ABSTRACT

Objective: To evaluate the initial shear bond strengths (SBSs) of ceramic brackets using either a self-etching primer (SEP) or the conventional method (CM) after intracoronal bleaching with sodium perborate and distilled water.

Methods: Eighty human incisors were divided into four groups according to bleaching and bonding procedures: Group 1, bleaching was not applied and the brackets were bonded with a self-etching primer; Group 2, bleaching was not applied and the brackets were bonded with the conventional method; Group 3, intracoronal bleaching with sodium perborate was applied for three weeks and the brackets were bonded with a self-etching primer; and Group 4, intracoronal bleaching with sodium perborate was applied for three weeks and the brackets were bonded with the conventional method. A self-etching primer (Transbond Plus) was applied as recommended by the manufacturer. After SEP application, the ceramic brackets were bonded with a light-curing adhesive (Transbond XT). For the conventional method, the teeth were etched with 37% phosphoric acid. After etching, a thin uniform coat of primer (Transbond XT Primer) was applied and the ceramic brackets were bonded with a light-curing adhesive (Transbond XT). SBSs were measured after water storage for 30 days, after 1000 cycles of thermocycling between 5°C and 55°C. Bond failure location was determined with the Adhesive Remnant Index (ARI).

Results: For the SEP method, there was no significant difference between SBS values of the bleaching and non-bleaching groups. Furthermore, for the conventional method, the SBS value of the non-bleaching group was not significantly different from that of the bleaching group. SBS values of the SEP method presented significant differences from those of the conventional method (p<0.001). SBS values of SEP application decreased with and without bleaching. The ARI scores did not show any significant difference among the groups (p=0.174).

Conclusion: Intracoronal bleaching with sodium perborate and distilled water did not affect the SBS values of ceramic brackets.

Keywords: Self-etching primer, intracoronal bleaching, ceramic brackets, bond strength

INTRODUCTION

The contamination of the pulp cavity, irrigants, root canal, and other restorative materials as well as pulpal injury may cause the discoloration of endodontically treated teeth. Intracoronal bleaching of the discolorized tooth is an option to overcome this. Hydrogen peroxide, sodium perborate, and carbamide peroxide are agents that are widely used for intracoronal bleaching. Sodium perborate is an oxidizing agent available as a powder. In the presence of water, it breaks down to form sodium metaborate, hydrogen peroxide, and nascent oxygen. Water-based sodium perborate paste has been reported to be less harmful to dental tissues.

The data about the effect of bleaching agents on the shear bond strengths (SBS) of orthodontic brackets is contradictory. Uysal et al. reported that bleaching did not adversely influence the bond strengths of brackets bonded
immediately after bleaching or at 30 days after bleaching. Conversely, Teixeira et al. reported that non-vital tooth bleaching affected the resin/enamel shear bond strength values when sodium perborate mixed with 30% hydrogen peroxide was used.

Recently, acid-etch primers have gained significant attention. A self-etching primer (SEP) combines the etching and priming steps, eliminating the need for distributing, etching, rinsing, and drying. In addition, SEP can be actively utilized to bond orthodontic brackets and can work as a practical alternative to the conventional two-stage bonding system. Several in vivo studies have been published concerning the rates of bond failure with the conventional method (CM) and SEP. Asgari et al. and dos Santos et al. reported significantly lower bond failure rates with SEP than with CM. Conversely, Ireland et al. and Murfitt et al. found significantly higher failure rates with SEP than with CM. On the other hand, Cal-Neto and Miguel and Aljubouri et al. did not observe any significant differences between the failure rates of SEP and CM bonds at the end of 6-month and 12-month observation periods.

Ceramic orthodontics brackets were introduced in 1987 as a more esthetic alternative to stainless steel brackets. Ceramic brackets demonstrate superior esthetics, biocompatibility, and resistance to physical and chemical factors and are reported to have bond strength greater than or equal to that of stainless steel brackets. A review of the literature found no studies on the effect of intracoronal bleaching treatments on the bond strength of ceramic brackets bonded with composites to enamel.

The aim of this in vitro study was to evaluate the initial SBSs of ceramic brackets using either SEP or CM after intracoronal bleaching with sodium perborate/distilled water and to determine the adhesive remnant index (ARI) scores of ceramic brackets bonded with SEP and CM.

METHODS

Eighty non-carious, freshly removed single-rooted mandibular incisors were used. The buccal surfaces were intact. Teeth with cracks, gross irregularities of the enamel structure, and histories of pretreatment with a chemical agent such as alcohol, formalin, or hydrogen peroxide were not included.

After extraction, the teeth were kept in distilled water until they were used. The water was changed weekly to avoid bacterial growth. The buccal surfaces were polished with a rubber cup and slurry of pumice and water, rinsed with water spray, and dried with compressed air.

Bleaching Procedures

The samples were randomly divided into four groups with 20 teeth in each group. The specimens in Groups 1 and 2 did not receive any bleaching agent, while specimens in Groups 3 and 4 received intracoronal bleaching with sodium perborate and distilled water. The bleaching procedure was as follows:

An endodontic access cavity was prepared with a round diamond bur (Diatech, Coltene Whaledent, Altstatten, Switzerland) and a high-speed hand piece under water cooling. The root canal was prepared by using ProTaper (Dentsply Mallefer, Ballaigues, Switzerland) nickel-titanium rotary instruments up to a size F3; an irrigation of 2.5% sodium hypochloride was provided between each file. The final irrigation was applied with saline solution, and the root canal was dried with sterile paper points. The canal was filled with AH26 (Dentsply, DeTrey, Konstanz, Germany) sealer and ProTaper F3 gutta-percha using a single-matched cone. The cervical third of the canal was prepared with Gates-Glidden drills (Dentsply Mallefer, Ballaigues, Switzerland). Approximately 2 mm of light-cured glass ionomer base (Ionoseal, Voco GmbH, Cuxhaven, Germany) was placed coronal to the gutta-percha in the canal before the bleaching agent was inserted into the pulp chamber to prevent apical leakage of the agent.

The intracoronal bleaching agent was then inserted to fill the pulp chamber, and a coronal seal was provided with light-curing glass ionomer cement. The bleaching agent was changed every seven days for three weeks. When the bleaching was completed, the access cavity was permanently sealed with composite resin restoration (Filtek Z250, 3M ESPE, St. Paul, MN, USA).

Brackets

Eighty identical ceramic mandibular incisor brackets (Clarity, 3M Unitek, Monrovia, California, USA) were used for all the experimental groups. The mean area of each bracket’s base was 8.65 mm², according to the manufacturer.

In Group 1 and 3, SEP was applied to the enamel surface and rubbed for 3 seconds. Then, a gentle burst of dry air was delivered to thin the primer. The adhesive resin (Transbond XT, 3M Unitek, CA, USA) was placed onto the bracket base and the bracket was positioned on the enamel surface. Excess adhesive resin was removed with an explorer. Polymerization for a total of 20 seconds from two directions using a visible light-curing unit having an output power of 600 mW/cm² was performed.

In Group 2 and 4, bonding was performed with the conventional method (CM): the teeth were etched with 37% phosphoric etchant liquid-gel (3M ESPE, St. Paul, MN, USA) for 30 seconds, rinsed, and dried. After etching, a thin uniform coat of primer (Transbond XT Primer, 3M Unitek, CA, USA) was applied. The adhesive resin (Transbond XT Light Cure Adhesive Paste, 3M Unitek, CA, USA) was placed onto the bracket base and the bracket was positioned on the enamel surface. Bonding with Transbond XT adhesive resin was performed as for SEP.

Debonding Procedure

Thirty days after the bracket bonding, thermocycling was performed between 5°C and 55°C, with a dwell of 30 seconds, as recommended by the International Organization for Standardization. After 1000 thermal cycles, the samples were debonded.

The samples were embedded into cold-cure acrylic resin (Orthocryl, Dentaurum, Ispringen, Germany) cylindrical blocks (31 x 15 mm) before the shear bond test.
The shear bond test was performed with a universal testing device (Lloyd LRX; Lloyd Instruments; Fareham, UK). Each specimen was secured in the lower part of the machine so that the bracket base was parallel to the direction of the shear force. The specimens were stressed in an occlusogingival direction with a cross-head speed of 1 mm/min.

Residual Adhesive

The enamel surfaces were examined with a stereomicroscope (Stemi 2000-C; Carl Zeiss, Göttingen, Germany) at a magnification of 10x to determine the amount of composite resin remaining according to the adhesive remnant index (ARI). The ARI scale has a range from 0 to 3: 0 indicates that no composite remains on the enamel; 1, less than half of the composite remains; 2, more than half of the composite remains; and 3, all the composite remains on the tooth surface.

Statistical Analysis

Descriptive statistics were performed with Statistical Packages for the Social Sciences (IBM SPSS Statistics; Armonk, NY, USA). Variables were expressed as the median, minimum, and maximum. ARI scores were compared using Pearson’s chi-square test for the groups. Kruskal Wallis test was used to determine for differences between the four groups for MPa variables. Bonferroni adjusted Mann–Whitney U test was used for the post-hoc test after the Kruskal–Wallis test. A p value of less than 0.05 was considered statistically significant for all the tests.

RESULTS

Descriptive statistics for each group are presented in Table 1 and Figure 1. The Kruskal Wallis analysis showed a significant difference among the groups (p<0.001). Pairwise comparison with the Mann–Whitney U test showed that there was no significant difference between Groups 1 and 3 (Table 2). Furthermore, Group 2 was not significantly different from Group 4. SBS values of SEP presented significant differences from the SBS values of the CM (p<0.0083). The SBS values of the SEP application decreased with and without bleaching.
The effect of the intracoronal bleaching agent on the enamel surface is still unknown. Ari and Üngor\(^2\) reported that sodium perborate should be mixed with water rather than with hydrogen peroxide in order to prevent or minimize the occurrence of bleaching-related surface alterations. According to our results, bleaching with sodium perborate and distilled water did not significantly affect the SBS. However, Gungor et al.\(^2\) concluded that intracoronal bleaching significantly affected the SBS of orthodontic brackets on human enamel. Contradictory to our results, they stated that bleaching with sodium perborate affected SBS more adversely than bleaching with hydrogen peroxide and carbamide peroxide agents. Nevertheless, the liquid mixed with sodium perborate was not stated in their study. The difference between the results of the two studies may be related to the liquid mixed with sodium perborate (i.e., whether they mixed it with hydrogen peroxide instead of distilled water). Similar to our results, Teixeira et al.\(^4\) observed no alteration in bond strength after bleaching with sodium perborate combined with distilled water. On the other hand, a reduction in SBS was reported only for the group bleached with a mixture of sodium perborate and hydrogen peroxide.

The bond strength of brackets can be affected by the surface preparation techniques,\(^2\) bonding technique,\(^2\) and the type of bonding materials.\(^2\) Similarly, our results demonstrated that the type of bonding agent is important for the shear bond strength. The only significant difference was recorded between the groups regarding the type of bonding.

**CONCLUSION**

- The results of this study showed that intracoronal bleaching with sodium perborate and distilled water did not affect the SBS values of ceramic brackets that were bonded 30 days after bleaching.
- Thus, the aforesaid mixture can be safely used before and/or during orthodontic treatment, if intracoronal bleaching is required.

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**REFERENCES**


