPa. Averages and standard deviations were calculated, and the data were analyzed by ANOVA. Fracture types at the surface/restorative material interface were verified under a stereoscopic microscope at 40 × magnification. Failure was considered adhesive, if it occurred at the GC/dentin interface, cohesive if it occurred in GC and mixed if it involved both. Bond failure sites were not statistically analyzed.

4. Results

The mean values and standard deviations of shear bond strength are presented in Table 1. Groups A and D failed, however, the remaining groups were analyzed with ANOVA, which showed that there were no significant differences between groups ($P=0.999$). The predominant type of fracture was adhesive in all groups.

5. Discussion

The aim of this study was to evaluate shear bond strength of GIC to dentin, with or without laser, CPP-ACP paste and polyacrylic acid treatments. Remineralization occurs if the acidic pH is neutralized by ensuring the availability of sufficient calcium and phosphate ions in the environment. The anticariogenic mechanism of CPP [U+2011] ACP is achieved by the incorporation of the ACP into the plaque and into the tooth structure. Tooth mousse (TM) is a water-based, sugar-free cream that contains CPP-ACP. It maintains optimal concentrations of ions on tooth surfaces to enhance remineralization. In vitro studies have reported that CPP-ACP can be absorbed by the salivary pellicle and dental plaque (17). The CPP has an important role as an ACP carrier localizing the highly soluble calcium phosphate phase at the tooth surface; thereby, induced remineralization (18-20). Regarding the results of this study, there was no significance difference in shear bond strength of the GI to dentin following the application of a CPP-ACP paste without prior conditioning. We speculated that there was not enough strong chemical bond to the calcium phosphate deposited by the CPP-ACP paste. Also this paste has many additional ingredients, including Glycerol, Xylitol, Propylene Glycol, Metal oxides,

Table 1. Mean Shear Bond Strength \pm SD in All Groups

Group	Tooth Mousse	Laser	Conditioner	Mean Shear Bond Strength \pm SD
A	+	-	-	0.00 (pretest failure)
B	+	+	+	11.40 \pm 3.84
C	-	+	+	11.37 \pm 3.3
D	+	+	-	0.00 (pretest failure)
E	-	+	-	11.86 \pm 4.54
F	-	-	-	11.77 \pm 5.13
G	-	-	+	12.07 \pm 3.5
H	+	-	+	11.87 \pm 4.79

water and a Benzoate composition, which could affect the bond strength. The laboratory application of the CPP-ACP paste employed in this study may be different from the clinical application because of dilution by saliva, pulpal pressure, inter tubular fluid and oro-muscular agitation (21). It was suggested that since the CPP-ACP binds to the hydroxyapatite, the demineralized surface layer may afford less hydroxyapatite, and this could be reflected in the bond strength. CPP-ACP increases the number of potential calcium-binding sites, thereby, decreasing the ion diffusion constant (22).

Polyacrylic acid improved the bond strength of GIC, but this was affected by its concentration, time of application and the quality of the surface (21).

There are studies which were performed on the synergistic effect of laser irradiation and fluoride or other remineralizing agents on remineralization (23, 24). Most of these studies have been conducted on permanent teeth and have primarily assessed mineral loss, fluoride content and surface topography of enamel following laser irradiation. However, studies on bond strength after Er, Cr: YSGG laser Irradiation along with CPP [U+2011] ACP are lacking.

Er, Cr: YSGG laser irradiation modifies the calcium-to-phosphorus ratio, reduces the carbon-to-phosphorus ratio and leads to the formation of more stable and less acid soluble composition. The Er, Cr: YSGG laser microblative process causes vaporization of water and dental organic components, promoting the microexplosive destruction of inorganic substra, resulting in irregularities (7, 25). The microcrater-like appearance and the absence of the smear layer of lasered surfaces were described as desirable for adhesion (7, 26). Laser irradiation with Er, Cr: YSGG energy at 1 W for conditioning does not improve bond strength of GIC due to collagen denaturation (27). Adhesion to dentin is more complex than adhesion to enamel (28, 29). More investigation is necessary to determine the ultimate effect of lasing on dental substrate and its applicability in restora-

tive dentistry, as well as to determine which material is more appropriate to facilitate an optimal bonding to laser prepared teeth.

Application of CPP-ACP without preconditioning with polyacrylic acid strong decrease shear bond strength. Laser irradiation had no effect on the shear bond strength of GIC to dentin in the current condition.

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Footnote

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