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ORIGINAL ARTICLE

Effect of ageing on the micro-tensile bond strength of resin based composite when bonded with resin luting cement

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KEYWORDS

Resin composite;
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Abstract *Objective:* Resin based composite (RBC) restoration, existing at tooth bonding sites can compromise the bond between the framework and the tooth. Therefore, the aim of the study was to evaluate the effect of *in vitro* ageing of RBC on its micro-tensile bond strength with resin luting cement (RLC).

Materials and methods: Forty standardised RBC blocks ($4 \times 6 \times 8$ mm) were fabricated. Twenty blocks were divided into four groups ($N = 5$ per group). Group 1 (control) received no ageing; in group 2, specimens were exposed to 500 cycles of thermocycling (TC) at 5–55 °C; in group 3, specimens were exposed to 5000 cycles of TC and in group 4 specimens were placed in Sodium hydroxide (0.1 N, NaOH) for one week. Following treatment, RBC blocks were paired with identical untreated RBC blocks and bonded, using RLC (Panavia F 2.0) under constant load. RLC was cured for 160 s at the intensity of 650 $mWcm^{-2}$. Bonded blocks were sectioned using a diamond saw at 500 rpm and 250 ground force. A total of 160 specimen sticks were subjected to micro-tensile bond strength testing (Bisco Inc., Virginia, USA) at a crosshead speed of 0.5 mm/min. Fractographic analysis was performed using a stereomicroscope (63×). Means of micro-tensile bond strength (μ-tbs) were analysed with ANOVA and Tukey-Kramer multiple comparisons test ($P = 0.05$).

Results: μ-tbs was significantly higher for group 1 (54.20 ± 7.34 MPa) as compared to group 2 (44.17 ± 8.61 MPa) and group 3 (20.32 ± 7.91 MPa). Specimens in group 4 debonded prior to μ-tbs testing. 77.5% specimens in group1 and 100% specimens in groups 2 and 3 showed adhesive failures at the RBC and RLC bonding interface.

Conclusion: RLC showed significantly lower micro tensile bond strengths when bonded to aged RBC as compared to when RLC was bonded to non-aged RBC.

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1. Introduction

Resin bonded bridge (RBB) is a predictable and conservative treatment option for the replacement of missing teeth.[1–3] Effective adhesive bonding of RBB metal retainers to tooth substrate (enamel) is critical in their long-term success.[4] Development in resin luting cements in combination with surface treatment of RBB metal retainers has improved their adhesive bonding to tooth enamel.[5,6] Moreover, quality and quantity of the remaining enamel are also an important factor in the adhesive bonding of RBB's.[1] The adhesive bond produced by bonding of RBB to tooth substrate comprises of two interfaces. One formed between the metal retainer and resin luting cement (RLC) and the other between the RLC and the tooth substrate. In the presence of an existing restoration at the bonding site, the second interface (between the RLC and tooth substrate) can compromise the adhesive cementation of RBB. However, abutments often present with existing resin restorations at bonding sites, potentially influencing the adhesive bond.[7] It is known that resin based composite (RBC) restorations during function in the oral environment are exposed to chemical and physical insults including, water sorption, erosion, chewing loads and bacterial activity.[8,9] These processes are implicated with the chemical and physical structural degradation of polymeric materials such as RBC's. For instance, water sorption into RBC reduces the stability and strength of the filler/matrix interface and induces 'plasticization'.[10,11]

Few studies have investigated the influence of existing aged restorations at the bonding site on the survival of RBB's. In a study by Creugers et al. [7] existing aged restorations at bonding sites were not regarded as risk factors for the survival of RBB's. Similarly, in the study by Djemal et al. [1] 23.6% of abutment teeth had existing restorations, however, the survival rates of RBB's were not influenced by these restorations. However, it is noteworthy that in both these studies[1,7] resin restorations at the bonding sites were replaced prior to cementation of RBB's.

Failures of RBB's tend to occur at the cement-retainer interface or by cohesive failure of the RLC,[12–14] resulting in little attention being drawn towards the bond between existing resin restoration and the cement interface. To our knowledge from indexed literature, there are no studies, which investigated the aged restoration- RLC interface. It is hypothesised that existing RBC restorations forming part of the bonding site on a RBB abutment, will potentially compromise the bond strength between the RLC and aged RBC. Therefore, the aim of the study was to evaluate the effect of *in vitro* ageing of RBC on its micro-tensile bond strength with RLC, in comparison to when RLC is bonded to non-aged RBC.

2. Materials and methods

2.1. Materials used in the study

RBC: Filtek Z250, 3 M ESPE. Shade B1.

RLC: Panavia™ F 2.0, Pastes A & B, Kuraray Medical Inc., Okayama, Japan.

Etchant: Total Etch, Ivoclar Vivadent.

Primer: Prime & Bond NT, Dentsply.

Oxygen-blocking agent: Oxyguard, Kuraray Medical Inc., Okayama, Japan.

Cyanoacrylate adhesives: ELFY, Al Nazeer-Nippon chemicals, Pakistan.

2.2. Methodology of the study

Forty RBC blocks (Filtek Z250, 3 M ESPE) (height 6 mm, width 4 mm and length 8 mm) were fabricated using the layering technique in a silicone mould. The RBC was polymerised in 2 mm layers, using a LED-curing unit (Bluephase ® C8, Ivoclar Vivadent) at the intensity of 650 $mWcm^{-2}$ for 20 s. The RBC blocks were then stored in distilled water at 37 °C for 24 h. Twenty RBC blocks were randomly divided in to four groups on the basis of the following treatments. Group 1 (Control) No ageing; group 2 (TC500): thermocycling (TC) for 500 cycles; group 3 (TC5000): TC for 5000 cycles; and group 4 (NaOH): immersed in 0.1 N sodium hydroxide solution (NaOH) with no TC for 1 week. TC was performed between 5 °C and 55 °C water baths, with a dwell time of 30 s and rest time of 20 s.

Following treatment, RBC blocks were randomly paired with identical untreated RBC blocks and bonded together. Treated RBC blocks in each pair received etching (37% phosphoric acid for 10 s–) (Total Etch, Ivoclar Vivadent), application of prime (Prime & Bond NT, Dentsply) (30 s–) and air-drying. Blocks were bonded using a thin layer of RLC (Panavia F 2.0, Kuraray) mixed as per manufacturer's instructions, under a constant load application of 1 kg for 10 s using a loading jig. Excess was removed and RLC was polymerised using an LED-curing unit (Bluephase ® C8, Ivoclar Vivadent) for 160 s (40 s each, for all four sides of the interface) at the intensity of 650 $mWcm^{-2}$. An oxygen-blocking gel (Oxyguard, Kuraray Medical Inc., Okayama, Japan) was applied to the adhesive interface. The bonded specimens were then stored in distilled water at 37 °C for 24 h.

A slow speed diamond wheel saw (Isomet 1000, Buehler, Lake Bluff, IL, USA) was used to section the bonded composite blocks at a constant speed of 500 rpm at 250 g force. A total of 160 specimen sticks of 1 mm^2 cross section were produced and stored for 24 h in distilled water at 37 °C. Forty specimens for each group were tested for microtensile bond strength. The specimens were attached to the tester jaws using cyanoacrylate adhesive (ELFY, Al Nazeer-Nippon chemicals, Pakistan) and loaded to failure under tension at a crosshead speed of 0.5 mm/min using a microtensile tester (Microtensile tester: Bisco Inc., Virginia, USA). The following formula was used for calculating microtensile bond strength (μ-tbs).

$$\mu - \text{tbs} = F/A$$

where 'F' was the load required to break the bond of the specimen and 'A' was the interface area of the specimen (mm^2).

All fractured specimens were assessed for fracture interface using a stereomicroscope (Olympus SZ-40, Olympus, Japan) at 63 times magnification (Fig. 1). Data were entered in the Statistical programme for social sciences version 21 (SPSS, Chicago, Illinios, USA) and means of μ-tbs were analysed with a one way ANOVA and Tukey–Kramer multiple comparison test. The College of Dentistry research centre, King Saud University, approved the study.