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### Original research

# Adhesive interface and microtensile bond strength evaluation of four adhesive systems to primary dentin



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#### ABSTRACT

**Objectives:** The aim of this study was to evaluate the microtensile bond strength and the adhesive interface of four adhesive systems to primary dentin.

**Methods:** Sixteen sound human primary molars were ground flat to expose dentin and randomly divided into four experimental groups according to the different adhesive material evaluated: three self-etching systems (Clearfil™ Protect Bond, Clearfil™ S<sup>3</sup> Bond Plus and Futurabond® U) and one etch-and-rinse system (Prime&Bond® NT). The adhesives were applied under manufacturer's instructions and the crowns "restored" with a composite resin (Synergy® D6). The "restored" teeth were then cross-sectioned to obtain sticks. Each stick was evaluated using a microtensile test in a universal testing machine. Additionally, eighteen dentin samples from four temporary molars were prepared for dentin conditioning and interface morphology evaluation using scanning electron microscopy. The bond strength results were analyzed using one-way ANOVA and a Tukey HSD test (confidence level of 95%).

**Results:** Clearfil™ S<sup>3</sup> Bond Plus (47,28 MPa), Prime&Bond® NT (43.11 MPa) and Clearfil™ Protect Bond (40.33 MPa), presented the highest adhesion values without statistical differences. Futurabond® U bond strengths (35.16 MPa) was statistically similar to Clearfil™ Protect Bond ( $p=0.271$ ) but significantly lower from Prime&Bond® NT ( $p=0.022$ ) and Clearfil™ S<sup>3</sup> Bond Plus ( $p<0.001$ ). An ultra-morphological evaluation showed marked differences in smear layer dissolution, depth of dentin demineralization and thickness of the hybrid layer promoted by the different adhesive strategies evaluated.

**Conclusions:** Considering the limitations of this *in vitro* study, some self-etch adhesives may be capable of producing high bond strengths to primary dentin, similar to the etch-and-rinse adhesive evaluated.

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## Avaliação das interfaces e da adesão em microtração à dentina decídua de quatro sistemas adesivos

### R E S U M O

#### Palavras-chave:

Adesivos dentários  
Dentes decíduos  
Ensaio de tração  
Condicionamento ácido dentário  
Dentina  
Adesão dentária

**Objetivos:** Avaliar forças de adesão e interfaces adesivas obtidas por quatro sistemas adesivos em dentina decídua.

**Métodos:** Seccionaram-se dezasseis molares decíduos humanos expondo uma superfície de dentina plana, dividindo-os aleatoriamente em quatro grupos experimentais de acordo com o adesivo avaliado: três autocondicionantes (Clearfil™ Protect Bond, Clearfil™ S3 Bond Plus e Futurabond®U) e um de “condicionar e lavar” (Prime&Bond® NT). Após aplicação de acordo com as instruções dos fabricantes seguiu-se a “restauração” com uma resina composta microhíbrida (Synergy® D6). Os dentes foram posteriormente seccionados obtendo-se bastonetes de secção quadrangular subsequentemente sujeitos a um teste de adesão por microtração. Os valores obtidos (MPa) analisaram-se pelos testes paramétricos ANOVA e de comparação múltipla de Tukey HSD ( $p \leq 0,05$ ). Adicionalmente prepararam-se dezoito amostras de dentina provenientes de quatro molares temporários tratadas com os mesmos adesivos objetivando estudar o condicionamento dentinário obtido e a ultramorfologia da interface por microscopia electrónica de varrimento.

**Resultados:** Os adesivos Clearfil™ S3 Bond Plus (47,28 MPa), Prime&Bond®NT (43,11 MPa) e Clearfil™ Protect Bond (39,38 MPa), registaram valores de adesão mais elevados sem diferenças estatisticamente significativas entre si. Os valores obtidos com o Futurabond®U (35,16 MPa) foram estatisticamente semelhantes ao Clearfil™ Protect Bond ( $p = 0,271$ ), mas estatisticamente inferiores aos do Prime&Bond®NT ( $p = 0,022$ ) e Clearfil™ S3 Bond Plus ( $p < 0,001$ ). Relativamente ao padrão de condicionamento dentinário e interfaces adesivas foram encontrados resultados substancialmente diferentes entre os adesivos.

**Conclusões:** Dentro das limitações inerentes pode ser concluído que alguns adesivos autocondicionantes proporcionam valores de adesão em dentina temporária elevados, similares ao adesivo do tipo “condicionar e lavar” avaliado.

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## Introduction

Modern restorative dentistry focuses on conserving tooth structure using adhesives and restorative materials. The clinical success of such restorations depends on the adhesive system, which provides a durable bond between the composite and the dentin and enamel.<sup>1-3</sup>

Presently, there are two main different approaches where adhesive systems can be used: etch-and-rinse and self-etching modes.<sup>4,5</sup> Current self-etch systems may represent an attractive addition to the day-to-day dental practice due to their shortened application protocol, a particularly significant advantage in pediatric dentistry.<sup>6-10</sup>

Despite extensive research in dental adhesion, it has been common practice that knowledge acquired by *in vivo* or *in vitro* studies using permanent teeth has been extrapolated to primary teeth. Regardless of eventual chemical and morphological peculiarities, the same protocols have been recommended for bonding to primary and permanent teeth.<sup>11</sup> Evidence regarding morphological differences suggests that the density and diameter of dentinal tubules is higher in primary than in permanent dentin, resulting in a reduced area of intertubular dentin available for bonding.<sup>12</sup> Also, the higher prevalence of microchannels in primary teeth would

further reduce bond strength.<sup>13</sup> Chemically, the concentration of calcium and phosphate in peritubular and intertubular dentin is lower in primary teeth than in permanent teeth,<sup>12,14</sup> which increases the reactivity of primary dentin to acidic solutions, resulting in the formation of thicker hybrid layers compared with permanent teeth.<sup>11,12,14-16</sup> The differences between permanent and primary dentin may influence adhesive performance, leading to lower bond strength for primary dentin.<sup>13,17</sup>

The aim of this study was to evaluate the dentin conditioning, adhesive interface and microtensile bond strength ( $\mu$ TBS) of four adhesives to primary dentin. The null hypothesis was that “there are no significant differences in the bond strength between the different adhesive systems evaluated”.

## Materials and methods

Sixteen sound human primary molars were used in the microtensile study. The pulp tissue of each tooth was gently removed with an excavator and the pulp chamber was adhesively filled with a dual-cure composite resin (ParaBond® adhesive system and ParaCore® white, Coltène/Whaledent AG, Switzerland).

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