Original Article

Influence of an Esthetic Therapy on an Esthetic Component

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Abstract

Objective: The objective of this study was to assess the impact of different concentrations of carbamide peroxide bleaching agents on the shear bond strength (SBS) of ceramic orthodontic brackets bonded to human premolar teeth. **Materials and Methods:** Forty-five extracted sound human premolars were randomly assigned into three groups (n = 15 each) based on bleaching protocol: Group A – unbleached control; Group B – bleached with 16% carbamide peroxide; and Group C – bleached with 35% carbamide peroxide. Ceramic brackets were bonded to all specimens using a standardized bonding procedure. SBS was measured using a universal testing machine. Data were analyzed using one-way analysis of variance and *post hoc* Tukey tests. **Results:** The highest mean SBS was observed in Group A (111.20 ± 11.42 MPa), followed by Group B (85.40 ± 5.73 MPa), and the lowest in Group C (41.88 ± 13.10 MPa). The differences among all groups were statistically significant (P = 0.001), indicating a marked decline in bond strength with increasing bleaching concentration. **Conclusion:** Bleaching with carbamide peroxide significantly reduces the SBS of ceramic brackets. The reduction is more pronounced at higher bleaching concentrations. It is recommended that clinicians consider the timing and concentration of bleaching agents before bracket bonding to ensure optimal adhesion.

Keywords: Bleaching, Carbamide peroxide, Ceramic brackets, Enamel bonding, Orthodontics, Shear bond strength.

Introduction

Tooth bleaching is a widely adopted procedure in esthetic dentistry, with carbamide peroxide being one of the most frequently used agents due to its effectiveness and relatively low risk of adverse effects.[1] As more patients seek esthetic enhancement before or during orthodontic treatment, understanding the implications of bleaching on enamel and subsequent bracket bonding has become clinically significant.[2]

Orthodontic ceramic brackets are increasingly favored for their translucency and esthetics, particularly among adult patients. However, their shear bond strength (SBS) is known to be more technique-sensitive compared to metal brackets.[3] The oxidative byproducts from bleaching agents can alter enamel morphology and interfere with resin polymerization, potentially reducing bond strength.[4-6] These alterations may persist for varying durations depending on the concentration and duration of the bleaching protocol.[7]

Although several studies have explored the effect of bleaching on bracket bonding, there is a lack of consensus regarding the impact of different carbamide peroxide concentrations, especially concerning high-concentration agents such as 35%, which are commonly used in in-office treatments.[8] Comparisons between low (16%) and high (35%) concentrations in terms of their effect on SBS of ceramic brackets remain limited.

This *in vitro* study aims to assess and compare the SBS of orthodontic ceramic brackets bonded to enamel surfaces treated with 16% and 35% carbamide peroxide. The objective is to provide evidence-based guidance for orthodontists on optimal clinical timing and protocol when bonding to bleached enamel

Material and Methods

This study involved 45 freshly extracted human maxillary and mandibular premolars collected over 6 months. The selected teeth were extracted solely for orthodontic purposes and exhibited no evidence of caries, enamel defects, fractures, or fluorosis. To ensure the integrity of the samples, no pre-treatment agents, such as hydrogen peroxide, were applied.

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Following extraction, the teeth were thoroughly cleaned using an ultrasonic scaler to remove any residual soft tissue and plaque, then stored in distilled water at room temperature until further processing.

To facilitate SBS testing, each tooth was embedded in a block of self-cure acrylic resin. The teeth were mounted with their long axis aligned parallel to the direction of the force to be applied during testing. The specimens were randomly divided into three groups of 15 teeth each, based on the bleaching treatment received, and all were bonded with ceramic brackets. The grouping was as follows:

- Group A (1–15): Unbleached (sound) teeth bonded with ceramic brackets (Figure 1).
- Group B (16–30): Teeth bleached with 16% carbamide peroxide before ceramic bracket bonding (Figure 2).
- Group C (31–45): Teeth bleached with 35% carbamide peroxide before ceramic bracket bonding (Figure 3).

For Group A, ceramic brackets (Garmi, 0.022" slot) were bonded to sound teeth. The bonding procedure began with enamel etching using 37% phosphoric acid for 40 s, followed by rinsing for 10 s and drying with compressed air. OrthoSolo adhesive primer was then applied, and the brackets were affixed using Enlight light-cure adhesive paste. Light curing was performed for 40 s.

In Group B, before bonding, the teeth were treated with a 16% carbamide peroxide gel (24 Carat) for 30 min. After bleaching, the same bonding protocol as Group A was followed: Acid etching, rinsing, drying, primer application, bracket placement with adhesive paste, and light curing.

Group C followed an identical bonding protocol; however, the bleaching was done using a 35% carbamide peroxide gel (24 Carat) for 30 min before bracket bonding.

Each group was assigned based on numbering for easy identification, and all samples were stored appropriately until testing. All three groups' SBS were assessed using a Universal Instron testing machine for debonding (Figure 4).

Results

The SBS of ceramic orthodontic brackets was evaluated across three groups: Unbleached teeth (Group A), teeth bleached with 16% carbamide peroxide (Group B), and teeth bleached with

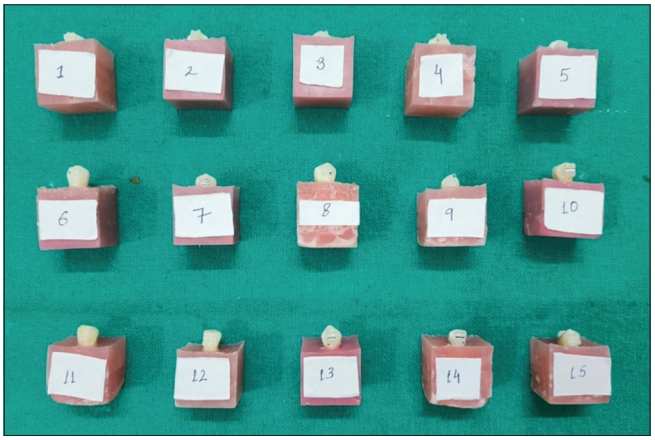


Figure 1: Unbleached (sound) teeth bonded with ceramic brackets

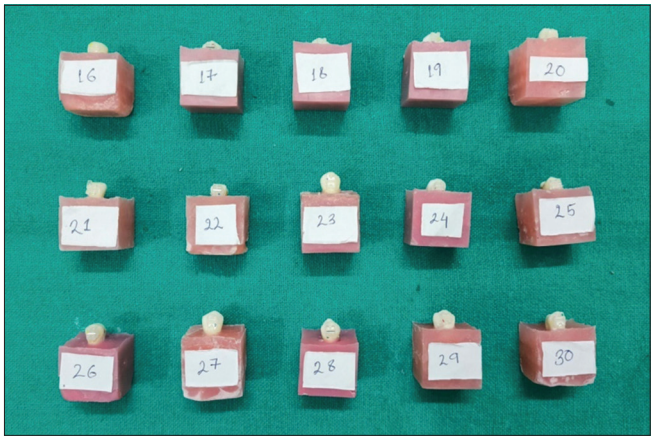


Figure 2: Teeth bleached with 16% carbamide peroxide before ceramic bracket bonding

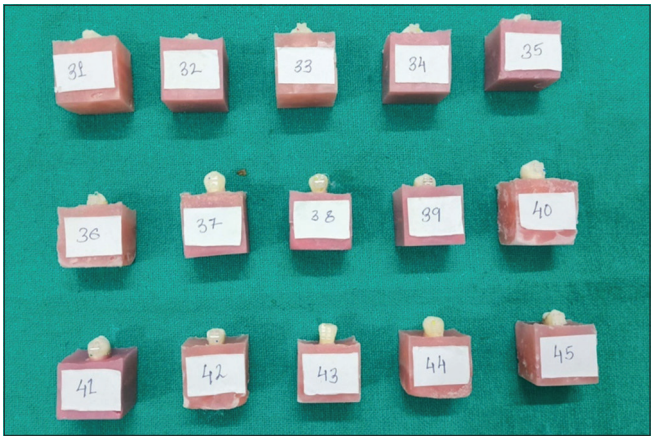


Figure 3: Teeth bleached with 35% carbamide peroxide before ceramic bracket bonding

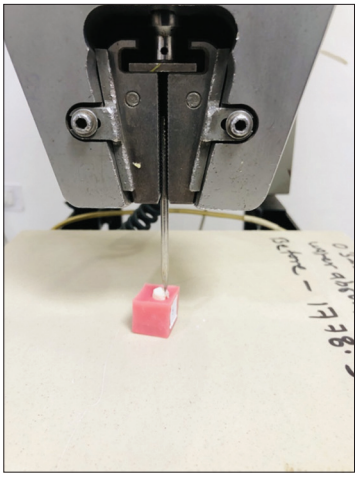


Figure 4: Measuring of shear bond strength

35% carbamide peroxide (Group C). Each group comprised 15 samples.

The highest mean bond strength was observed in Group A (sound and unbleached teeth), with a value of 111.20 ± 11.42 MPa**.** Group B, which involved teeth bleached with 16% carbamide peroxide**,** showed a moderate decrease in bond strength, with a mean of 85.40 ± 5.73 MPa. The lowest bond strength was recorded in Group C, where teeth were bleached using 35% carbamide peroxide**,** with a mean of 41.88 ± 13.10 MPa (Table 1)**.**

Statistical analysis using one-way analysis of variance revealed a highly significant difference in bond strength among the three ceramic bracket groups (F = 164.76, *P* = 0.001), indicating that bleaching concentration had a considerable impact on bonding performance.

To further investigate the differences, a *post hoc* Tukey test (Table 2) was applied. The difference in mean bond strength between:

- Group A and Group B were 25.79 MPa (statistically significant)
- Group A and Group C were 69.32 MPa (statistically significant)
- Group B and Group C were 43.52 MPa (statistically significant).

These findings clearly demonstrate a progressive reduction in SBS with increasing concentrations of carbamide peroxide. Thus, the order of bond strength for ceramic brackets was:

Group A (sound teeth) > Group B (16% bleached) > Group C (35% bleached) Graph 1.

Table 1: Comparison of bond strength between groups

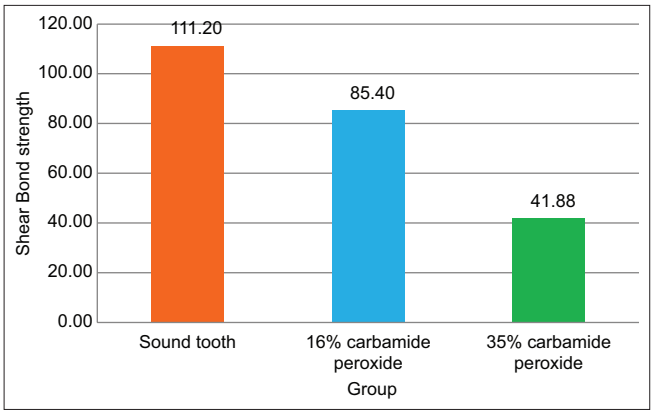
Groups	N	Mean	Standard deviation	F-value	*P*-value
Sound teeth	15	111.20	11.42	164.76	0.001**
16% carbamide peroxide	15	85.40	5.73		
35% carbamide peroxide	15	41.88	13.10		

One-way analysis of variance, **Highly significant

Table 2: *Post hoc* Tukey tests

(I) Group	(J) Group	Mean difference (I-J)	Standard error	Sig.
Sound teeth	16% carbamide peroxide	25.79	3.86	0.001*
Sound teeth	35% carbamide peroxide	69.32	3.86	0.001*
16% carbamide peroxide	35% carbamide peroxide	43.52	3.86	0.001*

*Highly significant



Graph 1: Comparison of bond strength between groups

Discussion

This study evaluated the effect of different concentrations of carbamide peroxide bleaching agents on the SBS of ceramic orthodontic brackets bonded to human premolar teeth. The findings revealed a notable reduction in SBS as the concentration of the bleaching agent increased. Teeth in the control group (Group A), which were not subjected to bleaching, exhibited the highest bond strength. In contrast, teeth bleached with 16% carbamide peroxide (Group B) demonstrated a moderate reduction, whereas those treated with 35% carbamide peroxide (Group C) showed the lowest bond strength values.

The reduction in bond strength observed in the bleached groups is consistent with previous reports that suggest bleaching agents alter the mineral composition and surface morphology of enamel, thereby compromising resin-enamel adhesion.[6,9,10] Residual oxygen released during bleaching can inhibit polymerization of adhesive resins, leading to suboptimal bonding performance.[11]

The statistically significant difference between Group A and Group B highlights the effect of even low-concentration bleaching agents on enamel bonding. However, the further reduction in Group C indicates a concentration-dependent effect, where higher carbamide peroxide levels cause greater enamel alteration and reduced mechanical retention for bracket bonding.[7]

Previous literature supports these findings. Bishara *et al*. reported decreased SBS in bleached enamel due to alterations in surface roughness and the presence of oxygen radicals interfering with the bonding process.[2] Similarly, Cehreli and Guzey observed that higher concentrations of bleaching agents adversely affect the adhesion of orthodontic brackets.[12] These alterations may persist for several days post-bleaching, suggesting that delaying bonding procedures may help restore enamel integrity and improve bond strength.[13]

Clinically, these results underscore the importance of timing bracket bonding procedures following bleaching treatments. It is advisable to postpone bonding or consider the use of antioxidants, such as sodium ascorbate, to neutralize residual oxygen and restore the adhesive potential of bleached enamel.[14,15]

In conclusion, the present study reinforces the influence of bleaching agents on the SBS of ceramic brackets. Higher concentrations of carbamide peroxide significantly

compromise bond strength, and thus, careful consideration should be given to the timing of orthodontic bonding following any bleaching procedure.

Conclusion

Within the limitations of this *in vitro* study, it can be concluded that bleaching with carbamide peroxide has a detrimental effect on the SBS of orthodontic brackets, particularly ceramic brackets. Among the ceramic bracket groups, the highest bond strength was recorded in unbleached teeth, followed by teeth bleached with 16% carbamide peroxide, and the lowest in those treated with 35% carbamide peroxide. This indicates that both the presence and concentration of bleaching agents significantly influence the bonding efficacy. Clinicians should be cautious when bonding ceramic brackets to recently bleached enamel and may consider delaying the bonding procedure or using additional measures to improve adhesion.

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