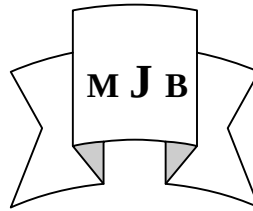


A Microtensile Bond Strength of The Pulp Chamber Dentine Treated with Different Bleaching Agents

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Abstract

This study was performed to determine the effect of intracoronal used bleaching agents on adhesion of bonding agents to pulp chamber dentine.

Forty extracted human maxillary central incisors teeth were randomly divided into four groups of 10 teeth each. Bleaching agents were sealed in pulp chambers for 7 days, as in clinical use. Group 1(control): distilled water, group 2: 35% hydrogen peroxide, group 3: sodium perborate mixed with water, group 4: sodium perborate mixed with 35% hydrogen peroxide. Teeth were stored in saline at 37 C for 7 days. After the bleaching agents was removed, teeth were leached in water for a further 7 days prior to bonding. The crown was cut vertically from mesial to distal and the labial pulp chamber dentine was prepared for bonding with Clearfil SE-Bond and filled resin composite (Clearfil AP-X). The bonded specimens were kept moist at 37 C for 24 h. microtensile bond strengths were determined using a universal testing machine. The mean values ($\pm$ SD) of microtensile bond strength for the experimental groups were: group 1: 5.29 ± 2.21 MPa, group 2: 5.99 ± 1.51 MPa, group 3: 9.17 ± 1.65 MPa, and group 4: 3.99 ± 1.31 MPa. Dentine treated with sodium perborate in water (group 3) had significantly higher mean bond strength when compared with the other three groups($p < 0.05$, Tukey's test). Mean bond strength was lowest when dentine was treated with sodium perborate plus hydrogen peroxide (group 4).

Conclusions In terms of subsequent bond strength during restoration, sodium perborate mixed with distilled water appears to be the best intracoronal bleaching agent.

الخلاصة

الهدف من هذه الدراسة لرؤية مدى تأثير استخدام العنصر القاصر على التصاق عامل الربط مع طبقة العاج الواقعة في لب السن . أربعون سن بشري أمامي علوي مقطوع قسمت عشوائياً إلى أربع مجاميع كل مجموعة مكونة من عشرة أسنان . تم وضع عنصر القاصر في لب السن كما مستعمل في داخل العيادة ثم أغلق بإحكام لسبعة أيام .

المجموعة الأولى (المسيطرة) : يستعمل فيها الماء المقطر .

المجموعة الثانية : 35% هيدروجين بيروكساييد .

المجموعة الثالثة : صوديوم بيربورييت مخلوط مع الماء .

المجموعة الرابعة: صوديوم بيربورييت مخلوط مع 35% هيدروجين بيروكساييد .

بعد ذلك تخزن الأسنان في محلول ملحي بدرجة 37°C لمدة سبعة أيام ثم يرفع القاصر وتوضع في الماء لسبعة أيام إضافية , يقطع تاج السن عمودياً وتحضر طبقة العاج في منطقة لب السن لاستقبال نوع الرابط (Clearfil) ثم تخزن في جو رطب بدرجة 37°C لمدة أربع وعشرون يوماً . تحضر النماذج لقياس قوة شد الرابط باستخدام ماكينة الفحص العالمية .

أظهرت النتائج بأن العاج المعالج بمادة صوديوم بيربورييت مع الماء أعطى أعلى قوة رابط عند مقارنته مع المجاميع

الأخرى .

Introduction

The primary indication for nonvital bleaching is to lighten teeth that have undergone root canal therapy. This discoloration may be a result of bleeding into the dentin from trauma before root canal therapy.

Bleaching of root filled teeth was first reported by Dwinelle(1850). Nutting and Poe(1967) sealed 35% hydrogen peroxide into the coronal pulp chamber and removed it 3 weeks later when the required result had been achieved ; they called this technique the (walking bleach). A technique using sodium perborate mixed with water was suggested in order to minimize the risk of cervical root resorption (Spasser 1961). Hydrogen peroxide(30%) mixed with sodium perborate was later proposed as a bleaching agent because bleaching efficacy is enhanced (Ho and Goerig 1989). Currently the most commonly used intracoronal bleaching materials are hydrogen peroxide(H_2O_2) and sodium perborate ($NaBO_3.4H_2O$) (Rotstein and Walton 2002). Although these agents are effective in lightening tooth colour (Kaneko et al. 2000), their use has been associated with undesirable complications, including increased dentine permeability, changes in tooth structure, restorations and reduced bond strength of composite resins (Crim 1992, Stokes et al. 1992, Titley et al. 1993, Chng et al. 2002) .

Due to specific properties of dentine, bonding has not yet achieved ideal characteristics. Most bonding systems adhere more strongly to superficial dentine, with progressively lower bond strength to deeper dentine. The dentine walls that make up the pulp chamber are the deepest possible dentine(Pashley et al. 1993) .

When the adhesive material is used properly, there is usually no gap between these materials and tooth

structure, greatly reducing microleakage. Application of adhesives to acid-etched dentine creates an acid-resistant, resin-infiltrated collagen layer, the so-called hybrid layer that not only retains composites to dentine, but also seal dentine against the ingress of oral fluids. When an access cavity is restored with resin composite, it is important to bond to pulp chamber dentine to enhance the adhesive area and hence the marginal seal (Sano et al. 1995).

Bond strength is significantly reduced when bonding is performed immediately after bleaching. Oxygen produced during bleaching remains in the enamel and dentine for up to 2 weeks, and may interfere with the chemistry of bonding agents(Titley et al. 1995).

Aim

To determine the effect of intracoronal bleaching agents on adhesion of bonding agents to pulp chamber dentine .

Materials and Methods

Selection and preparation of teeth

Forty extracted human maxillary central incisor teeth with intact crowns were collected and stored at 4 C° in normal saline solution. The criteria for tooth selection were: complete root formation, no caries, no restoration and no fracture line. The teeth were thoroughly cleaned. During subsequent preparation, care was taken to prevent dehydration of the specimens by keeping all teeth wrapped in gauze moistened with water. A conventional endodontic access cavity was prepared in each tooth, using a diamond bur in a high speed hand piece under water coolant. The pulp tissue was removed and cleaning and shaping was carried out using the stepback technique. Canals were irrigated with 2ml, 2.5%

sodium hypochlorite between successive files. Each canal was irrigated with 5ml, 2.5% distal water as a final rinsing of the canal. Then the root canal was dried with paper points. The coronal 1/3 of the root canal was packed with Cavition to 4mm below the cemento-enamel junction, using an endodontic plugger.

The teeth were divided randomly into four groups of 10 teeth each, by pooling all prepared teeth and assigning them to four groups using a random numbers table. Bleaching agents were placed into the pulp chambers as follows:

Group 1: (control) cotton pellet soaked with distilled water.

Group 2: 35% hydrogen peroxide on a cotton pellet filling the pulp chamber

Group 3: sodium perborate mixed with distilled water in a ratio of 2 g powder to 1ml liquid. A similar quantity (about 0.1g sodium perborate and 0.05ml liquid) of bleaching paste was placed into the pulp chamber of each tooth.

Group 4: sodium perborate mixed with 35% hydrogen peroxide in the same ratio as for group 3 and a similar quantity of bleaching paste was placed into the pulp chamber.

Access cavities were sealed with 4mm thickness of Cavit. Each tooth was placed in a capped plastic tube and stored at 37 °C in 100% humidity for 7 days. Cavit and treatment agents were removed from the access cavity and the pulp chamber was rinsed with 20ml distilled water. A cotton pellet soaked in distilled water was placed in the pulp chamber and sealed with Cavit. The specimens were stored in 100% humidity at 37 °C for 7 days before bonding and microtensile testing.

Preparation of samples for micro tensile testing

The root was removed from the crown approximately 2mm below the cemento-enamel junction using a slow

speed diamond saw, under copious water spray and then cut vertically from mesial to distal to expose labial pulp chamber dentine. The specimens were cleaned with distilled water to remove debris, then air-dried with a triple syringe. The pulp chamber dentine was bonded with Clearfil SE-Bond according to the manufacturer's instructions, as follows:

The primer was thinly applied with disposable brushes for 20 s, dried with a mild air flow, and the bonding agent was applied, air-flowed gently and light-cured for 10 s. A block of resin composite was built up on the bonded surface and light cured. The specimens were then kept in tap water for 24 h at 37 °C.

Each specimen was sectioned in a bucco-lingual direction to provide two sections each 0.7mm thick. Thus 20 specimens were prepared from each group. As described in detail (Sano et al. 1994) these sections were then shaped to a dumbbell shape with the narrowest portion at the bonded interface and standardized to produce a bonded surface area of $1.0 \pm 0.2 \text{ mm}^2$ by using a superfine diamond bur with a high-speed hand piece under copious air-water spray. The thickness and width of the bonded area of each specimen were checked before testing using a digital micrometer. The specimens were then attached to a Bencor-MULTI-T testing apparatus with a cyanocrylate adhesive and stressed in tension using a universal testing machine at a crosshead speed of 1mm min⁻¹. The mean microtensile bond strengths (MPa) at failure mode were calculated as the maximum load at failure divided by the bonded cross-sectional area.

Statistical analysis

The mean bond strengths were statistically analyzed using multiple comparison range tests, following by

Tukey's test. A P-value < 0.05 was considered to be significant.

Results

The effects of the various bleaching agents on the microtensile bond strength of Clearfil-SE bond to pulp chamber dentine are shown in table 1. The mean bond strength to dentine irrigated with 2.5% NaOCl during cleaning and shaping but not treated with bleaching agent (control) was 5.29 ± 2.21 MPa (mean $\pm$ SD, n =20). Mean microtensile bond strength was highest for dentine treated with sodium perborate in distilled water (9.17 ± 1.65

MPa) and lowest for dentine treated with sodium perborate plus hydrogen peroxide (3.99 ± 1.31 MPa). With an intermediate value for hydrogen peroxide alone. Multiple comparisons showed a highly significant effect of treatment with bleaching agents ($p < 0.01$). The mean bond strength to dentine treated with sodium perborate in water (group 3) was significantly higher than for the other three groups including the control (group 1), and the only other statistically significant difference was between groups 2 and 4 ($p < 0.05$).

Microtensile bond strength to pulp chamber dentine (n=20)

		Mean	SD	Max	Min
Group1:control		5.29	2.21	8.96	2.01
Group2:hydrogen peroxide		5.99	1.51	9.21	4.22
Group3:sodium perborate +distilled water	9.17	1.65	11.91	6.77	
Group4: sodium perborate + hydrogen peroxide		3.99	1.31	6.18	2.29

Group identified by different superscript letters are significantly different ($p < 0.05$).

Discussions

The microtensile bond strength test used in this study (Sano et al. 1994) allows the testing of very small cross-sectional areas of dentine-resin specimens (1.0 ± 0.2 mm²) and develops a uniform stress distribution during testing. The strength of dental adhesive systems has commonly been evaluated using the shear bond strength test. This traditional method uses large surface areas (about 7-12 mm²) in testing, which are difficult to achieve in studies of pulpal surface dentine. The typical form of fracture with shear testing (mostly cohesive failure) does not provide reliable information with regard to the adhesive strength of the bond (Erickson et al. 1989, Perinka et al. 1992) Furthermore, a high bond strength is almost impossible to

measure using this method. Later the method of microtensile bond test demonstrated higher bond strength than other methods that used larger surface areas (Sano et al. 1994). Since then, a microtensile test method has become commonly used.

Overall, the mean values for bond strength in this study were low because bonding may be affected by differences in the dentine location and changes in the properties in different locations within a tooth. The bond strength to dentine close to the pulp was much less than that to superficial dentine (Suzuki and Finger 1988). Regional variations in permeability of dentine have also been reported (Pashley et al. 1987, Maroli et al. 1992), related to variations in the density and diameter tubules. This

study was performed on pulp chamber dentine, which is the deepest possible dentine, in addition, pulpal dentine was exposed to sodium hypochlorite during canal preparation. This is in accordance with previous studies that reported a reduction of bond strength of bovine coronal dentine treated with 5% NaOCl, from 16 MPa to approximately 5 MPa (Nikaido et al. 1999, Morris et al. 2001).

Several factors may be associated with the adverse effect of hydrogen peroxide on bond strength. Hydrogen peroxide is capable of generating hydroxyl radical, an oxygen-derived free radical which is known to accumulate in dentine and inhibit polymerization of resin (Titley et al. 1993). Although this study delayed bonding for 7 days after bleaching residual oxygen may remain in dentine and retard polymerization. In addition, different properties of bleaching agents, such as pH of the solutions and decomposition products of each agents may affect the dentine surface. The pH variation amongst bleaching agents was reported by Rotstein and Friedman(1991). Sodium perborate is alkaline, whereas 30% hydrogen peroxide is acidic. The pH of the materials when mixed together gradually changes from acidic to alkaline as the concentration of dissolved sodium perborate gradually increases. A previous study has shown that there was a relation between microhardness and calcium concentration and bond strength (Pernka et al. 1992). In this study sodium perborate did not adversely effect bond strength, and actually increased it. This may be related to the absence of a significant reduction in calcium levels or microhardness Of dentine following treatment with sodium perborate (Lewinstein et al. 1994, Rotstien et al. 1996, Chng et al. 2002). On the contrary, exposure to

high concentrations of hydrogen peroxide decreased dentine microhardness and led to alterations of chemical structure of dentine (Lewinstein et al. 1994, Rotstein et al. 1996, Teptoranintra et al. 2001).

It has been reported that dentine treated with 35% hydrogen peroxide and 35% carbamide peroxide would achieve significantly higher bond strength if bonding treatments were delayed for another week (Spyrides et al. 2000). Several studies have suggested that inhibition of resin polymerization by residual oxygen can be reversed by leaching dentine in water for a period of 7 days prior to bonding (Torneck et al. 1991, Spyrides et al. 2000). This study suggested that high concentrations of hydrogen peroxide should not be used as part of the bleaching process, because of the persistent effect on bond strength even after leaching .

Conclusions

Hydrogen peroxide should be avoided as a bleaching agent for the (walking bleach) if bonding agents are to be used during subsequent restoration. Pulp chamber dentine bleached with sodium perborate in distilled water exhibited an elevated microtensile bond strength, and it is therefore recommended that, whenever possible, sodium perborate should be used for intracoronal bleaching.

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