

# Tensile Bond Strength of Brackets After Antioxidant Treatment on Bleached Teeth

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## الخلاصة

**الأهداف:** من هذه الدراسة لتحديد تأثير مضادات الأكسدة على قوة الشد للحاصرات التقيومية المعدنية مع مينا الإنسان بعد تبييضها. **المواد والطرق:** تم جمع 32 من الصواك العلوية والسفلية انتزعت لأسباب تقيومية. وإن جميع الأسنان سليمة ، بدون تسوس وغير معالج مع أي مواد كيميائية. تم تخزينها بعد ذلك في محلول الثيمول 0.1٪ قبل التجربة. **النتائج:** في هذه الدراسة ، وجدنا أن قوة الشد للحاصرات في مجموعة من الروابط المباشرة بعد تبييض أقل من المجموعات الأخرى بالمقارنة مع مجموعة المراقبة والفرق كان كبيرا على مستوى 0.05. وأكد أيضا أن الانتظار لمدة 7 أيام بعد التبييض يكفي للحصول على القوة الكافية لظروف الشد للحاصرات التقيومية المعدنية. وكان هناك اختلاف كبير في قوة الشد للحاصرات التقيومية عندما خضعت الروابط المباشرة والابنانول، كذلك مع مجموعة السيطرة اختلاف كبير في قوة الشد بالمقارنة مع الشريحة مغمورة في الماء المقطر مع شريحة والسيطرة عليها. **الاستنتاجات:** في هذه الدراسة وجدنا أن قوة الشد للحاصرات التقيومية المعدنية في مجموعة من الروابط المباشرة بعد التبييض أقل من المجموعات الأخرى وعند مقارنتها مع مجموعة السيطرة و الفرق كبير. **الكلمات المفتاحية:** قوة الشد للحاصرات التقيومية المعدنية ، تبييض الأسنان.

## ABSTRACT

**Aims:** To determine the effect of an antioxidant agent on the tensile bond strength values of metal brackets bonded with to human enamel after bleaching. **Materials and Methods:** Thirty two sound human maxillary and mandibular premolars extracted for orthodontic reasons were collected. All teeth had undamaged buccal enamel, no caries and no pre-treatment with any chemicals. They were then stored in a solution of 0.1 % thymol before the experiment. **Results:** In the present study, we found that , tensile bond strength in group of direct bonding after bleaching was lower than other groups when compared with control group and the difference was significant at level  $p < 0.05$  . The present investigation confirmed that waiting for a period of 7 days after bleaching is sufficient to obtain adequate tensile bond strength for clinical conditions. There was significant difference in tensile bond strength when the brackets that underwent direct bonding and ethanol with control group. No significant difference in tensile bond strength was observed when compared with the bracket immersed in a distilled water & with control bracket. **Conclusions:** In the present study we found that , tensile bond strength in group of direct bonding after bleaching were the lowest than other groups and when compared with the control group, the difference is significant. There was a significant difference in tensile bond strength when comparing the group that underwent direct bonding with control group.

**Key words:** Tensile, Bond strength, Bleaching.

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## INTRODUCTION

Tooth whitening, or tooth bleaching, is a procedure that involves the removal of stains and discoloration, as well as lighting of pigmentation within the teeth through the application of a chemical agent to oxidize the organic pigmentation in the tooth<sup>(1)</sup>. Although restorative methods are available such as crown and veneer, frequently discoloration can be totally cor-

rected or partially by bleaching. Bleaching procedure is a conservative of tooth tissue and may delay the need for more invasive methods<sup>(2)</sup>. Vital tooth bleaching is a safe and well-accepted procedure for the treatment of surface and intrinsic staining of teeth<sup>(3)</sup>. In-office whitening systems are effective for treating the superficial enamel layers, such as food staining, mild uniform yellow, orange, or light brown discolora-

tions, and also for very mild cases of tetracycline staining, fluorosis or enamel mottling<sup>(4)</sup>. Bleaching of discolored teeth can be performed before or after fixed orthodontic appliance treatment. An in vitro study on clinical color differences when bleaching was applied after debonding of brackets was carried out by Hintz *et al.*,<sup>(5)</sup>. It required at least two to four weeks of continuous bleaching to achieve a significant difference. Conversely, when patients have previously had their teeth bleached, they often become aware of orthodontic problems and want to be treated. Nevertheless, numerous studies have revealed that if an in-office or an at-home system is used prior to adhesive restorations or before application of resin bonded fixed appliances, the bonding strength to tooth structures is significantly reduced<sup>(6-10)</sup>. To eliminate or reduce clinical problems related to post-bleached compromised bond strength, some techniques have been suggested, such as the removal of a superficial layer of enamel<sup>(11)</sup>. Sung *et al.*,<sup>(12)</sup> advised the use of adhesives containing organic solvents, others agreed to reschedule any bonding procedure after the last bleaching session, since the reduction of composite resin bond strength to freshly bleached enamel has been shown to be temporary<sup>(13,14)</sup>. The waiting period for bonding procedures after bleaching has been reported to vary from 24 hours to four weeks<sup>(14-17)</sup>.

Compromised bonding to bleached enamel being due to inhibition of polymerization of resin-based materials is attributed to residual oxygen. In an in vitro study on extracted and sandblasted human third molars, Lai *et al.*,<sup>(10)</sup> found that when sodium ascorbate, an antioxidant was applied for 3 hours to enamel after bleaching with carbamide peroxide, the shear bond strength of the composite was reversed. If the bond strength decreases on enamel treated with carbamide peroxide as a result of the oxidizing action, it may be reversed by applying a biocompatible and neutral antioxidant before applying the resin composite.

The aim of this study was to determine whether the tensile bond strength of standard metal orthodontic brackets, immediately bonded (in office bleaching) to

newly bleached enamel surfaces by using 35% hydrogen peroxide increases after application of an antioxidant agent (ethanol).

## MATERIALS AND METHODS

### *Preparation of specimens*

Bleaching agent used was in office tooth whitening gel (35% HP) Hellerdent<sup>®</sup> Supreme 40<sup>™</sup> (European Union). Thirty two sound human maxillary and mandibular premolars extracted for orthodontic reasons were collected. All teeth had undamaged buccal enamel, no caries and no pre-treatment with any chemicals. Following extraction, residue on the teeth was removed and washed away with tap water. They were then stored in a solution 0.1 % thymol. Before the experiment, the roots of all teeth were separated using a water-cooled diamond bur the coronal pulps were removed and again washed with water and an under cut was made in pulp chamber to ensure that the crown remained in its position during measuring tensile Bond strength. The crown was placed in the metal ring, using soft wax at plated surface, the middle third of buccal surface was oriented to be paralleled with analyzing rod of surveyor (Quadyle Dental England), a cold cure resin (Germany) was poured around the crown of the tooth and left for setting for one hour. Then rechecking the position of the crown was made to ensure that the position of crown was not changed.

### *Experimental Groups*

The samples were randomly divided into three bleaching groups of 35% CP ( $n = 24$ ) and a control group ( $n = 8$ ). Group 1 consisted of specimens bonded immediately after bleaching ( $n = 8$ ). The teeth in group 2 were immersed in distilled water solution for 7 days after bleaching ( $n = 8$ ), while group 3 specimens were treated with antioxidant agent (absolute ethanol) after bleaching, just before bonding ( $n = 8$ ). Specimens in the control group were not bleached, and were only immersed in distilled water solution for 7 days before bonding.

### *Bleaching Procedure*

The bleaching procedure consisted of three applications for 10 minutes. In each

application, the gel was light activated four times for 40 seconds with a photo – curing unit Astralis 540mW /cm<sup>2</sup> (Trans bond XT, 3m Unitek CO.USA). The gel was agitated with a dental explorer to displace bubbles after light activations, at the end of the bleaching procedures, the surface was rinsed with tap water for one minute to remove the bleaching gel. The ethanol solution (antioxidant) was applied with a cotton pellet on the surface for 20 minutes. The surfaces were kept moist regularly due to the quick evaporation of ethanol. Then they were rinsed with tap water for 30 seconds and then air dried with Oil Free Compressor and Slow speed Hand Piece 'NSK Co. Japan' (China) for 20 seconds<sup>(18)</sup>.

*Bond Strength Test*

The tensile bond strength of all groups (control and experimental groups) were tested by using the universal testing machine (Zweigle Co. Germany) in textile factory in Mosul city. The specimens were mounted in metal ring and fixed in a lower Jaw of the machine. While the testing rod was attached on the upper jaw of machine the tensile made the lower jaw remained fixed and the upper jaw moved away from the lower jaw at the required speed 0.5 mm/ minute. The rod was linked to the calibrated gauge with kilogram weights suspended and the moment when brackets

tensile from the tooth by force applied by testing machine, the reading value was taken from the gauge this force was measured in Kilogram; the force converted to mega Pascal (Mps) by converting kilogram to Newton then this force (Newton) divided by area of bracket base which is 10.5mm<sup>2</sup> to yield MPs, then tensile bonding strength was evaluated.

The tensile bond strength data of the groups were subjected to a test of normality. With respect to this, a non-parametric test (Kruskal–Wallis) was used to determine the significance between the groups. The level of significance was established as  $p \leq 0.05$  for all statistical tests. Statistical analyses were processed with the SPSS 12.0 software system (SPSS Inc., Chicago, Illinois, USA).

**RESULTS**

Tensile bond strengths in MPs, descriptive statistics that include mean, standard deviation, minimum and maximum value of the four groups are listed in Table (1).

The Findings of this study showed the mean of the control group gave rise to the highest tensile strength, followed by the group that was immersed in distilled water, then the ethanol group while the direct bonding showed lowest value when compared with remaining groups.

Table (1): Description of the measurements.

<b>Group</b>	<b>Mean</b>	<b>SD</b>	<b>Min.</b>	<b>Max.</b>
<b>Control</b>	6157.75	1176	4764.2	8575.6
<b>bonding after bleaching</b>	2548.86	584.6	1905.69	3716.09
<b>Ethanol</b>	5830.84	1318.2	4049.95	6906.66
<b>Bleached then in D.W.</b>	5907.64	1180.2	4287.8	8099.17

Measurements in Mps, D.W=Distilled water; SD= Standard deviation.

Table (2) displays the comparison between control and all other groups, it can be observed that the lowest tensile bond was observed in the group that was bleached and directly bonded with brackets with significant difference, while the groups that was treated with antioxidant (ethanol) and the group that was immersed in distilled water had mean tensile bond higher than that of direct bonding groups,

but less than the control with no significant difference with it. The comparison among the groups can be seen in Table (3), that showed that the difference between mean value of distilled water and Ethanol is non significant while the difference between direct bonding and Ethanol and between direct bonding and distilled water is significant which support the result in Table (2).

Table (2): Comparison between control and other groups.

Groups	Median	chi – square	p value
Direct bonding	4240.16	11.33	0.001 S
Ethanol	6335.65	0.541	0.462 NS
Bleached then applied in D.W.	5836.17	0.044	0.834 NS

Measurements in Mps (control group = 6157.75).

Table(3): Comparison among the groups.

Groups	Median	Chi square	p value
Ethanol	6335.65		
Bleached then applied in D.W.	5836.17	0.224	0.64 NS
Direct bonding	4240.16		
Ethanol	6335.65	11.34	0.001 S
Direct bonding	4240.16		
Bleached then applied in D.W.	5836.17	11.34	0.001 S

### DISCUSSION

Testing the bond strength by tensile loading produces more adhesive failures, which may favor the evaluation of the true bond strength<sup>(19)</sup>. Several investigations clarify the decrease in enamel bond strength, weak bonding surfaces and staining susceptibility caused after bleaching are related to enamel surface morphology with varying degrees of surface roughness and structural changes by loss of prismatic formation<sup>(20)</sup>. In the present study it is found that, tensile bond strength in group of direct bonding after bleaching were the lower than other groups and when compared with control group the difference is significant. This is in agreement with McCracken and Haywood<sup>(21)</sup> and Hegedus<sup>(22)</sup> in which they stated that, in bleaching there is changes in the organic substance, the loss of calcium, and decrease in micro hardness are potential causes of a reduction in tensile bond strength.

It is known that hydrogen peroxide released from carbamide peroxide, due to its low molecular weight, can penetrate enamel to reach the dental pulp, and that there is a continuous leaching of the hydrogen peroxide that is retained in the bleached enamel<sup>(23)</sup>. Release of oxygen from the bleached enamel probably results in incomplete polymerization of the adhesive in these regions<sup>(24)</sup>. This could account for the observation of an increased density of voids along the acid-etched, bleached

enamel interface<sup>(24-25)</sup>.

Table (2) showed that the mean value of bonding strength with Ethanol is significantly higher than that for direct bonding and less than the control group in which the difference is not significant, This means that Ethanol reversed the action of bleaching, this with the agreement of Hegedus *et al.*,<sup>(22)</sup>. Another finding in this study, the bond strength of the specimen after being immersed in distilled water for 7 days, increased to be more than the mean value of bond strength of direct bonding and Ethanol, but it still less than that with control group; in which the difference is not significant. This is with the agreement of previous investigations which demonstrated that immersion of in vitro specimens in distilled water, artificial saliva or even saline results in a complete reversal of the reduced enamel bonds<sup>(24,26-27)</sup>. The results of the present study are in agreement with those findings, assuming that the immersion process results in removing the residual oxygen from the bleaching material. The delay period after bleaching required to return the bonding strength to a pre-bleached level is still debated, but the commonly suggested post-bleaching time period is 7 days before bonding<sup>(28,29)</sup>. The present investigation confirmed that a period of 7 days after bleaching is sufficient to obtain adequate tensile bond strength for clinical conditions.

In more recent studies<sup>(30,31,32)</sup>, 10 mi-

nutes of antioxidant treatment was found to be effective. This time period was used for antioxidant treatment since it is a beneficial time for clinical conditions.

### CONCLUSIONS

The results obtained in this in vitro study demonstrated that bleaching of enamel with 35% immediately before bonding results in a reduction of bracket tensile bond strength. A period of 7 days in distilled water and In the samples, where antioxidant was applied for 20 minutes immediately after bleaching provides re-establishment of adequate tensile bond strength. Treating the bleached enamel surface with antioxidant reversed the decreased tensile bond strength and may be an innovative option for 'instant' fixed orthodontic treatment after whitening. There is significant difference in tensile bond strength when compared the group that under go direct bonding with control group. There is no significant difference in tensile bond strength when comparing the group that was immersed in distilled water and Ethanol with bracket of control group.

### REFERENCES

1. Roberson TM, Heymann HO, Swift ED. Sturdevant's Art and Science of Operative Dentistry. 4<sup>th</sup> ed. The Mosby, Inc. St. Louis. 2002. Pp: 608–614.
2. Bartlett D. Bleaching discolored tooth. *Dent Update*. 2001; 28(1): 14–18.
3. Sulieman M. An over view of bleaching techniques: Night guard vital bleaching and non-vital bleaching. *Dent Update*. 2005; 32(1): 39–46.
4. Goldstein RE. In-office bleaching: where we came from, where we are today. *J Am Dent Assoc*. 1997; 128(Suppl): 11–15.
5. Hintz JK, Bradley TG, Eliades T. Enamel colour changes following whitening with 10 per cent carbamide peroxide: A comparison of orthodontically-bonded/debonded and untreated teeth. *Europ J Orthod*. 2001; 23: 411–415.
6. Garcia-Godoy F, Dodge WW, Donohue M, O'Quinn JA. Composite resin bond strength after enamel bleaching. *J Oper Dent*. 1993; 18:144–147.
7. Toko T, Hisamitsu H. Shear bond strength of composite resin to unbleached and bleached human dentin. *Asian J Aesth Dent*. 1993; 1: 33–36.
8. Miles PG, Pontier J, Bahiraei D, Close J. The effect of carbamide peroxide bleach on the tensile bond strength of ceramic brackets: an in vitro study. *Am J Ortho Dentofacial Orthoped*. 1994; 106: 371–375.
9. Ben-Amar A, Liberman R, Gorfil C, Bernstein Y. Effect of mouthguard bleaching on enamel surface. *Am J Dentis*. 1995; 8: 29–32.
10. Lai SCN, Tay FR, Cheung GSP, Mak YF, Carvalho RM, Wei1 SHY, Toledano M, Osorio R, Pashley DH. Reversal of compromised bonding in bleached enamel. *J Dent Res*. 2002; 81: 477–481.
11. Cvitko E, Denehy GE, Swift E Jr, Pires JA. Bond strength of composite resin to enamel bleached with carbamide peroxide. *J Esth Dent*. 1991; 3: 100–102.
12. Sung EC, Chan M, Mito R, Caputo A. Effect of carbamide peroxide bleaching on the shear bond strength of composite to dental bonding agent enhanced enamel. *J Prosth Dent*. 1999; 82: 595–598.
13. McGuckin RS, Thurmond BA, Osovitz S. Enamel shear bond strengths after vital bleaching. *Am J Dentis*. 1992; 5: 216–222.
14. Miles PG, Pontier J, Bahiraei D, Close J. The effect of carbamideperoxide bleach on the tensile bond strength of ceramic brackets: an in vitro study. *Am J Ortho Dentofacial Orthoped*. 1994; 106: 371–375.
15. Van der Vyder PJ, Lewis SB, Marais JT. The effect of bleaching agent on composite/enamel bonding. *J Dent Ass South Afri*. 1997; 52: 601–603.
16. Cavalli V, Reis AF, Giannini M, Ambrosano GM. The effect of elapsed time following bleaching on enamel bond strength of resin composite. *J Oper Dent*. 2001; 26: 597–602.
17. Uysal T, Basciftci F A, Usumez S, Sari Z, Buyukerkmen A. Can previously bleached teeth be bonded safely. *Am J Ortho Dentofacial Orthoped*. 2003; 123: 628–632.
18. Torris CRG, Koga AF, Borges AB. The effects of antioxidant agents as neutralizers of bleaching agents on enamel bond strength. *Braz J Oral Sci*. 2006; 5(16): 971–975 .
19. Della Bona A, van Noort R. Shear Vs. tensile bond strength of resin composite bonded to ceramic. *J Dent Res*. 1995; 74:

- 1591–1596.
20. Cavalli V, Arrais CA G, Giannini M, Ambrosano B. High-concentrated carbamide peroxide bleaching agents effects on enamel surface. *J Oral Rehabil.* 2004; 31: 155–159.
21. McCracken MS, Haywood VB. Demineralization effects of 10 per cent carbamide peroxide. *J Dentistry.* 1996; 24: 395–398.
22. Hegedus C, Bistey T, Flora-Nagy E, Keszthelyi G, Jenei A. An atomic force microscopy study on the effect of bleaching agents on enamel surface. *J Dentist.* 1999; 27: 509–515.
23. Gokay O, Tuncbilek M, Ertan R. Penetration of the pulp chamber by carbamide peroxide bleaching agents on teeth restored with a composite resin. *J Oral Rehabil.* 2000; 27: 428–431.
24. Dishman MV, Covey DA, Baughan LW. The effect of peroxide bleaching on composite to enamel bond strength. *Dent Mater.* 1994; 10: 33–36.
25. Kalili T, Caputo AA, Mito R, Sperbeck G, Matyas J. In vitro toothbrush abrasion and bond strength of bleached enamel. *Practic Perio Aesthe Dent.* 1991; 3: 22–24 .
26. Titley KC, Torneck CD, Ruse ND. The effect of carbamide-peroxide gel on the shear bond strength of a microfil resin to bovine enamel. *J Dent Res.* 1992; 71: 20–24.
27. Cavalli V, Reis AF, Giannini M, Ambrosano GM. The effect of elapsed time following bleaching on enamel bond strength of resin composite. *J Oper Dent.* 2001; 26: 597–602 .
28. Miles PG, Pontier J, Bahiraei D, Close J. The effect of carbamide peroxide bleach on the tensile bond strength of ceramic brackets: an in vitro study. *Am J Ortho Dentofacial Orthoped.* 1994; 106: 371–375.
29. Spyrides GM, Perdigao J, Pagani C, Araujo MA, Spyrides SM. Effect of whitening agents on dentin bonding. *J Esth Dent.* 2000; 12: 264–270.
30. Kaya A D, Turkun M. Reversal of dentin bonding to bleached teeth. *J Oper Dent.* 2003; 28: 825–829.
31. Turkun M, Kaya AD. Effect of 10% sodium ascorbate on the shear bond strength of composite resin to bleached bovine enamel. *J Oral Rehab.* 2004; 31: 1184–1191.
32. Josey AL, Meyers IA, Romaniuk K, Symons AL. The effect of a vital bleaching technique on enamel surface morphology and the bonding of composite resin to enamel. *J Oral Rehab.* 1996; 23: 244–250.