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# Original Research

## Comparative evaluation of shear bond strength of different bonding system with effect of saliva contamination and decontamination - An in vitro study

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***ABSTRACT:***
**Introduction**: This study aims for the bond strength measurement of two new self etch bonding agent and effect of salivary contamination and decontamination on the bonding agent strength. **Materials and Methods**: A total of 60 premolar teeth were collected after they were removed during orthodontic treatment. The buccal surfaces of the teeth were ground to create a plane dentinal surface. The samples were randomly divided into three subgroups for Optibond All-in-One Kerr (BSA) and three subgroups for Single Bond Universal 3M (BSB), each comprising 10 samples. For Optibond All-in-One Kerr (BSA), BSA-I served as the control group, where a self-etch bonding agent was applied to the flat dentine surface. BSA-II represented the contamination group, where the self-etch bonding agent was applied, followed by the application of saliva and subsequent drying with air. BSA-III represented the decontamination group, where the self-etch bonding agent was applied, followed by saliva contamination, drying with air, and then the reapplication of the self-etch bonding agent. Similarly, for Single Bond Universal 3M (BSB), BSB-I was the control group, where a self-etch bonding agent was applied to the flat dentine surface. BSB-II was the contamination group, where the self-etch bonding agent was applied, followed by the application of saliva and subsequent drying with air. BSB-III represented the decontamination group, where the self-etch bonding agent was applied, followed by saliva contamination, drying with air, and then the reapplication of the self-etch bonding agent. After the bonding procedure, a 5 mm composite block with bulk fill (Ivoclar Vivadent) was built on the flat dentine surface. A 1 mm per minute crosshead speed on an Instron universal testing machine (USA) was used to measure the bonding strength. The obtained data was subjected to statistical analysis using one-way ANOVA, Tukey's multiple comparison, and unpaired t-test for intergroup comparison. **Result:** In the Kerr group (BSA), the shear bond strength of the contaminated sub-group (BSA-II) showed a significant reduction to 4.35 ± 2.67 MPa, whereas the control group (BSA-I) and decontamination group (BSA-III) recorded bond strengths of 14.77± 1.27 MPa and 15.7 ± 1.50 MPa, respectively. The bond strength of BSA-I and BSA-III did not exhibit any significant difference. For the 3M Universal group (BSB), the bond strength significantly decreased to 4.5 ± 2.15 MPa in the contaminated group (BSB-II) in comparison to the control group (BSB-I) and the decontamination group (BSB-III), which had bond strengths of 6.51± 0.21 MPa and 10.5 ± 2.19 MPa, respectively. The bond strength of BSB-III, where the 3M universal bond was re-applied after saliva contamination, was found to be statistically significant compared to BSB-I and BSB-II. **Conclusion**: The dentine bond strength was found to decrease when saliva contamination occurred during the restorative procedure, for both the Optibond All-in-One Kerr and the Single Bond Universal 3M self-etch systems. However, reapplication of the bonding agent and air drying off the saliva over the dentine surface helped recover the bond strength for both systems. The application of additional bonding agent also significantly improved the bond strength in the Single Bond Universal 3M group after saliva decontamination.

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### INTRODUCTION

Dental bonding of dentine has garnered significant attention due to its heterogeneous nature with higher organic and water constituents compared to enamel. The bonding strength is reliant on the tooth structure and chemical composition, which has been established in previous studies. As a result, enhancing the bonding agent's strength in restorative materials has become a focus of research in recent years.

With increased demand and use of aesthetic restorations, contamination control has become an important topic since dental adhesives and composites are highly vulnerable to contamination. Moisture such as gingival fluid, blood, hand piece oil, and in particular, saliva can affect the quality of the bond leading to microleakage at the interface. As a result, loss of the restoration, recurrent caries, postoperative sensitivity, and discoloration may occur. [1] Therefore, proper isolation and control of contamination are essentially required during bonding procedure. {2}Controlling saliva in the field of operation is difficult in adhesive dentistry, especially in those cases where cavity margins extend below the gingival tissues or when indirect restorations are seated or in newly erupted molars or when patients have problem in mouth opening.{3}

There has been a dramatic progression within the restorative and bonding procedure to enamel and dentin in last forty years since Buonocore introduced the technique of etching with phosphoric acid to enhance adhesion to enamel. Recently, self-etch adhesive systems have been introduced in an effort to simplify the bonding procedure. [5]

Two-step system combines a weak phosphoric acid and primer in one bottle and an adhesive in a second bottle. One-step system, also called all-in-one adhesives, combines conditioner, primer, and bond in one bottle. [6] These adhesives eliminate the rinsing and drying steps, thereby reducing the possibility of over wetting or over drying, both of which can negatively influence adhesion. [7],[8]Siloranes are a totally new class of methacrylate-free compounds for use in dentistry. This monomer type can be chemically explained as a combination of siloxanes and oxiranes, thereby combining the properties of both, i.e., low polymerization shrinkage due to oxirane monomers and increased hydrophobicity due to the presence of siloxane species in the composition.

To evaluate the influence of saliva when incorporated in the restorative procedures, and its effect on bond strength, and to find out the impact of decontamination on bond strength during restorative procedure using two self etch bonding agents, this study was conducted.

Composition of 3M universal bonding agent: 1. MDP Phosphate Monomer 2. Dimethacrylate resins 3. HEMA 4. Vitrebond™ Copolymer 5. Filler 6. Ethanol 7. Water 8. Initiators 9. Silane Composition of Kerr Optibond All in one bonding agent 1. Monomers: a. Glycerol phosphate dimethacrylate – selfetching bonding agent monomer b. Co-monomers including mono- and difunctional methacrylate monomers 2. Solvents: water, acetone and ethanol 3. Photo-initiator: camphorquinone based 4. Fillers: three nano-sized fillers 5. Fluoride-releasing fillers: sodium hexafluorosilicate and ylterbium fluoride

## MATERIAL AND METHODS

The study focused on dentine bonding agents, specifically OptibondAll in one kerr (BSA) and Single Bond Universal 3M (BSB), with both groups using bulkfill (ivoclar vivdent). Sixty premolar teeth that were removed during orthodontic treatment were obtained for the experiment. The teeth were cleaned, debrided, and stored in isotonic saline. The buccal surface of the teeth was reduced to create a flat dentinal surface using a medium grit diamond bur and high-speed handpiece under regular air water spray. The teeth were then randomly divided into two groups: KERR (BSA) group and 3M (BSB) group, each with 30 samples. For each bonding agent, the specimens were divided into non-contaminated (control group), contaminated, and decontaminated sub-groups (experimental groups), with ten specimens made for each procedure. In the experimental groups, freshly collected saliva was applied to the bonded dentinal surface of the sample with a disposable applicator tip for 5 seconds, followed by decontamination treatment. Details of the bonding procedure for each bonding agent are mentioned below.

After the bonding procedure, a composite block of 5 mm was built on the flat dentinal surface using a round plastic tube with an internal diameter of 4.9 mm by progressively adding 2 mm thick increments. The light tip was positioned as close to the tooth as possible for proper polymerization of each added layer of composite resin. Shear bond strength was measured using an Instron Universal testing machine (USA) with a shearing rod that had a chisel-shaped end and a cross-head speed of 1 mm per minute. The data obtained for shear bond strength was then subjected to statistical analysis using One-way ANOVA test and Tukey multiple comparison & Unpaired t-test for intergroup comparison.

Dentine bonding has garnered considerable interest due to its heterogeneous component with higher water and organic constituents than enamel. It has been discovered that bond strength is reliant on tooth structure and chemical composition. Consequently, researchers have made it their goal to enhance the strength of bonding agents in restorative materials in recent years.

BSA- KERR optibond all in one 20 Seconds- Apply bonding agent to tooth surface by scrubbing action. 20 seconds -re dip in bonding agent and reapply bonding agent to tooth surface by scrubbing action. 5 seconds- Dry the bonding agent 10 Seconds. Light cure BSB- 3MSingle Bond Universal 20 Seconds. Apply bonding agent to tooth surface by scrubbing action 5 Seconds. Dry the bonding agent 10 Seconds. Light cure

**Table 1-Mean bond strength values (MPa) of Kerr Optibond group (BSA)**

| Group | Sub group | N | Mean SBS ± SD |
|---|---|---|---|
| BSA | Non-Contaminated Group BSA-I | 10 | 14.77± 1.27 |

| | | | |
|---|---|---|---|
| | Contaminated Group BSA-II | 10 | 4.35 ± 2.67 |
| | Decontamination Group BSA-III | 10 | 15.7 ± 1.50 |

**Table 2-Mean bond strength values (MPa) of 3M universal group (BSB)**

| GROUP | SUB GROUP | N | Mean SBS ± SD |
|---|---|---|---|
| BSB | Non-Contaminated Group BSB-I | 10 | 6.51± 0.21 |
| | Contaminated Group BSB-II | 10 | 4.5 ± 2.15 |
| | Decontamination Group BSB-III | 10 | 10.5 ± 2.19 |

**Table 3- Comparison among BSA group**

| Group | A subgroup | (B)Subgroup | Mean Differences A-B | P value |
|---|---|---|---|---|
| BSA | Non-Contaminated group (BSA-I) | Contaminated group (BSA-II) | 7.89 | 0.00013 vhs |
| | Non-Contaminated group (BSA-I) | De-contaminated group (BSA-III | -0.93 | 0.4896 vhs |
| | Contaminated group (BSA-II) | De-contaminated group (BSA-III) | -8.88 | 0.00008 vhs |

**Table 4: Comparison among BSB group**

| Group | A subgroup | (B)Subgroup | Mean Differences A-B | P value |
|---|---|---|---|---|
| BSB | Non-Contaminated group (BSB-I) | Contaminated group (BSB-II) | 1.7 | 0.0298 sig |
| | Non-Contaminated group (BSB-I) | De-contaminated group (BSB-III) | -3.99 | 0.0005 vhs |
| | Contaminated group (BSB-II) | De-contaminated group (BSB-III) | -5.89 | 0.00032 vhs |

**Table 5 -Comparisons of mean bond strengths between BSA-I (control) and BSB-I (control) Sub**

| Sub-Group | Group | N | Mean Differences | P value |
|---|---|---|---|---|
| BSB | BSA-I | 10 | 12.87 ± 0.12 | 0.00011 vhs |
| | BSB-I | 10 | 4.52 ± 0.47 | |

***vhs- very highly significant.**

**DISCUSSSION**

Contamination of saliva is a common problem in restorative dentistry, especially when dealing with deep cervical lesions or placing indirect restorations. Rubber dam isolation may not always be feasible, and limited mouth opening can further complicate the situation. To address this issue, researchers chose to use natural saliva as a contaminating medium in their study, which simulated clinical conditions in vitro. The study found that both saliva and plasma can disrupt the formation of the hybrid layer, which is important for the success of restorative procedures. Overall, the results highlight the need for effective contamination control measures in restorative dentistry.[9]

**Fritz et al**[9] showed that after contamination with the saliva happens re-etching of the surface does not provide any sufficient strength.

**EL -Kalla and Godoy**[10] believed that drying the surface after salivary contamination over etched dentine can regain the bond strength. Further Studies have conjointly shown that bonding efficacy can be improved after reapplication of bonding agent after salivary contamination.

In 2006, **Sattabanasuk etal**. Evaluated the effect of salivary contamination on dentin bond strength in all-in-one adhesives and showed that salivary contamination decreases the strength of bond between dentin and all-in-one adhesives. They recommended application of extra adhesive after cleansing the saliva from the dentin surface .[11]

**Eiriksson (2004)** reported that salivary contamination of a composite surface even for every short time salivary pellicles are formed on the composite surface and result in reduced bond strength and rinsing alone for re-establishing the original bond strength is not reliable[(12)] Etch-and-rinse adhesives have been reported to reduce the microleakage of fissure seal-ants that were applied following saliva contamination.[13]

**Nair etal.,**[14] stated that when the toot surface is contaminated after the application of adhesive, but before the polymerization, the degree of conversion may be affected. The hydrophilic molecules may retain water within the adhesive layer and disperse in water. Hence, they become unable to participate in chain growth during polymerization. This results in an alteration of the bond strength.

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