



## Can Chlorhexidine enhance the Bond Strength of Self-etch and Etch-and-rinse Systems to Primary Teeth Dentin?

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### ABSTRACT

**Introduction:** Modifying the durability of resin bonding systems resulted in introducing materials with cross-link property, such as chlorhexidine (CHX) that can promote the strength of resin-dentin bonding. The aim of this study was evaluation of the effect of CHX on shear bond strength (SBS) of self-etch (SE) and etch-and-rinse (E&R) bonding systems to the primary teeth dentin.

**Materials and methods:** In this *in vitro* study, 40 freshly extracted primary molars collected and were cut mesiodistally, and then the buccal and lingual surface enamel was grounded. The specimens were randomly divided into two groups: I: Single Bond adhesive and II: Clearfil SE Bond adhesive. Then, each group was divided into two subgroups: On the buccal surface of each sample (I<sub>1</sub>, II<sub>1</sub>), CHX was applied for 30 seconds and on the lingual surface of (I<sub>2</sub>, II<sub>2</sub> groups), CHX was not applied. The SBS (MPa) of samples was assessed using the Zwick universal testing machine. Data were analyzed by paired t-test and independent t-test using Statistical Package for the Social Sciences (SPSS), version 16.

**Results:** The mean SBS was significantly higher in the Single Bond group with CHX (66.45 ± 8.3) than without CHX (25.43 ± 12.94) in the nonaging group (p = 0.002). There was no significant difference in the mean SBS in the Clearfil SE Bond group with CHX and without CHX in the aging and nonaging groups.

**Conclusion:** CHX had positive influence on immediate SBS of Single Bond adhesive to primary teeth dentin. In addition, no positive effect has been seen in the Clearfil SE Bond system.

**Clinical significance:** Now more researches are needed about the recommendation of CHX in resin restorations of primary teeth.

**Keywords:** Chlorhexidine, Etch-and-rinse adhesive, Failure pattern, Self-etch adhesive, Shear bond strength.

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**Conflict of interest:** None

### INTRODUCTION

If you are a dentist and have practical experiences in restorative and cosmetic dentistry, then you must be familiar with imperfections and complications of composite resins and their adhesives. Perhaps as a dentist, you may have wished at one time that there was a substance that could promote the seal and bond strength of dentin-resin and increase the durability of bonding. As a result, destructive factors, such as mastication forces, polymerizing shrinkage, and matrix metalloproteinase (MMP) enzymes could not compromise this bonding.

To achieve this prospect, new materials were introduced with cross-link properties, such as CHX, tannic acid, glutaraldehyde, and proanthocyanidin.<sup>1-3</sup>

Among these materials, CHX, an antimicrobial agent, preserves its cationic property in the oral cavity environment. A decrease in residual microbial contamination and promotion of the seal of restoration were observed when CHX was used before the application of adhesives. Besides, CHX is known as a specific inhibitor for MMP2, MMP9, as well as enzyme-inhibitor for the endogen collagenolytic enzyme of dentin.<sup>3-5</sup>

Several researchers have investigated the different abilities and properties of CHX, such as its inhibition

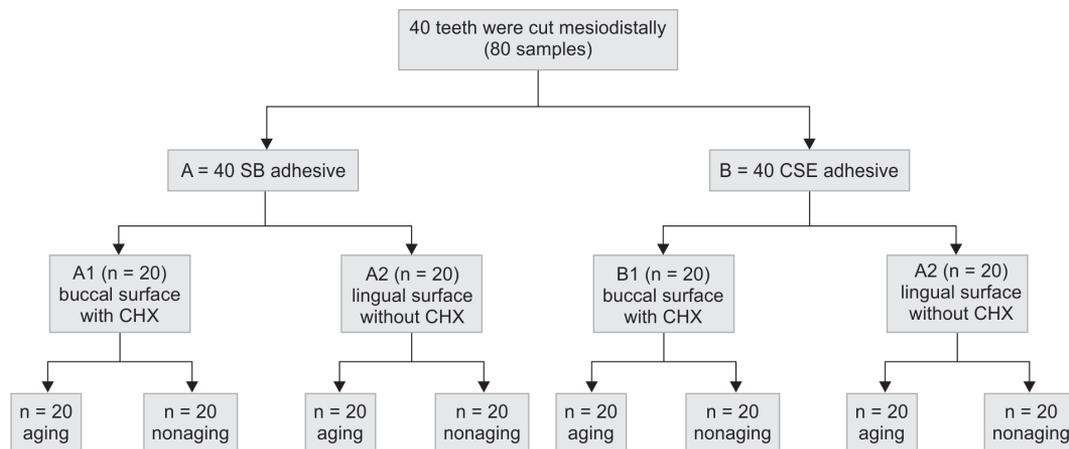
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Flow Chart 1: Flowchart of included samples



ability on MMPs, if applied prior to E&R adhesive systems.<sup>6,7</sup>

In addition, there are controversial results about the benefits of using CHX prior to SE adhesive systems.<sup>8-12</sup>

Recently, parents have recognized the importance of primary teeth on the promotion of oral health and the role of maintaining them in the final permanent occlusion. With regard to esthetics and conservative cavity preparation, composite restoration has obtained widespread popularity in pediatric dentistry. Therefore, it is necessary to conduct researches about improving the strength and durability of bond in primary teeth.

To the best of the authors' knowledge, few controversial studies have been published to find the role of CHX on the bond strength of primary dentin.<sup>13-18</sup> The aim of this study was to assess the effect of CHX in enhancing the SBS of SE and E&R bonding systems of primary teeth dentin.

The objectives of this study were: (A) determination of CHX effect on the SBS of SE and E&R bonding systems; (B) comparison of immediate SBS of SE as well as E&R bonding systems; (C) comparison of SBS of SE as well as E&R bonding systems after aging with and without application of CHX; and (D) determination of failure pattern of the dentin–resin interface.

## MATERIALS AND METHODS

For this *in vitro* interventional parallel study, 40 freshly extracted primary molars (due to therapeutic reasons) stored in 0.1% thymol solution were used. Our inclusion criteria were: (1) primary molar tooth; (2) absence of crack and fracture in tooth; and (3) existence of enough dentin on the buccal and lingual surfaces of tooth (at least 2 mm thickness) after eliminating the enamel of both surfaces.

With a high-speed hand-piece and a long needle diamond bur (Mani, Japan) with water coolant, the teeth were cut mesiodistally. Thereafter, the buccal and lingual enamel of the samples (n = 80) was grounded with a

trimmer (Dentaurum, Pforzheim, Germany) to form a flat dentin surface and finally finished by 300, 600, and 1,200 grit silicon carbide papers.

To make the dentin surface parallel with the horizontal line, the samples were placed on a glass slab by their flat surface, a cut of a plastic 5 cc syringe was placed on each sample and self-cure acryl was injected into the syringe such that the flat surface of the dentin was accessible.

The samples were randomly assigned into two groups (n = 40): group I: E&R adhesive system (Adper Single Bond, 3M ESPE, USA) and group II: SE adhesive system (Clearfil SE Bond, Kuraray Dental, Tokyo, Japan).

Each group was divided into two subgroups (n = 20): on the buccal surface of each sample (I<sub>1</sub> and II<sub>1</sub> groups), the adhesive was applied with CHX and on the lingual surface of each sample (I<sub>2</sub> and II<sub>2</sub> groups), the adhesive was applied without CHX (Flow Chart 1).

In the I<sub>1</sub> group, dentin surface was etched with 37% phosphoric acid for 15 seconds, then rinsed with gentle water flow for 10 seconds. After mild drying of the surface with cotton roll, CHX was then applied for 30 seconds and the excess CHX was eliminated by slow air flow and Single Bond adhesive was used in two layers and thereafter cured for 20 seconds (light-emitting diode: Bluephase 16i, Ivoclar-Vivadent, high-power mode). By a mold which had 2 mm depth, Z250 composite (3M ESPE, USA) was condensed in a 2 mm layer and cured for 40 seconds. In the II<sub>1</sub> group, dentin was treated with Clearfil SE Bond primer according to the manufacturer's instruction, CHX was then applied for 30 seconds and excess CHX was eliminated by gentle air flow, and Clearfil SE Bond adhesive was applied, followed by curing for 20 seconds. Thereafter, Clearfil APX composite was applied same as the I<sub>2</sub> group. For I<sub>2</sub> and II<sub>2</sub> groups, these procedures were done without applying CHX. Our samples were randomly divided into two groups (n = 10) based on the application and nonapplication of the aging process. In the aging groups, samples were stored in water and incubated at 37°C for 3 months. Samples were then thermocycled 1,000 times at 5 to 55°C

with a 20 second dwell time. The SBS (MPa) of samples was assessed using the Zwick universal testing machine (Zwick GmbH and Co, Ulm, Germany) at a cross-head speed of 1 mm/min. Then, bonding surfaces were observed under a stereomicroscope (Dino-Lite, Taiwan) to determine the failure pattern and results were classified as adhesive, cohesive, and mixed types. Data were analyzed by paired t-test (when the data were collected from the buccal and lingual surfaces of the same tooth) and independent t-test (when the data were collected from different teeth) using SPSS 16 (SPSS Inc., Chicago, Illinois).

**RESULTS**

The value of SBS of each sample was recorded and the mean SBS of each group was calculated. The mean SBS was significantly higher in the Single Bond group with CHX (66.45 ± 8.3) than without CHX (25.43 ± 12.94) in the nonaging group (p = 0.002). There was no significant difference in the mean SBS in the Clearfil SE Bond group with CHX (46.25 ± 9.34) and without CHX (47.83 ± 19.83) in the nonaging group (p = 0.82) (Table 1). Also, no significant difference was observed in the mean SBS in Single Bond groups with and without CHX in the aging group (p = 0.93). In addition, no significant difference was found in the Clearfil SE Bond groups with and without CHX in the aging group (p = 0.67) (Table 2). Tables 1 and 2 show the detailed mean SBS of the study groups.

The failure pattern of the dentin–resin interface was assessed in all eight experimental groups using a stereomicroscope. The results were classified as: (1) adhesive type (when the fracture occurs in the bonding zone); (2) cohesive type (when the fracture occurs in the composite resin or dentin), and (3) mixed type (when the failure is observed in both the composite resin and dentin).

In the present study, the failure pattern in all groups was mainly type I (adhesive type). Graphs 1 and 2 describe the failure pattern in the study groups based on aging/nonaging patterns.

**DISCUSSION**

This study demonstrated that when the primary dentin was rewetted by CHX before applying the Single Bond adhesive, the immediate SBS significantly increased (Table 1). This result is in line with the study of Ricci et al,<sup>18</sup> but these two studies are otherwise different because Ricci et al measured the tensile bond strength (TBS) in their research.

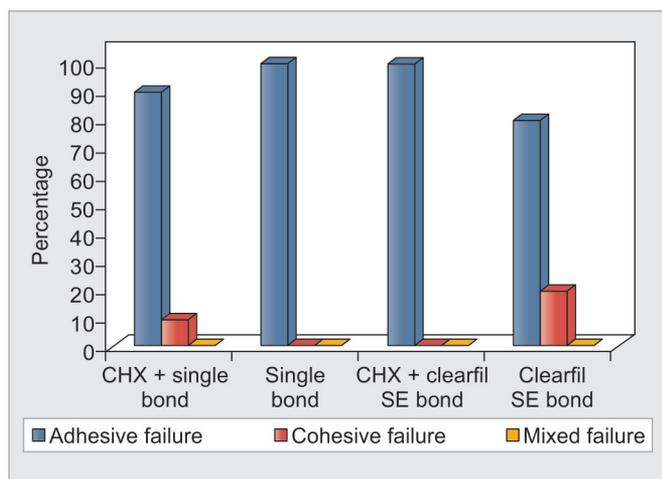
Several studies stated that CHX can increase the durability of dentin–resin bonding after 6 months’ storage in water, both in permanent dentin<sup>6,19</sup> and in primary teeth.<sup>14,15,17</sup> Unlike these results, CHX had no influence on the bond strength after 3 months storage of samples in the present study (Table 2).

**Table 1:** Comparison of mean SBS of study groups with and without CHX in the nonaging group

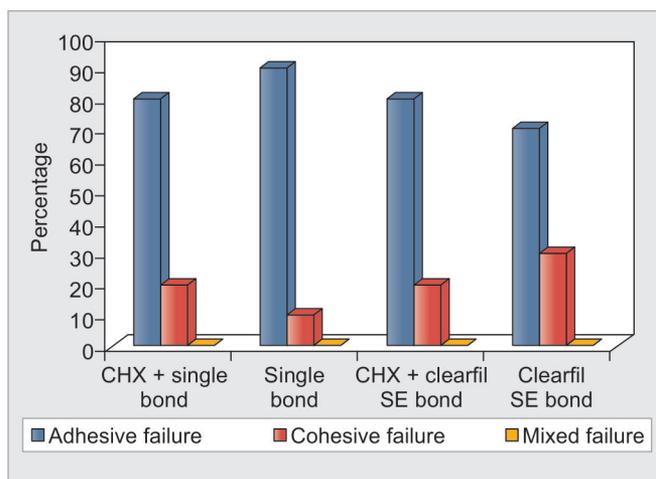
Groups	Type of bonding		p-value (paired t-test)
	Single bond (mean ± SD)	Clearfil SE bond (mean ± SD)	
With CHX	66.45 ± 8.3	46.25 ± 9.34	0.88
Without CHX	25.43 ± 12.94	47.83 ± 19.83	0.19
p-value (paired t-test)	0.002	0.82	

**Table 2:** Comparison of mean SBS of study groups with and without CHX in the aging group

Groups	Type of bonding		p-value (paired t-test)
	Single bond (mean ± SD)	Clearfil SE bond (mean ± SD)	
With CHX	39.02 ± 23.29	56.4 ± 22.18	0.10
Without CHX	39.96 ± 21.75	53.36 ± 18.05	0.001
p-value (paired t-test)	0.93	0.67	



**Graph 1:** Failure patterns in specimens with and without CHX in the nonaging group



**Graph 2:** Failure patterns in specimens with and without CHX in the aging group

The researches of Kapdan and Öztaş<sup>13</sup> and De Sousa Vieira and Da Silva<sup>20</sup> demonstrated that immediate bond strength was significantly decreased when CHX was applied before the Single Bond adhesive. In Kapdan's study, SBS was evaluated, but De Sousa Vieira measured the  $\mu$ TBS. Several studies showed that CHX does not have any interference with immediate bond strength to primary dentin.<sup>14,16,21,22</sup> Besides, Lenzi et al<sup>14</sup> and Ricci et al<sup>17</sup> reported that bond degradation decreased after several months. Manfro et al's<sup>15</sup> study showed that CHX might be prevented from bond degradation immediately and after 1 year on the interface zone of the primary teeth.<sup>15</sup>

In the present study, unlike Single Bond adhesive, CHX did not raise the immediate SBS of Clearfil SE Bond adhesive in the primary dentin (Table 1). Several studies showed that CHX modifies the strength and durability of dentin-resin bonding in SE adhesive systems.<sup>8,11</sup> On the contrary, few studies revealed that CHX has no effect on the strength of this bonding.<sup>9</sup> Researches also indicated that CHX has an adverse effect on dentin-resin bonding and increases microleakage after a 24-hour storage in water.<sup>12</sup> In addition, Shafiei et al's<sup>11</sup> study showed that immediate SBS of Clearfil SE Bond adhesive in the primary dentin significantly decreased after using CHX. However, the SBS did not change after 6 months storage as compared with the control group. On the contrary, Campos et al<sup>8</sup> revealed that 2% CHX decreased the immediate bonding of the SE adhesive system in permanent teeth. This result was probably due to the reaction of CHX with components of the adhesive or decrease of rewetting ability of CHX and may also be related to bonding of CHX with the phosphate portion of hydroxyapatite due to its cationic property and as such, interact with the acidic monomer function.

According to a review of previous studies about the effects of CHX on bond durability, and regarding the results of this study, it seems that more studies are required, in order to successfully determine the effect of CHX on the bond strength of the primary dentin. Although in the present study CHX increased the immediate SBS of the Single Bond adhesive in the primary dentin, our goal should be to preserve an ideal bond for a longer period.

In relation to the type of failure in this study, adhesive pattern was the major form found to be in line with the study of Ricci et al.<sup>18</sup> However, De Sousa Vieira and Da Silva,<sup>20</sup> and Lenzi et al<sup>16</sup> reported cohesive and mixed types as major failure patterns in the primary dentin respectively.

Since this research is one of the first studies about the effect of CHX on SBS in the primary dentin, the authors recommend the following:

- Studies on different concentrations and application time of CHX in the primary dentin should be performed.

- Long-term clinical studies as regards the effect of application of CHX prior to SE and E&R bonding systems on the primary dentin should be designed.

## CONCLUSION

Although using CHX before two-step E&R adhesive (Single Bond) increased the immediate SBS, no effect was observed after the aging procedure. Since no positive effect was found either on immediate SBS or after the aging procedure of the two-step SE adhesive (Clearfil SE Bond) in the primary dentin, more researches are recommended.

## CLINICAL SIGNIFICANCE

Now more researches are needed about the recommendation of CHX in resin restorations of primary teeth.

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