The effect of different dentin hypersensitivity treatments on the shear bond strength of self-adhesive resin to dentin

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ABSTRACT

The effect of different dentin hypersensitivity treatments on the shear bond strength of self-adhesive resin to dentin

Background: This in vitro study evaluated the shear bond strength of self adhesive resin cement to dentin with different dentin hypersensitivity treatments.

Methods: Forty-eight dentin specimens were randomly divided into four groups (n=12). (1) Group C (control); (2) Group G (treated with Gluma Desensitizer); (3) Group E (treated with Er:YAG laser); (4) Group E+G (treated with Er:YAG laser following Gluma Desensitizer). Flowable self adhesive resin cement was applied to dentin surface and shear bond strength tests were performed. The mean SBS values were calculated and data were analyzed by one-way ANOVA test and Post Hoc test.

Results: Statistical analysis revealed that Group E statistically significantly lower bond strength values than the other desensitizing treatment groups tested (p<0.005). While there were no significant differences among the other groups (p>0.05).

Conclusion: The shear bond strength of self-adhesive resin will be decrease if dentin surface is irradiated with Er:YAG laser

KEYWORDS

Dentin hypersensitivity, erbium:yttrium-aluminum-garnet (Er:YAG) laser, gluma, self-adhesive resin, bond strength

ÖZ

Self adeziv rezin simanın bağlanma dayanımına farklı dentin hassasiyet tedavilerinin etkisi

Amaç: Bu in vitro çalışmada farklı dentin hassasiyet tedavilerinin self adeziv rezin simanın bağlanma dayanımına etkisi değerlendirildi.

Gereç ve Yöntemler: Kırk sekiz dentin örnek rastgele dört gruba ayrıldı (n=12). Grup K (kontrol); (2) Grup G (Gluma hassasiyet giderici uygulaması); (3) Grup E (Er:YAG lazer uygulaması); (4) Grup E+G (Er:YAG lazer uygulaması takiben Gluma uygulaması). Akıcı self adeziv rezin siman dentin yüzeylerine yapıtıldı ve makaslama bağlanma testleri yapıtıldı. Ortalama makaslama bağlanma değerleri hesaplandı ve veriler tek yönlü varıans analizi ve post hoc testiyle analiz edildi.

Bulgular: İstatistiksel analiz değerlendirildiğinde Grup E, diğer hassasiyet giderici gruplardan istatistiksel olarak anlamlı ölçüde düşük bağlanma değerleri gösterırken (p<0.005), diğer gruplar arasında anlamlı fark bulunmadi (p>0.05).

Sonuç: Dentin yüzeyi Er:Yag lazer ile muamele edilecekse, self adeziv rezinin bağlanma dayanımı azalacaktır.

ANAHTAR KELİMELER

Dentin hassasiyeti, erbium:yttrium-aluminum-garnet (Er:YAG) lazer, gluma, self adeziv rezin, bağlanma dayanımı

Dentin sensitivity, the most commonly diagnosed type of pain in clinical dentistry, is a dental pain which is sharp in character and of short duration arising from dentin exposed to various chemical and physical factors.1,2 Tooth enamel and cement surrounding dentin creates a protective layer for nerves. In the case of hard tissue loss as a result of several dental procedures such as cavity and crown preparations, dentinal tubules become exposed to oral cavity and a direct connection occurs between environmental stimuli and dental pulp.3,4

The most commonly accepted argument in the formation mechanism of dentin sensitivity is Hydrodynamic Theory.5 According to this theory, thermal, osmotic and chemical stimuli stops dental fluid flow in dentinal tubules, which stimulates nerve endings in dentin or pulp and dental pain occurs.6 In order to lower fluid flow in dentinal tubules, blocking tubule openings or nerve conduction are methods used in sensitivity treatment.7 To achieve this purpose, Gluma Desensitizer, one of the most commonly used desensitizer agents, is a glutaraldehyde-based substance.8,9 Gluma is used to block exposed dentinal tubules by helping plasma protein in dentin fluid precipitate, and diminish permeability by the presence of HEMA.10,11 In addition after tooth preparation, the diffusion of monomers to dentin is probably to be accelerated glutaraldehyde was combined with hydroxyethylmethacrylate (HEMA), advanced bond strengths were acquired.11-13

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In the management of dentinal sensitivity, laser therapy is an alternative method: erbium:yttrium-aluminum-garnet (Er:YAG) laser reducing the diameters of dentin tubules with the partial obliteration of the tubules below the ablation threshold. Er:YAG-irradiated dentine is characterized by denatured collagen fibrils and a fragile surface structure. The bond strength of adhesives to Er:YAG-irradiated dentin may be improve. As a consequence of slower dentinal fluid flow, dentin sensitivity may lower. Although dentin sensitivity treatments may make patients have less complaints, its effects into the shear bond strength of adhesive cementation should not be ignored. In practice, adhesive cementation is commonly used in desensitizer treatments. Since these treatments may change the characteristics of dentinal tubules, a later adhesive restoration practice may affect its shear bond strength.

In literature, a few studies examine the effects of desensitizer implementations into the shear bond strength of adhesive resin. Therefore, the aim of this in vitro study is to determine the effects of Er:YAG laser and Glutaraldehyde-HEMA into the shear bond strength of self-adhesive resin cement.

MATERIALS AND METHODS

In the study 48 pieces of healthy permanent third molar teeth were included. Soft tissue remains on teeth were cleaned by periodontal scaler and soaked in 0.2% timol solution. By using auto-polymerizing acrylic resin, the teeth were placed on their buccal surfaces collaterally and buried into cylindrical plastic containers. Then, to reveal their buccal dentinal tissue, buccal enamel tissue was cut by diamond saw (low speed) under water cooling and in order to obtain standard smear layers, buccal surfaces were grinded underwater by using 600 grit silicone carbide sandpaper.

Surface treatment of dentin specimens

The samples were randomly divided into 4 groups (n=12):

1. Control group: No implementation was realized.
2. Gluma implementation (Gluma Desensitizer, Heraeus Kulzer, Hanau, Germany): Gluma agent was used on dentinal surface by using a cotton brush and kept on the surface for about 30-60 seconds. Then, it was dried and rinsed till the film layer on the surface was removed.
3. Er:YAG laser irradiation: To simulate clinical conditions, dentinal surfaces were manually irradiated by scanning movements performed perpendicular to and approximately 6 mm away from the surface under the following conditions: 90 mJ, 2 Hz, short pulse mode for 60 seconds, two times.
4. Er:YAG laser irradiation and one of desensitizer implementation (Er:YAG + Gluma): Er:YAG laser and Gluma implementations were used respectively.

After storage in artificial salvia for 14 days at 37°C, all the specimens were rinsed with distilled water. Then, cylindrical teflon molds, 3mm in diameter and 2.5 mm in height, were placed on dentinal surface and treated by self-adhesive resin RelyX U200 (3M ESPE, ABD) in accordance with manufacturer’s instructions.

Test procedure for shear bond strength

All prepared samples were soaked into distilled water set at 37°C for 24 hours and then shear bond strength was measured using a universal testing machine (TSTM 02500, Elisa Ltd, İstanbul, Turkey) at 0.5mm/min crosshead until fracture occurred. Shear bond strength values (MPa) were calculated as the ratio of the fracture load and bonding area.

Statistical analysis

One way ANOVA and Post-hoc Tukey HSD test were used to determine statistical differences in SBS between the desensitizing treatment and control groups at a level of α=0.05.

SEM Analysis

One specimen from each group, was randomly chosen for scanning electron microscopic (SEM) examination. The specimens sputter-coated with gold-palladium and visualized with a magnification (2000x) adequate to evaluate the surface characteristics of dentin sites of the debonded.

RESULTS

Table 1 shows the mean values and standard deviations of the shear bond strength (MPa). The results of the statistical analysis showed significant differences in mean values of bond strength for the different desensitizing treatment groups. The bond strength for the Er:YAG irradiated group had significantly lower values than the other groups (p<0.05). Gluma group showed comparable high values although no significant differences were observed between the control and Er:YAG+Gluma groups (p>0.05).

Table 1.

Mean and SD values for shear bond strength (MPa)

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Gluma</th>
<th>Er:Yag</th>
<th>Er:Yag + Gluma</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.34±3.95</td>
<td>17.2±4.56</td>
<td>8.19±2.8</td>
<td>13.91±3.86</td>
<td></td>
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</tbody>
</table>
SEM Analysis

In the SEM examination, Gluma group some partial tubules were occluded, some dentin tubules were generally observed to be open (Figure 1b). Er:YAG laser was treated (Figure 1c) and Er:YAG + Gluma (Figure 1d) was treated, contracted and occluded dentin tubules were clearly observed. Er:YAG irradiated specimens showed narrowing and degradation in the diameter of the dentin tubules. In control group, fracture surface predominantly showed cohesive failure (Figure 1a). In contrast, the fracture patterns for the other groups adhesive and mixed failure.

DISCUSSION

Various treatment options are available to be used in dentin hypersensitivity treatment. Therefore, mostly, desensitizer agents are effectively used, however, their efficacy may rapidly diminish. Previous clinical studies on laser therapy to lower dentin sensitivity symptoms had been published and it had been shown to reduce dentin hypersensitivity. Er:YAG laser is absorbed by water molecules in hydroxyapatite. This condition causes ablation on dentin surface and causes a partial coating in dentinal tubules. However, a few studies focus on the effects of Er:YAG laser and desensitizer application into shear bond strength between resin material and dentin. Makkar et al. assessed the effects of Er:YAG laser and Thermokind-F Gel desensitizer on tensile bond strength of self-etch adhesive to dentin and reported that Er:YAG lasers decreased the tensile bond strength of self-etch adhesive to dentin. Er:YAG-irradiated dentin is coated with laser-modified dentin layer which is about 3-5 μm and microfractures are located underneath the dentin surface. Yazici et al. showed that Er:YAG laser therapy reduced the bond strength of the self-etch adhesives to dentin. Our findings also agrees with similar reported results in which the bond strength of different adhesive systems applied to Er:YAG laser-treated dentin was tested until failure, in micro-tensile or shear mode. According to authors in this denatured dentin layer without water is characterized with high acid resistance and the composition and structure of the collagen presents a modified structure and exposed collagen fibrils are hydrolyzed. We assume that the Er:YAG laser irradiation to dentin may have a negative effect on dentin bonding and a lower level of shear bond strength is considered as this condition prevents monomer diffusion into dentinal tubules.

In dentins on which both Gluma and Er:YAG were used, a higher level of shear bond strength was measured than Er:YAG groups in current study. According to this result Gluma improved the bonding strength with a self adhesive to Er:YAG irradiated dentin. Gluma desensitizer agent includes Glutaraldehyde and HEMA. Glutaraldehyde reacts with proteins producing precipitation on the dentin surface. The aldehyde group of glutaraldehyde cross-linking with the amino groups in dentin collagen resulting in protein fixation indicates that glutaraldehyde may bond to dentin collagen fibrils. HEMA plays an important role as a hardening agent preventing any subsequent shrinkage and undergoes a chemical reaction between its ester functional group and dentin collagen. In addition HEMA decreases surface tension of water and increases dentinal monomer diffusion by using HEMA implementation on dentin surface which was structurally modified by laser irradiation, the level of shear bond strength increases because resin diffusion into the dentinal tubules is simplified. Moreover, it was also reported that owing to the reaction between phosphate and glutaraldehyde in Gluma, Gluma desensitizer agent combined with self-adhesive resin cement provided a strong and suitable shear bond. Omae et al. who reported that although application of Er:YAG-irradiated dentine reduced, the Er:YAG laser irradiation followed by application of Gluma increased the bond strength of the self-etching priming adhesives. Although pretreatment on dentin surface with Gluma to increased shear bond strength of self adhesive resin cement to dentin, were not statistically significant difference control and...
Er:YAG + Gluma groups in this study. Acar et al in 2012 evaluated the effect of Gluma Aqua-Prep F, BisBlock, Cervitec Plus, Smart Protect, and Nd:YAG laser desensitizer on microtensile bond strength of RelyX U200 self-adhesive cement to dentin and reported that Gluma increased the microtensile bond strength, but not significantly; which was in agreement with our findings. However, they performed, test of microtensile, while we performed test of shear bond. In addition Aranha et al compared the effect of different dentin desensitizers on microtensile bond strength of composite resin and concluded that implementation of Gluma had no significant effect on microtensile bond strength. In previous studies, it was reported that dentinal fluid flow decreases shear bond strength since it affects adhesive resin diffusion into dentinal tubules. Despite the fact that desensitizer treatments causing tubular blockage restricts hybridization, the blockage of dentinal fluid flow may provide positive effects.

Adhesive cements have higher technical sensitivity and their clinical achievement may be threatened by technical errors. Moreover adhesive systems including acid implementation phases may stimulate the pain of patients suffering from dentin sensitivity. Recently, innovative self-adhesive methods which do not require surface preparations and do provide easier treatments have been introduced. RelyX U200 self adhesive resin cement used in this study, as a one-step solution, spares any pre-treatment steps like etching, priming and bonding. Self-adhesive systems include acidic monomer in their formation and they do not require another acid implementation phase. In addition, the fact that these self-adhesive systems are hydrophilic makes them humidity-tolerant and improves adaptation to tooth structure. In contrary to these advantages, its dentin demineralization depth and hybridization abilities are limited. Although our findings in the study open up new perspectives, since shear bond strength may be affected due to the reasons that dentinal fluid flow and pulpal pressure may not exist in extracted teeth, clinical performance for in vivo conditions may not be expected. Therefore, we believe that further in vivo studies are required to evaluate the potential effects of dentin sensitivity treatment including Gluma and Er:YAG laser into adhesive restorative materials dentin bonding.

CONCLUSION

Application of Gluma desensitizing and Gluma desensitizing to Er:YAG-irradiated dentin did not affect the shear bond strength when used a self-adhesive resin cement. The Er:YAG laser created a laser-modified layer that adversely affects adhesion to dentin.
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