

EFFECT OF BLEACHING ON SHEAR BOND STRENGTH OF ORTHODONTIC BRACKETS

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ABSTRACT

The purpose of this in vitro study was to determine the effect of bleaching on shear bond strength of orthodontic brackets.

This randomized control trial was performed over a period of 6 months in the department of orthodontics, de, Montmorency College of Dentistry, Lahore. A total of one hundred and forty extracted premolar teeth were included which were further divided into two groups. Group A was assigned as control group without bleaching and Group B as study group with bleaching. The teeth in both groups were embedded individually in acrylic placed in rubber moulds using a mounting jig so that the labial surfaces would be parallel to the applied force during the shear test. Group B was bleached with Pola office advanced tooth whitening system and were stored in a solution of 0.9% saline till they were bonded. The bonding process for both groups was then performed in a standard manner. After bonding bracket was properly positioned on its respective tooth. An occluso-gingival load was applied to the bracket producing a shear force at the bracket tooth interface using a computerized shear bonding testing machine. The results showed that there was no statistically significant difference between the shear bond strength of unbleached teeth and that of bleached teeth following a two weeks interval after bleaching.

Key words: Premolar teeth, Tooth bleaching, Brackets, Shear strength

INTRODUCTION

Bleaching of teeth is rapidly gaining popularity due to increased awareness of cosmetic dentistry among the population.¹ A brighter smile improves self-image and confidence and projects an aura of health to others.²

Tooth discoloration varies in etiology, appearance, localization and severity. It may be classified as intrinsic, extrinsic, and a combination of both.³ Wear of the tooth structure, deposition of secondary dentin due to

aging or as a consequence of pulp inflammation and dentin sclerosis affect the light-transmission through teeth, consequently giving the teeth a darker color/hue.⁴

Scaling and polishing of the teeth remove many extrinsic stains. Harder/deeper extrinsic discoloration and intrinsic staining require various bleaching techniques. Tooth bleaching can be performed externally, termed vital tooth bleaching, or intracoronally in root-filled teeth, called non-vital tooth bleaching.

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Bleaching is usually done by a 35% hydrogen peroxide gel in a dental office. Hydrogen peroxide is known to release free oxygen radicals which cause cellular changes on the tooth surface, producing reactive oxygen molecules and hydrogen peroxide anions.⁵ These reactive molecules attack the long-chained, dark-colored chromophore molecules and split them into smaller, less colored and more diffusible molecules and change the surface topography of the tooth. After bleaching the changes which occur in enamel morphology includes the loss of prismatic form, changes in the superficial enamel structure and loss of resin tags.⁶

Vital bleaching could alter the surface topography of enamel and thus affect the bond strength of adhesives to the teeth. It has been demonstrated that 35% hydrogen peroxide solutions change enamel structure and composition.⁷ Alterations in bond strength might be significant during clinical procedures that involve composite resin bonding, such as composite restorations, veneers, and bonding orthodontic brackets.⁸

As some adults who are having orthodontic treatment might also want bleaching, it is important to determine whether bleaching significantly affects the bond strength of orthodontic bracket adhesives to the enamel surface.³ Several authors have dealt with this subject and found different results.^{3,9,10} Some stated that bleaching did not affect the shear bond strength of pre-coated orthodontic brackets to enamel¹⁰, while others have reported a significant reduction in bond strength after bleaching.¹ It is stated that a reduction of resin-enamel bond strength in bleached enamel might be caused by a delayed release of oxygen that affects polymerization of resin components.¹¹ On the other hand, a study showed that there was a significant increase in bond strength when bonding was delayed for a week for both the 35% carbamide peroxide and the 35% hydrogen peroxide.¹⁰

METHODOLOGY

This *in vitro* study based on randomized control trial was done over a period of six months in the Department of Orthodontics, de Montmorency College of Dentistry / Punjab Dental Hospital, Lahore (tertiary health center).

One hundred and forty extracted human premolar teeth were selected as per inclusion criteria from the OPD, regarding their inclusion of teeth in the study.

The sampling technique used was based on non-probability purposive sampling.

Teeth were randomly allocated to study group and control group using Table of Random Numbers. Group A was assigned as control group (without intervention) in which orthodontic brackets were bonded to unbleached teeth. Group B was the study group in which the intervention was used i.e. all the teeth were bleached and orthodontic brackets were bonded after two weeks of bleaching.

The teeth in the two groups were cleansed and polished with pumice and rubber prophylactic cups for 10 seconds and washed with water.

The teeth were then embedded in acrylic (Fig 1) placed in rubber moulds using a mounting jig so that the labial surfaces would be parallel to the applied force during the shear test.

In Group B bleaching on seventy teeth was performed with Pola office advanced tooth whitening system (SDI, Bays water, Victoria, Australia) (Fig 2). After air drying, teeth were bleached by applying the material on the buccal surface which was mixed in the recommended consistency. The bleaching agent was light cured using LED light placed in close proximity i.e. within 2-3 mm of the buccal surface of the tooth (Fig 3). A second cycle was also being repeated.

Teeth in Group A and Group B were bonded simultaneously. The bonding process was proceeded in the standard manner i.e. after fulfilling the above-mentioned prerequisites, a 37% phosphoric acid gel was applied on the buccal surface of each tooth (irrespective of the group) for 15 seconds. Then teeth were rinsed and dried until chalky white appearance of enamel. Primer was applied on the etched surface and the bracket base. Composite adhesive chemically cured (Herculite, Kerr, USA) was placed on each bracket base. 120 identical (premolar brackets with mean area of 2.2 mm²) non-coated metal brackets (Mini diamond, Ormco, Kerr, USA) were used in this study. Each bracket was properly positioned on its respective tooth and left for curing for 30 minutes (Fig 4). An occluso-gingival load was applied to the bracket, producing a shear force at the bracket-tooth interface. Shear bond strengths was measured at a crosshead speed of 5 mm/minute (Fig 5). The shear bond strength value was determined in megapascals (MPa). The brackets

were de-bonded after 30 minutes of bonding, to approximate the time that the initial arch wires are inserted and tied to the teeth, which is the recommended time (Fig 6).

De-bonding was carried out with computerized machine (AGS-J Shimadzu) to calculate the shear bond strength in both groups (Fig 7).

RESULTS

Using the statistical package for the social sciences (SPSS) version 11.0 the data was statistically analyzed. Descriptive statistics were calculated including mean, standard deviation, minimum and maximum values for age, time elapsed and shear bond strength, which are numerical variables presented by mean standard deviation and sex being a qualitative variable was presented as percentage. Student's t-test was used to determine whether significant differences existed between the various groups in respect of shear bond strength.

$P < 0.05$ was considered significant. A comparison of age distribution among the two groups was done. The mean age of the patients from which the premolar teeth were extracted was 17.99 ± 2.97 years with a minimum age of 14 years and maximum age of 25 years. The mean age of patients in group A was 18.16 ± 3.11 years with minimum age 14 years and maximum 25 years. The mean age of patients in Group B (bleaching followed two weeks later by bonding) was 17.83 ± 2.83 years with minimum age 14 years and maximum 24 years. The difference between the age groups in both these sets of patients was found to be insignificant.

Along with age comparison, a comparison of gender was also done among the two groups. Of the 140 premolar teeth taken, 72 were extracted from females which make up 51.4% of the sample while 68 were taken from males patients which make up 48.6% of the total sample.

The shear bond strength of both groups was 6.97 ± 1.79 with minimum shear bond strength of 4 MPa and maximum shear bond strength of 11 MPa. In group A, the shear bond strength was 7.13 ± 1.71 MPa with minimum shear bond strength at 4 MPa and maximum at 11 MPa. In group B, the shear bond strength was 6.81 ± 1.86 MPa with minimum shear bond strength of 4 MPa and maximum at 11 MPa (Table 1).

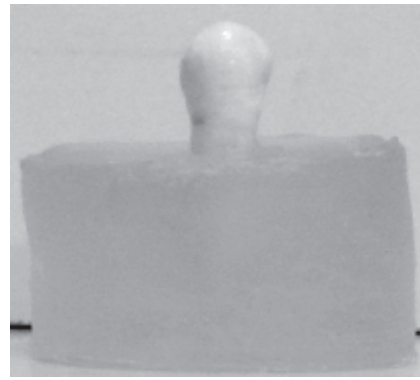


Fig 1: Tooth placed in acrylic jig



Fig 2: Pola-office advanced tooth whitening system

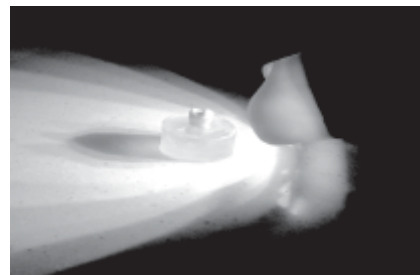


Fig 3: Bleached tooth placed under light-emitting diode

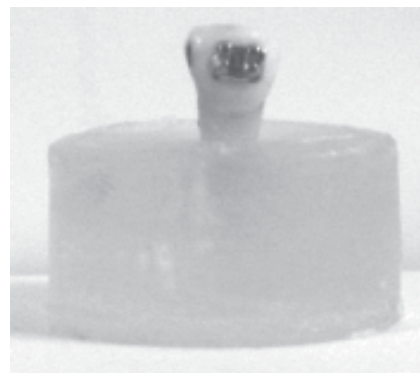


Fig 4: Bracket placed on tooth (bleached and unbleached groups)

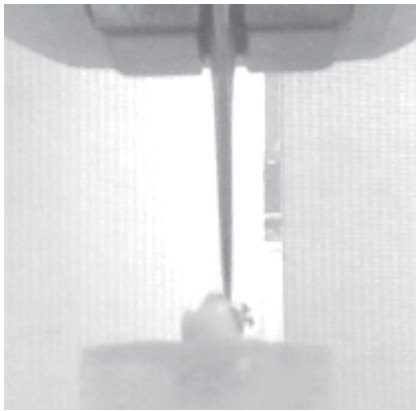


Fig 5: Occluso-gingival load applied to the bracket

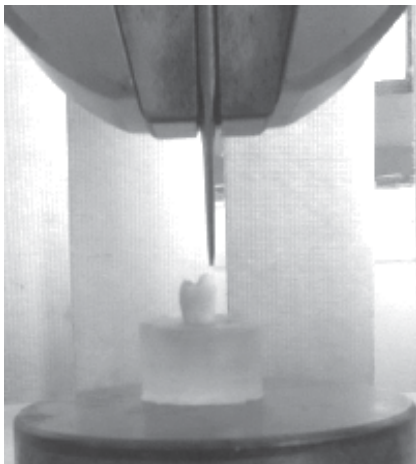


Fig 6: Bracket removed after shear bond testing

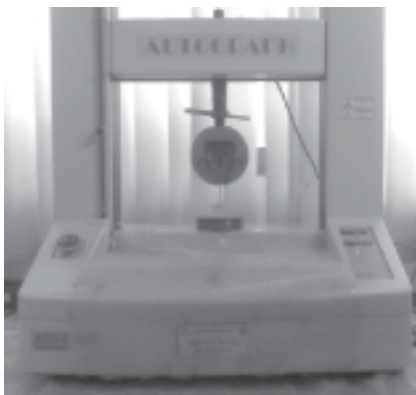


Fig 7: Computerized Shear Bond Testing Machine

Student's t-test was used to determine whether significant differences existed between the various groups in respect of shear bond strength and time delay. The statistics showed that both in respect of shear bond strength and time delay no significant difference exists as one sided p-value in both groups is $0.151 > 0.05$.

TABLE 1: COMPARISON OF SHEAR BOND STRENGTH OF GROUP A AND GROUP B

	Shear Bond strength of both groups (MPa)	Shear Bond strength (Group A)	Shear Bond strength (Group B)
Standard Deviation	1.795	1.719	1.867
Range	7	7	7
Standard Error Mean	—	0.205	0.223
Minimum	4	4	4
Maximum	11	11	11

DISCUSSION

The number of patients undergoing orthodontic treatment has increased tremendously over the years. Most of these patients are advised to undertake bleaching of their teeth prior to the initiation of the orthodontic treatment. This bleaching is usually done by using a 35% concentration gel of hydrogen peroxide, which by releasing free radicals, initiates the process of bleaching.

This study conducted at the department of Orthodontics at de, Montmorency college of dentistry, Lahore focused on one critical point; whether this pre-orthodontic bleaching would, in any way, affect the shear bond strength of the orthodontic brackets used for the subsequent orthodontic treatment.

Dishman *et al* suggested that bleaching causes polymerization inhibition which decreases bond strength.¹² This change should then negatively affect the shear bond strength of the orthodontic brackets, thereby reducing it. However, in our study the difference between both the groups is insignificant which is contrary to the findings of Dishman *et al*.¹² This may be attributed to the fact that we gave a two weeks waiting period after bleaching.

Studies have shown that bleaching immediately before bonding brackets to the teeth reduces tensile and shear bond strength of composite resin to enamel.¹⁰ Present study doesn't support or negate this finding as this study involved a two week waiting period before bonding.

Spyrider *et al*¹³ suggested that bonding brackets a week after bleaching would significantly improve the shear bond strength as compared to bonding immediately after bleaching. This also supports our findings.

Cavalli *et al*¹⁴ felt that a period of up to 3 weeks is required between bleaching and bonding before resin-enamel bond strengths return to values obtained for unbleached enamel. However, this study suggests that the difference between the shear bond strengths of bleached and un-bleached enamel is insignificant, therefore ruling out the need for an additional week's wait. As suggested by evidence¹⁵, a two-week wait is sufficient to balance out the detrimental effects of bleaching.

It was also suggested by Josey *et al*¹⁵ that a consistent increase in shear bond strength of teeth occurs upto six weeks after bleaching, after which there is no significant increase in bond strength. Our findings rule out such a long wait and suggest that a two weeks period is ample to decrease the difference between both the groups to an insignificant level. This is more practical in terms of prevalent clinical practices and encourages patient compliance.

The shear bond strength of group B (bleaching followed two weeks later by bonding) was 6.81 ± 1.86 MPa with minimum shear bond strength at 4 MPa and maximum at 11 MPa. This was in-line with the findings of Bishara *et al*⁹ who found a comparable range of shear bond strength two weeks after bleaching (6.6 ± 2.6 MPa). Bishara *et al*⁹ also found that at one week interval after bleaching, the shear bond strength of teeth was significantly less than that found at two weeks interval; 5.1 MPa at one week and 6.6 at two weeks. This further supports our contention that one week is too short a period after bleaching while two weeks is an adequate period for effective and clinically acceptable bond strength.

However, a clear cause and effect relationship is difficult to establish as other factors including contamination, atmospheric alterations, humidity effects etc. cannot be ruled out. We will endeavor to establish a relationship between these factors by reviewing work from respected peers in this field.

This study was successful in not only lessening the waiting period but also proving that even at two weeks interval after bleaching, the shear bond strength is almost similar to that of un-bleached teeth, therefore obliterating the need for a further wait of four weeks. This shear bond strength is also compliant with the

clinically desirable shear bond strength required for proper orthodontic movements.

CONCLUSION

It was concluded that after bleaching, there is no harm in immediate bonding to initiate orthodontic movements as no significant difference was recorded between bleached and unbleached teeth. Pre-bonding bleaching may be considered as one of the routine procedures in all patients who have staining.

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