



Brackets bonding failure after in-office bleaching in vivo

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Abstract

The aim of this in vivo study was to determine the effect of high concentration 35% hydrogen peroxide bleaching agent on metallic brackets bonding failure. Forty patients who received first orthodontic treatment phase, were included in this study. A split mouth technique was used; one arch exposed to in-office bleaching gel containing 35% hydrogen peroxide for 30 minutes, while the unbleached arch served as the control. Patients were divided into four groups: First two groups, the brackets bonded 48 hours after bleaching while the third and fourth groups, brackets bonded 3 weeks after bleaching. The bracket failure was computed using independent T-test. The higher bracket failure occurs in mandibular bleached group 48 hours before bonding (18.33%) while the lowest bracket failure occurs in unbleached groups (1.67 %). Significant differences were showed in bracket failure between the mandibular bleached teeth 3 weeks before bonding and those 48 hours before bonding. Adhesive Remnant Index scores revealed that the majority of failure in bleached teeth occurred in the enamel/resin interface. The 48 hours bleached teeth before bonding significantly had a high bracket failure. We should increase the time lapse between bleaching and bonding procedure more than 3 weeks to improve the bracket bonding strength.

Key words: Bleaching, Bonding, Bracket failure, in vivo

Introduction

Vital tooth bleaching has become a well-accepted and successful procedure for the treatment of surface and intrinsic staining of teeth¹. Various products are currently used to bleach teeth.^{2,3} The use in-office bleaching of high concentrations of hydrogen peroxide has only gained increasing acceptance in the past 30 years as a non invasive, conservative treatment for discolored teeth^{4,5}

Hydrogen peroxide can move through the tooth structure for effective stain removal.⁶ This is due to the

smaller size of hydrogen peroxide molecules compared to those of carbamide peroxide. These molecules are more likely to move easily and quickly within the gel matrix, which provides greater osmotic pressure on the tooth/ gel interface and accelerates the diffusion of peroxide into the dental structure so the faster is the whitening process⁷.

Many orthodontic patients may have bleaching done at home or may be interested in having their teeth bleached at the time of orthodontic

treatment. There have been controversial reports regarding the interaction between bleaching agents and bond strengths of composite materials to enamel. Several in vitro studies have reported on bleaching and its effects on orthodontic bonding.⁸⁻¹¹

For a successful bracket bonding three conditions may be considered: (1) the enamel and its preparation, (2) the shape of the bracket base, and (3) the bonding material.¹² Various factors can influence the bond strength of brackets bonded to enamel, such as dental prophylaxis, acid etching, and dental bleaching.¹³ Some studies reported an increase of enamel porosity, a loss of mineral content, and a loss of prismatic form by the effect of aqueous solutions of hydrogen peroxide at concentrations of 3% to 35%.^{6,14-17}

Some authors have suggested that the adverse effects of bleaching on bonding are caused by residual oxygen in the enamel pores which may interfere with resin infiltration into enamel¹⁸ or inhibit polymerization of the resin.¹⁹⁻²⁰ Others found that the peroxide completely leaches from 35% hydrogen bleached enamel already within 7 days after application.²¹

However, some studies identified no significant alteration on composite bond strength after bleaching,^{3,4,6,22} others show that the shear and tensile bond strength of all composite restorative materials were significantly reduced when composite application was performed immediately, i.e. within 1 day, after completion of bleaching regime.^{18-20,23-26} This was true irrespective of the application time (5, 30 or 60 min, respectively) of the 35% hydrogen peroxide solution during the bleaching procedure.^{20,24-25} Other studies also showed that a delay of 1 week was not long enough to allow for optimal bonding.^{19,23}

In orthodontics, most studies showed bracket failure at the adhesive/enamel interface.^{10,25,27}

However, there is no consensus on how long orthodontists should wait before bonding brackets to teeth that have been exposed to whitening agents.^{3, 10} There is only one documented in vivo study on bracket survival rate with bleaching, which recommends a waiting period of 2-3 week.²⁷ The aim of this study was to determine the effect of high concentration 35% hydrogen peroxide bleaching agent on metallic brackets bonding failure.

Materials and Methods

Forty patients who received first phase orthodontic treatment (Alignment and leveling treatment phase) at private dental office were recruited for the study. The criteria for patient selection include: (1) Skeletal Class I malocclusion with mild to moderate crowding in upper and lower anterior segment. (2) Permanent maxillary and mandibular dentition. (3) No prior history of using tooth whitening agents. (4) The age of the patients ranged from 16 to 20 years. Patients were divided into four groups of 10 patients each:

Group 1: Ten patients had their maxillary arch bleached with Pola-office tooth whitening gel (35% hydrogen peroxide) 48 hours before bonding brackets

Group 2: Ten patients had their mandibular arch bleached 48 hours before bonding brackets.

Group 3: Ten patients had their maxillary arch bleached, but there was a time lapse of 3 weeks between the bleaching and bonding of orthodontic brackets.

Group 4: Ten patients had their mandibular arch bleached, but there was a time lapse of 3 weeks

between the bleaching and bonding of orthodontic brackets.

A split mouth technique was used where one arch was used as treatment and the other arch as a control. The six anterior teeth (incisors and canines) from each arch of the patient were included in this study; a total 60 teeth from each group were following up for bracket failure rate for a period of 3 months duration

Light enhanced bleaching technique was used including Pola-office tooth whitening system with Beyond Whitening Accelerator Unit. The bleaching was completed according the manufacturer's directions for Pola-office tooth whitening system, each study arch was bleached for 30 min (two 15-minute cycles).

Bonding procedure; the buccal surfaces of the teeth were cleaned with a pumice/water paste in a rubber cup on a slow-speed hand piece, washed for 10 seconds, and dried for 10 seconds using an air water syringe. The tooth bonding area was etched with 37% phosphoric acid for 30 seconds, washed for 10 seconds, and air dried for the same amount of time. A One-step orthodontic adhesive system (PRIME-DENT) was used by one operator to bond orthodontic metallic brackets (3M Gemini Metal Brackets, 0.022" Roth Rx with hooks) to the tooth bonding area. All excess resin was removed from around the bracket. The bracket was pressed firmly until it adhered to the tooth, any bracket failures were noted in the patient chart.

The failed brackets were not re-bonded but placed in separate envelopes and labeled to indicate the group in which the patient was included. Any adhesive remaining after bracket failure was assessed. The Adhesive Remnant Index (ARI) was used to evaluate the amount of adhesive remaining on the tooth, set

according to the criteria of Table 1. The bracket failure was followed up for a period of 3 months which represented alignment and leveling treatment phase.

Statistical analysis

Descriptive statistics, including mean and standard deviation were calculated for bracket failure of four groups of patients. In-dependent (T) test analysis was used to determine significant differences in the bracket failure scores between each two groups.

Results

The number and percentage of bracket failure were shown in Table No.2 which revealed the higher bracket failure percentage in mandibular bleached group 48 hr before bonding (18.33%) while the lowest bracket failure percentage were found in all unbleached groups (1.67 %); this indicates a higher survival rate of brackets on un bleached teeth. From a total 240 teeth that were bleached; 27 brackets were failed (18 brackets were failed in 48 hours group and 9 brackets were failed in 3 weeks group) and from a total 240 teeth that were unbleached; 4 brackets were failed only (Figure 1, 2).

The adhesive remnant on the bleached teeth had a mean Adhesive Remnant Index (ARI) score of 0, indicating that all of the bracket failures occurred at the enamel/resin interface. The sample size of the failed brackets collected was too small to justify a statistical analysis.

T-test analysis were shown in Table No.3 revealed significant differences in brackets failure between mandibular bleached teeth and maxillary unbleached (control) in both 48 hr. ($P = 0.003$) and 3 weeks ($P = 0.021$)

before bonding. Significant differences showed in bracket failure between maxillary bleached teeth and mandibular unbleached teeth (control) in 48 hrs before bonding ($P = 0.026$) while there were non significant differences in 3 weeks before bonding ($P = 0.29$). Significant differences were found between the bracket failure of mandibular bleaching done 3 weeks before bonding and those done 48 hours before bonding ($P = 0.055$), while non significant differences were found between maxillary arches with bleaching done 48 hours before bonding and those with bleaching done 3 weeks before bonding ($P = 0.15$). Non significant differences in bracket failure between the bleached maxillary and mandibular arches in both 48 hr. before bonding ($P = 0.17$) and 3 weeks before bonding ($P = 0.20$) were found.

Discussion

There is concern that vital bleaching could alter the surface morphology of enamel and thus affects the bond strength of adhesives to enamel.^{15,28} This adverse effect is clinically critical when bonding resin composite, porcelain veneers, and orthodontic brackets to bleached enamel surfaces.

Some authors suggested that residual bleaching agents affected the bonding process and were responsible for decreased bond strengths.^{9,30} As recommended by some previous studies^{9,31,32} we involve pumicing procedure before bonding to reduce any residual hydrogen peroxide. Acid etching of the bleached enamel surface produced loss of prismatic form and the enamel appeared over etched. Moreover, loss of calcium, decrease in microhardness, and alterations in the organic substance have been associated with reduced bond strengths.^{33,34}

Several authors recommended delaying bonding after bleaching, with delay periods varying from 24 hours to 4 weeks.^{4,18,35,36} Others recommended treating the bleached enamel surface with 10% sodium ascorbate, an antioxidant agent, to reverse the reduced bond strengths obtained immediately after bleaching.^{9,32,36-38}

In this study the higher brackets failure percentage occurs in mandibular bleached group 48 hr before bonding while the lowest bracket failure percentage in all unbleached groups, this indicates a higher survival rate of bracket on unbleached teeth, this is in agreement with Joseph et al.²⁷ The Adhesive Remnant Index score shows bond failure occurred at the resin/ enamel interface, this is in agreement with those reported by Uysal et al.,⁴ Torneck et al.²⁴ and Joseph et al.²⁷

The present study shows significant differences in bracket failure between bleached group 48 hr before bonding and unbleached groups, this is in agreement with those reported by Joseph et al.²⁷ This may be due to the residual bleaching agent which affected the bonding process and were responsible for decreased bond strengths.^{30,31} However, other studies found non significant differences in composite bond strengths between bleached and unbleached teeth.^{3,4,6}

Higher percentage of brackets failure occurs in teeth with bleaching done 48 hours before bonding than those bleaching done 3 weeks before bonding. Significant differences were found between the brackets failure of mandibular bleached teeth 3 weeks before bonding and those bleaching done 48 hours before bonding, while non significant differences were found between maxillary arches with bleaching done 48 hours before bonding and those with bleaching done 3 weeks before bonding. Although this

is statistically non significant difference the bonding brackets to maxillary teeth 48 hours bleached before had a higher percentage of bracket failure. This indicates that the bracket failure is depending on the time lapse between bleaching and bonding procedure. This is in agreement with Joseph et al.²⁷ who recommends a waiting period of 2–3 weeks before brackets bonding.

The non significant differences in bracket failure between the bleached maxillary and mandibular arches in both 48 hr. and 3 weeks before bonding were due to involve the anterior segment rather than the full arch for bracket failure follow up.

Conclusion

The use of high concentration 35% of hydrogen peroxide bleaching agent 48 hours before bracket bonding will significantly increase the brackets bonding failure. It's preferable to increase the time lapse between bleaching and bonding procedure more than 3 weeks to improve the bonding strength.

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Table 1: Adhesive Remnant Index (ARI)

Index	Enamel Adhesive Remnant
0	No adhesive on enamel
1	Less than 50% of the adhesive on enamel
2	More than 50% of the adhesive on enamel
3	100% of the adhesive on enamel

Table 2: The number and percentage of brackets failure in each group

Time of bonding	Maxillary bleached (60 teeth)	Mandibular unbleached control (60 teeth)	Mandibular bleached (60 teeth)	Maxillary unbleached control (60 teeth)
48 hrs	7 (11.67 %)	1 (1.67 %)	11 (18.33%)	1 (1.67 %)
3 weeks	3 (5.00 %)	1 (1.67 %)	6 (10.00 %)	1 (1.67 %)
Total	10	2	17	2

Table 3: T-test comparison for bracket failure

Groups	Mean1	St. D1	Mean2	St. D2	T value	P value	Sig.
Max B 48 & Mand UB	0.700	0.675	0.100	0.316	2.55	0.026	S
Max B 3W & Mand UB	0.300	0.483	0.100	0.316	1.10	0.29	NS
Mand B 48 & Max UB	1.100	0.568	0.100	0.316	4.87	0.0003	S
Mand B 3W & Max UB	0.600	0.516	0.100	0.136	2.61	0.021	S
Max B 48 & Max B 3W	0.700	0.675	0.300	0.483	1.52	0.15	NS
Mand B48 & Mand B3 W	1.100	0.568	0.600	0.516	2.06	0.055	S
Max B 48 & Mand B 48	0.700	0.675	1.100	0.568	-1.43	0.17	NS
Max B 3W & Mand B 3W	0.300	0.483	0.600	0.516	-1.34	0.20	NS

Max B 48 ; maxillary bleached 48 hours, **Max B 3W**; maxillary bleached 3 weeks, **Mand B 48**; mandibular bleached 48 hours, **Mand B 3W** ; mandibular bleached 3 weeks, **Mand UB**; mandibular unbleached (control), **Max UB**; maxillary unbleached (control)

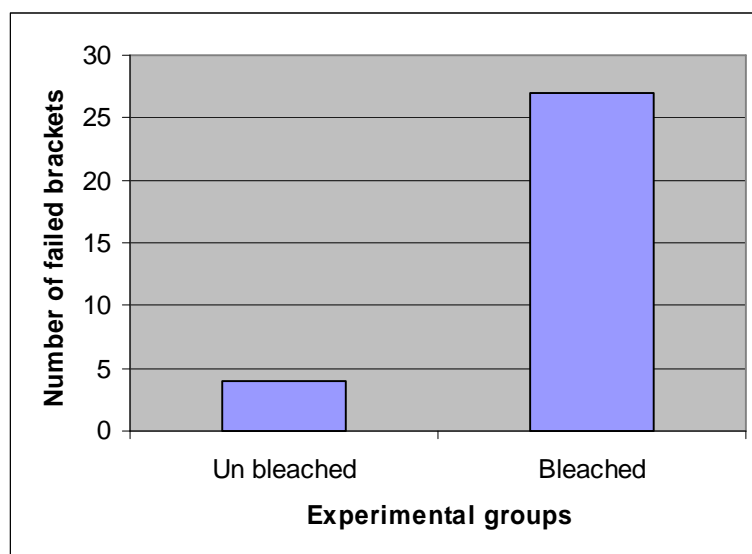


Figure 1: Comparison of brackets failure between bleached and unbleached teeth

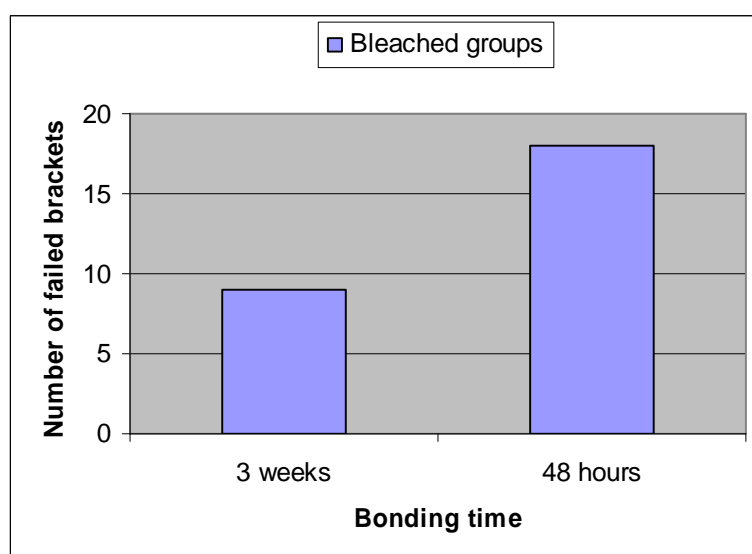


Figure 2: Comparison of brackets failure between teeth that were bleached 48 hours and teeth that were bleached 3 weeks before bonding.