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ORIGINAL ARTICLE

Effect of 2% Chlorhexidine on Appearance of Hybrid Layer with Two different Seventh-generation Bonding Agents

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ABSTRACT

Aim: To evaluate the appearance of a hybrid layer in two seventh-generation bonding agents on human teeth with and without the application of 2% chlorhexidine.

Materials and methods: Class II cavities (MO-OD) were prepared on 12 human maxillary teeth. These teeth were divided into two groups (n = 6) to receive either of the two seventh-generation bonding agents. The bonding agent was applied in the mesio-occlusal cavity. On the disto-occlusal cavity, 2% chlorhexidine was applied for 30 seconds before the application of the bonding agent. Teeth were sectioned mesiodistally with a slow-speed diamond disk and stored in water at 37°C for 30 days. The teeth were prepared for scanning electron microscope observation. The hybrid layer was measured by two variables – clear image of hybrid layer and presence of resin tags in tubules. Data were analyzed using chi-square and Kruskal–Wallis H tests.

Results: No statistically significant difference was found between the groups ($p > 0.05$).

Conclusion: CLEARFIL S^3 performed better than the One Coat 7.0 bond.

Keywords: Chlorhexidine, CLEARFIL S^3, One Coat 7.0 bond.

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INTRODUCTION

Dental adhesives have changed the field of restorative dentistry.[1] The main challenge for a dental adhesive is the ability to bond effectively to two substrates of a different nature.

Bonding to enamel is reliable and durable.[2] In contrast, bonding to dentin has been difficult due to its variable nature and heterogeneous structure. Hybridization with resin by monomer interdiffusion has been identified as the basic bonding mechanism resulting in an intimate interlocking of the cured resin with the dentin.[2]

Different factors are shown to synergistically affect the integrity of each component of the hybrid layer, thereby contributing to a rapid and catastrophic failure of the resin–dentin bond. The success of adhesion to acid-etched enamel was further propelled by Buonocore et al.[10] They recommended the treatment of the enamel surface with an aqueous acid solution, which resulted in the formation of resin tags by penetration of the resin monomer into the resulting microporosities, and a micromechanical bond was formed after polymerization.

The enamel bonding technique has become the standard and is well accepted. However, bonding to dentin has evolved significantly with the development of various bonding systems. During the early 1990s, dentin bonding agents were introduced, which are referred to as fourth-generation agents. However, their use has been minimal due to the complexity to perform bonding and due to these adhesives being time consuming and consisting of a separate etchant, primer, and bonding resin.[2] To overcome these drawbacks, the evolution of new dentin bonding agents, i.e., seventh-generation (all-in-one) bonding agents, has occurred in the recent past. They are less technique sensitive, less time consuming, and effective.[4] The advantages of the self-etching system include complete infiltration of the bonding agent into the demineralized dentin and a reduced number of clinical procedural steps.[5]

Evidence-based studies have shown that bacteria left in the tooth remain viable for a long duration.[3] Hence, an antibacterial cavity cleanser is recommended to eliminate the potential risks due to bacterial activity. A 2% chlorhexidine has been proven to be an effective agent to disinfect dentin.[1] It preserves the dentin bond strength by inhibiting host-derived matrix metalloproteinases (MMPs).[3] The use of 0.2% chlorhexidine gluconate for 60 seconds was found to inhibit collagenitic activity, thus maintaining the resin–dentin interface.[3] The purpose of this study was to evaluate appearance of the hybrid layer in two different seventh-generation bonding agents on human teeth with and without the application of 2% chlorhexidine.

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MATERIALS AND METHODS

Class II cavities (MO-OD) were prepared on 12 human maxillary teeth using 558 carbide bur, leaving a 1-mm thick enamel wall to separate the mesial cavity from the distal cavity. Cavities were prepared to a depth of 1 mm below the dentinoenamel junction with no axial wall, but with elimination of the proximal enamel ridge on both the sides. These teeth were divided into two groups (n = 6) to receive either CLEARFIL S^3 (Kuraray Dental) or One Coat 7.0 bond (Coltene) bonding agent.

The mesial cavity in group I was coated with CLEARFIL S^3 and group II with One Coat 7.0 bond for 10 seconds and light cured for 20 seconds (3M ESPE). Composite resin (3M ESPE) was placed in three increments. A 2% chlorhexidine was applied for 30 seconds in the distal occlusal cavity, and the excess was eliminated before application of the respective bonding agent. The cavity was filled with composite resin.

The teeth were sectioned in the mesiodistal direction into two halves using a slow-speed diamond saw and placed in water at 37°C for 30 days. The specimens were polished with silicon carbide paper under water using sequentially 400, 600, 1000 grit. They were placed in 70, 80, 90, and 99% alcohol to eliminate water before being desiccated and prepared for scanning electron microscope observation under 800× magnification. All the specimens were assessed by two variables – clear image of the hybrid layer, which is at least 75% of the length of the interface (yes = 1, no = 0), and the presence of resin tags in tubules at least 75% of length of the interface (yes = 1, no = 0).

Statistical analysis was performed using chi-square and Kruskal–Wallis H tests.

RESULTS

The composite–dentin interface was given a score of 0 or 1. Specimens treated with 2% chlorhexidine before the application of the dentin bonding agent showed a higher presence of a hybrid layer in the interface when compared with bonding agent in the same tooth that was not treated with the 2% chlorhexidine. No statistically significant difference was found between the groups ($p > 0.05$) (Tables 1 and 2).

Table 1: Presence of hybrid layer and resin tags with or without application of chlorhexidine

	Treatment	*Hybrid layer*	*Resin tags*	*χ^2-value*
Group I	Chlorhexidine	3	3	0.000
	Without chlorhexidine	6	6	p-value = 1.00 NS, p > 0.05
Group II	Chlorhexidine	3	3	0.15
	Without chlorhexidine	6	4	p-value = 0.69 NS, p > 0.05

NS: Nonsignificant

Table 2: Mean comparison between the groups with or without application of chlorhexidine

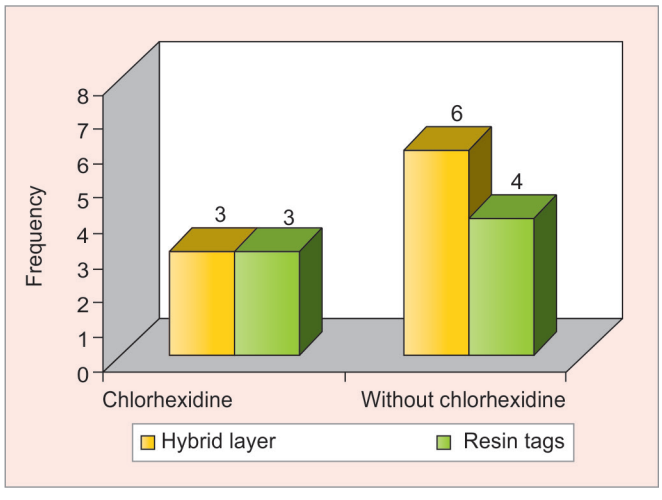
	Sample size	*Sum of ranks*
Group 1	6	42
Group 2	6	35
H	2.92	
Degrees of freedom	1.0	
H Corrected	3.9	
N	12	
p-value	0.231, NS, p > 0.05	

NS: Nonsignificant

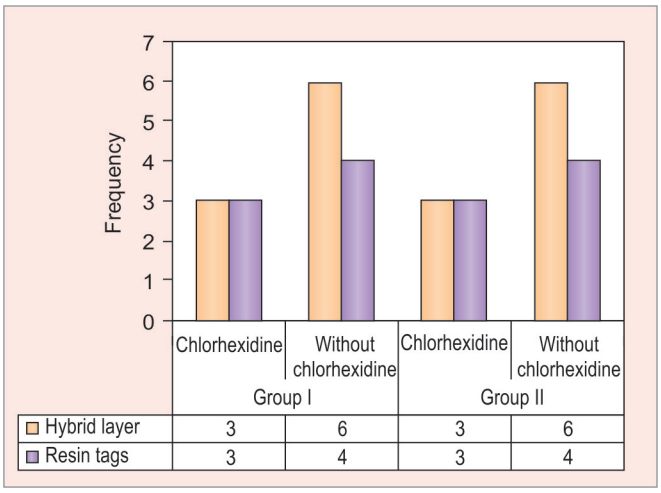
DISCUSSION

Dentin, the fundamental substrate of restorative dentistry, determines all restorative parameters along with preventive and disease processes affecting teeth. Nevertheless, an enormous amount of research is focused on understanding its characteristics, properties, histology, and structure to develop a suitable restorative, which may form a biologic composite.[6] The deterioration of the hybrid layer after water storage is a concept well studied and accepted.[7] In the present study, reduction in thickness of the hybrid layer was due to storage in water.[8] The negative effect of water storage in the hybrid layer is due to hydrolysis of the unstable polymeric hydrogels that are less concentrated and diffuse in the acid-etched dentin. Another reason could be that the unprotected collagen fibers get degraded by the MMP.

No statistically significant difference was observed between the mesio-occlusal and disto-occlusal cavities of both the groups with or without 0.2% chlorhexidine ($p > 0.05$) (Graphs 1 and 2). No statistically significant difference was observed between groups I and II with or without 2% chlorhexidine ($p > 0.05$).



Graph 1: Presence of hybrid layer and resin tags with or without application of chlorhexidine



Graph 2: Comparison between the groups with or without application of chlorhexidine

Chlorhexidine is a broad-spectrum antiseptic, and its use has been generalized over the past two decades. Previous studies have demonstrated that chlorhexidine application prior to acid-etching in etch-and-rinse adhesives has no adverse effects on composite-adhesive bonding to dentin.[3] The cavities treated with 0.2% chlorhexidine surfaces showed enhanced bond strength. However, the cavities not treated with chlorhexidine showed lack of resin tags.[1,3]

Both are based on hydroxyethylmethacrylate–alcohol mixture and have shown to have high bond-strength potential.[7] Both the bonding agents utilize ethanol as a primer component solvent. Ethanol increases the miscibility of monomer and water. Both contain nanofillers and fumed silica, which deliver the homogeneous bond layer, improved mechanical strength, abrasion resistance, and marginal integrity.

In the present study, group I performed better than group II (Graph 1). These results could be attributed to the following[4,6]:

- The presence of 10-methacryloyloxydecyl dihydrogen phosphate (MDP), which has chemical affinity for dental tissues and chelates favorably to calcium.[6,9]
- The CLEARFIL S^3 bond formulation includes a proprietary "Molecular Dispersion Technology," enabling a two-phase liquid, hydrophilic/hydrophobic component homogeneous state at the molecular level, resulting in reduction of water droplets at the adhesive interface and, therefore, a superior bond.[6,7,9]

Negligible documentation is available regarding One Coat 7.0 bond, as it has been recently introduced into the market. The success rate for group II is 80% – the reason for this could be due to nanofilled technology. One Coat 7.0 uses urethane dimethacrylate as a resin monomer; however, the balance of water-acidic monomers and resin monomers in self-etch adhesives is paramount in optimizing bond efficacy to dentin.[7] One Coat 7.0 has phosphoric acid mono-methacrylate (comparable to MDP) and a methacrylated polyacrylic acid that results in chemical bonding with the tooth surface.[7]

Future research is needed on the appearance of a hybrid layer by using chlorhexidine before using dentin bonding agents. However, it is still controversial whether the application of a chlorhexidine solution in a cavity preparation influences the effectiveness of a self-etching adhesive and ultimately the marginal microleakage of resin composite restorations. A durable interfacial adhesion between the tooth and biomaterial is essential for an ideal restoration. Ideally, the lifetime of a restoration would match that of its host.[8] In reality, the continuing search for better restorative systems necessitates an awareness of the current materials that might give optimal clinical durability.

CONCLUSION

Within the limitations of this *in vitro* study, it can be concluded that the use of a 2% chlorhexidine cavity disinfectant increases the bond strength in cavities restored with light-cured composites using self-etching adhesives.[1]

CLINICAL SIGNIFICANCE

Disinfectant is recommended prior to application of bonding agent, as it increases the bond strength. A 0.2% chlorhexidine has proved as a good disinfectant. *In vivo* studies are to be carried out because the present study did not simulate the oral environment.

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