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An in-vitro assessment of the shear bond strength of bulk-fill resin composites to permanent and deciduous teeth

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ABSTRACT

Objectives: This study aimed to evaluate the shear bond strength (SBS) of bulk-fill resin composites (RCs) to deciduous and permanent teeth.

Methods: The following parameters were investigated: (1) tooth type (deciduous and permanent), (2) tooth substrate (enamel and dentine), (3) restorative material (a high- and a low-viscosity bulk-fill RC and a regular nanohybrid RC as control), and (4) adhesive (two self-etching adhesives). The combination of those parameters resulted in a total of 24 different groups ($n = 20$). Permanent caries-free human molars (240) and deciduous teeth (240) were selected. The bulk-fill RCs (Tetric Evo Ceram Bulk Fill and SureFil SDR) were applied in one 4-mm increment, whereas the regular RC (Tetric Evo Ceram) was layered in two consecutive 2-mm increments. The SBS was examined after storing the specimens for 24 h at 37 °C in distilled water, followed by thermal ageing (5000 cycles between 5 °C and 55 °C).

Results: Data were statistically analyzed using one- and multiway analyses of variance and an independent-samples *t*-test ($\alpha = 0.05$). The multivariate analysis (general linear model with partial eta-squared statistics) tested the influence of the parameters tooth type, tooth substrate, restorative material, and adhesive on the SBS. The parameter tooth type showed no significant impact on the SBS ($p = 0.576$). The influence of the other parameters was significant ($p < 0.05$) but low, and the highest influence was exerted by the parameter adhesive ($\eta_P^2 = 0.120$, $p = 0.0001$) followed by tooth substrate ($\eta_P^2 = 0.092$, $p = 0.0001$) and restorative material ($\eta_P^2 = 0.028$, $p = 0.0001$). The fracture pattern was predominantly adhesive (61.9%) or mixed (38.1), and no cohesive or prefailure was registered.

Conclusions: Bulk-fill materials performed comparable or better than the nanohybrid RC used as control, but the adhesive used was the most relevant factor of influence. This material type might be clinically an option for a faster restoration in both permanent and deciduous teeth.

Clinical significance: Bulk-fill materials performed comparable or slightly better than the nanohybrid RC used as control. Clinically, flowable bulk-fill RCs might be an advantage in restoring deep, narrow cavities, with difficult access angles, whereas larger cavities might be restored easily and faster using high-viscosity compounds.

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1. Introduction

The search for faster and easier restorative procedures sustains the efforts of cost-efficiency in dentistry and might be important also in the paediatric dentistry. Restorative materials necessitating less application steps, thus reducing the treatment time, are therefore in focus, especially as amalgam replacements.[1] The time-consuming layering process with regular resin composites (RCs) can be skipped by using bulk-fill RCs while self-etching adhesives involve less application steps for the bonding procedure compared with etch-and-rinse techniques. This trend in simplifying the restorative procedure by creating multipurpose materials mostly implies compromises in material properties. Compared with regular RCs, several bulk-fill RCs show decreased filler content and increased filler size (filler size >20 μm as observed in several materials such as x-tra fil and x-tra base, VOCO, Cuxhaven, Germany; SureFil SDR flow, Dentsply Caulk, Milford, DE, USA; SonicFill, Kerr, Orange, CA, USA)[2] to improve translucency,[3] with the consequence of worsening aesthetic properties, lowering mechanical properties,[2] and potentially increasing abrasion or surface roughness.

Bulk-fill RCs have been proven in several studies to enable restoration in thick layers, up to 4 mm, maintaining the mechanical properties and the degree of conversion within the whole increment.[4–7] Besides, decreased polymerization shrinkage stress,[8–10] reduced cusp deflection in standardized class II cavities,[11] good bond strengths regardless of the filling technique and the cavity configuration,[12] and improved self-levelling ability for low-viscosity materials[13] are reported.

The mechanical properties of the bulk-fill RCs vary in a large range[2] as the function of the filler content. Therefore, this material class includes low-viscosity (flowable) and high-viscosity paste material types. The lower mechanical properties of the former[2] require an additional step in the restoration process by adding a capping layer made of regular RCs, thus diminishing the advantages of a fast restoration, in part, and presumably predisposing the restorations on long term to a higher degradation.

However, based on their chemical composition on regular RCs, bulk-fill RCs also benefit from innovative changes, such as the implementation of new higher-molecular weight monomers (SureFil SDR flow) or new initiator systems (Ivocerin in Tetric Evo Ceram Bulk Fill; Ivoclar Vivadent Inc., Schaan, Liechtenstein).[14]

A retrospective study analyzing 1017 fillings in 855 primary teeth identified that resin composite restorations are a long lasting and promise restorative option in paediatric patients suffering from early childhood caries.[15] In the perspective of a faster restorative procedure, the use of bulk-fill RCs in patients that lack the ability to cooperate appropriately during invasive therapy is therefore pertinent. Moreover, there is a need to verify whether these materials are efficient in both deciduous and permanent teeth. Therefore, the study aims to evaluate and to compare the shear bond strength (SBS) of bulk-fill materials to deciduous and permanent teeth, by separately considering the dentine and the enamel as substrates and using a clinically established RC as a reference restorative material.

The tested null hypotheses are as follows: (i) type of tooth (permanent or deciduous), (ii) type of dental substrate (dentine or enamel), (iii) type of restorative material (bulk-fill or regular RC), and (iv) adhesive used show no impact on the SBS.

2. Materials and methods

High-viscosity (Tetric Evo Ceram Bulk Fill; Ivoclar Vivadent Inc.) and low-viscosity bulk-fill RCs (SureFil SDR flow; Dentsply, Konstanz, Germany) were compared in terms of SBS to different tooth substrates and tooth types with a regular nanohybrid RC (Tetric Evo Ceram; Ivoclar Vivadent Inc.) (Table 1).

The following parameters were analyzed: (1) tooth type (deciduous and permanent), (2) tooth substrate (enamel and dentine), (3) restorative material (Tetric Evo Ceram Bulk Fill, SureFil SDR, and Tetric Evo Ceram as control), and (4) adhesive (two self-etching adhesives: Adhese One F and Xeno V). The combination of those parameters resulted in a total of 24 different groups ($n = 20$).

Table 1 – Materials, manufacturer, chemical composition of matrix and filler as well as filler content by weight (wt.) and volume (vol.) %.

Resin composites	Manufacturer, colour, batch	Resin matrix	Filler	Filler (wt/vol)
Tetric Evo Ceram	Ivoclar Vivadent AG, R08292	BisGMA, UDMA	Ba-Glas, YbF_3, MO, PPF	76/54
Tetric Evo Ceram Bulk fill	Ivoclar Vivadent AG, P84129	BisGMA, UDMA	Ba-Glas, YbF_3, MO, PPF	80/60
SureFil® SDR™ flow Flowable base RBC	Dentsply Caulk, Universal, 1202000287	Modified UDMA, TEGDMA, EBPDMA	Ba–Al–F–B–Si–glass and Sr–Al–F–Si–glass	68/44
Adhesives	Manufacturer, Batch	Composition		
Adhese OneF	Ivoclar Vivadent AG, P85622	Bis-acrylamide derivative 25–50%; bis-methacrylamide dihydrogen phosphate 10–<20%; amino acid acrylamide 1–<10%; propan-2-ol 1–<10%; 2-acrylamido-2-methylpropanesulphonic acid 1–≤2.5%; potassium fluoride 0.1–<1%; highly dispersed silicon dioxide; water; alcohol		
Xeno V	Dentsply Detrey GmbH 1112000093	Bifunctional acrylate; acidic acrylate; functionalized phosphoric acid ester; acrylic acid; water; tertiary butanol;		

Abbreviations: Bis-GMA, bisphenol-A diglycidyl ether dimethacrylate; EBPDMA, ethoxylated bisphenol-A-dimethacrylate; TEGDMA, triethyleneglycol dimethacrylate; UDMA, urethane dimethacrylate.
Data are provided by manufacturers.