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Original

Influence of temporary cement remnant and surface cleaning method on bond strength to dentin of a composite luting system

Katsuhito Kanakuri[§], Yoshikazu Kawamoto[§,†] and Hideo Matsumura[§,†]

[§]Department of Crown and Bridge Prosthodontics, Nihon University School of Dentistry, Tokyo, Japan
[†]Division of Advanced Dental Treatment, Dental Research Center, Nihon University School of Dentistry, Tokyo, Japan

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Abstract: The aim of the current study was to evaluate the influence of polycarboxylate temporary cement remaining on the dentin surface on the bond strength of a composite luting system. An acrylic resin plate was luted to bovine dentin with a polycarboxylate temporary cement (HY-Bond Temporary Cement Hard, HYB). The temporary cement was not used for the control groups. After removing the temporary cement with an excavator, dentin specimens were divided into five groups; 1) no subsequent treatment, 2) cleaning with a rotational brush (RTB), 3) cleaning with a rotational brush and non-fluoridated flour of pumice, 4) sweeping with an air scaler, and 5) treated with a sonic toothbrush. A silane-treated ceramic disk (IPS Empress) was bonded to each dentin specimen with a composite luting system (Panavia F). Shear testing results showed that the RTB groups exhibited the highest bond strength regardless of the use of temporary cement (*P* < 0.05). The use of a rotational brush with water coolant is recommended to achieve ideal bond strength between the Panavia F luting system and dentin to which HYB temporary cement was primarily applied. (J. Oral Sci. 47, 9-13, 2005)

Keywords: bond strength; composite; dentin; remnant; rotational brush; temporary cement.

Correspondence to Dr. Hideo Matsumura, Department of Crown and Bridge Prosthodontics, Nihon University School of Dentistry, 1-8-13 Kanda-Surugadai, Chiyoda-ku, Tokyo 101-8310, Japan
Tel: +81-3-3219-8145
Fax: +81-3-3219-8351
E-mail: matsumura@dent.nihon-u.ac.jp

Introduction

Application of tooth-colored materials to anterior as well as posterior restorations has increased substantially due to improvements in the bonding characteristics of luting systems, particularly for bonding to dentin. During fabrication of indirect restorations, provisional restorations are seated with temporary cement. It is desirable that temporary cement be removed as completely as possible immediately prior to seating definitive restorations, although removing remnants with an excavator is reported to be difficult (1,2). Remnants of temporary cements adversely affect bonding between resin-based luting agents and dentin (3-5). Various methods for removing temporary cement have therefore been proposed. Schwartz et al. (6) reported that pumice is effective for removing remnants from dentin surfaces, while Paul et al. (7) reported contrary findings. Yap et al. (8) mechanically removed remnants by means of an ultrasonic scaler, and then cleaned the dentin surfaces with a pumice-water slurry. Application of ultrasonic vibration elevated bond strength and resin infiltration to dentin (9). Rotational and sonic toothbrushes are commonly used as instruments to clean the tooth surface. These instruments have been shown to be effective in plaque and gingivitis reduction (10,11).

Although the influence of temporary cements on dentin bonding have extensively been reported, only limited information is available regarding comparisons of the methods for removing remnants and resultant dentin bond strength. The current study determined the bond strengths of a composite luting system joined to dentin specimens, which were primarily subjected to temporary cementation.

Materials and Methods

A polycarboxylate cement (HY-Bond Temporary Cement Hard, Shofu, Japan, HYB) was assessed as the material to be removed after temporary cementation. A heat-pressed ceramic material (IPS Empress, Ivoclar Vivadent AG, Liechtenstein) was used as the restorative material. A dual-polymerizing luting system (Panavia F, Kuraray Medical, Japan) was selected for seating the ceramic materials (Table 1).

A total of 100 bovine mandibular incisors frozen immediately after extraction were used as adherend materials. The facial surface was ground with a rotary cutting instrument to expose the dentin, which was embedded in an aluminum mold (15 × 15 × 10 mm) using a self-polymerizing acrylic resin. The exposed dentin was ground flat using waterproof 800-grit silicon-carbide (SiC) abrasive paper under running water. An acrylic resin plate mimicking a provisional restoration (10 × 10 × 1 mm) was fabricated with a self-polymerizing acrylic resin (Unifast II, GC, Japan). The plate was then luted to each of the 50 dentin surfaces with the temporary cement (HYB). The temporary cement was not used for the remaining 50 teeth, which were considered control teeth (CON). Fifteen minutes after cementation, the HYB specimens were immersed in water at 37°C for 1 week. The 50 teeth belonging to the CON group were also stored in water at 37°C for 1 week. The acrylic resin plate was then dislodged and the remainder of the temporary cement on the dentinal surface was removed with an excavator. All specimens including the HYB and CON groups were divided into five groups and were subjected to additional mechanical cleaning for 15 s (Table 2); 1) no treatment (None), 2) rotational brush (Merssage Brush, Shofu; RTB), 3) rotational brush and non-fluoridated flour of pumice (Pressage, Shofu; RBP), 4) air scaler (Emmy 560 ST, Yoshida, Japan; ARS), and 5) sonic toothbrush (Sonicare Elite 7000 Series, Philips Oral Healthcare Inc., Snoqualmie, WA, USA; STB).

A total of 100 ceramic disk specimens (5.0 mm i.d. × 2.0 mm) were fabricated using a heat-pressed ceramic material (IPS Empress). The surface to be bonded was sanded with #800 SiC abrasive paper, followed by air-abrasion with 50-μm grain alumina. Phosphoric acid etchant (Total Etch, Ivoclar Vivadent AG) was applied to the ceramic surface for 60 s, rinsed with tap water, and air-dried. A single liquid silane primer (Monobond-S, Ivoclar

Table 1 Materials assessed

Material	Trade name		Composition
Temporary cement	HY-Bond Temporary Cement Hard (HYB)	Powder:	Zinc oxide, magnesium oxide, HY-agent (ZnF_2, SrF_2, tannic acid)
		Liquid:	Polycarboxylic acid aq.
Luting agent	Panavia F	A paste:	MDP, Bis-GMA, hydrophobic dimethacrylate, silanized silica, BPO, photo initiator
		B paste:	Bis-GMA, hydrophobic dimethacrylate, barium glass, treated sodium fluoride, aromatic tert-amine
Primer	ED primer II		HEMA, MDP, water

MDP: 10-methacryloyloxydecyl dihydrogen phosphate, Bis-GMA: adduct of bisphenol A and glycidyl methacrylate, BPO: benzoyl peroxide, HEMA: 2-hydroxyethyl methacrylate

Table 2 Methods for cleaning dentin

Abbreviation	Methods
None	No treatment
RTB	Rotational brush (Merssage Brush) application for 15 s at 2,000 rpm
RBP	Rotational brush application with a non-fluoridated flour of pumice (Pressage) for 15 s at 2,000 rpm
ARS	Air scaler (Emmy 560 ST) instrumentation with 0.2 MPa pressure for 15 s
STB	Sonic toothbrush (Sonicare Elite 7000 Series) application for 15 s at 31,000 bruth strokes per minute

Vivadent AG) was applied to the ceramic surface and air-dried.

Prior to bonding with the luting composite material, all dentin specimens were treated with a self-etching primer in the Panavia system (ED Primer II, Kuraray Medical) for 30 s, and air-dried. A piece of tape with a circular hole 3.0 mm in diameter, positioned on the surface of the dentin, was used to define the area of the bond and ensure a consistent 50-μm thickness for the luting agent. The ceramic disk was then bonded to the dentin substrate with the Panavia luting agent under a constant load of 5 N. The bonded specimens were exposed to visible light for 20 s using a hand-held unit (Optilux 501, sds Kerr, CT, USA). Light exposure was repeated three times from three different directions.

Thirty minutes after bonding, specimens were immersed in water at 37°C for 24 hours. Shear bond strengths were determined using a mechanical testing device (Type 5567, Instron, MA, USA) at a crosshead speed of 1.0 mm per min (Fig. 1). For each set of conditions, the average bond strength and standard deviation (SD) of ten replications was calculated. The bond strength results were compared by two-way analysis of variance (ANOVA). When significant interactions were found, one-way ANOVA and post-hoc Duncan's new multiple range test were performed, with statistical significance being set at the 0.05 level.

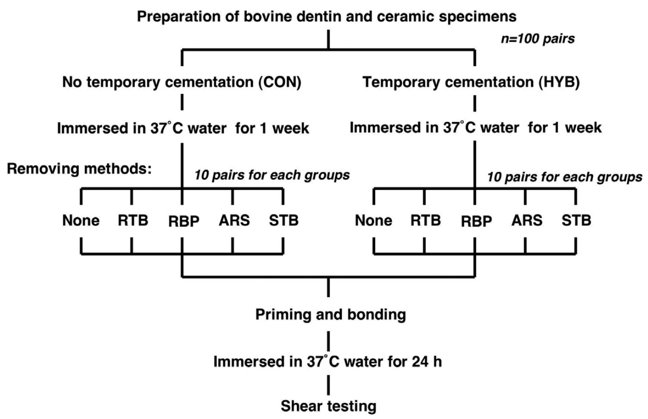

Fig. 1 Schematic diagram of specimen preparation and shear testing.

The dentin specimens before definitive bonding with the Panavia F material were dehydrated in ascending grades of t-butyl alcohol. The specimens were then sputter-coated with osmium and observed under a scanning electron microscope operated at 15 kV (S-4300, Hitachi High-Technologies, Japan; SEM).

Results

Two-way ANOVA of the shear testing results indicated that the bond strength was influenced by both application of temporary cement ($F = 15.5$, $P = 0.0001$) and removal procedure employed ($F = 10.1$, $P = 0.0001$). The interaction between the two factors was also significant ($F = 2.6$, $P = 0.036$). The bond strengths were therefore compared by one-way ANOVA followed by Duncan's new multiple comparison test.

The average bond strengths, standard deviations (SD), and statistical categories are presented in Table 3. Average bond strength between dentin and the Empress ceramic bonded with the Panavia luting system varied from a high of 12.7 MPa to a low of 7.6 MPa. Adhesive failure at the interface between the luting agent and the ceramic was not observed. Three groups showed statistically higher bond strength (category a). Two groups in which the temporary cement was not used and the rotational brush was used exhibited bond strengths of 12.1 MPa (CON-RBP) and 12.7 MPa (CON-RTB), respectively. In addition, bond strength in the RTB group was not negatively affected by application of HYB temporary cement (12.6 MPa, category a). Bond

Table 3 Shear bond strengths in MPa and statistical categories

	CON		HYB	
Cleaning methods	Mean (SD)	Duncan grouping	Mean (SD)	Duncan grouping
None	10.0 (1.9)	d, e	7.8 (1.2)[a]	f, g
RTB	12.7 (2.9)	a	12.6 (2.8)	a
RBP	12.1 (2.1)	a, b	11.1 (1.8)	c
ARS	11.8 (2.2)	b	7.6 (2.1)	g
STB	10.6 (1.6)	c, d	9.5 (2.1)	e, f

SD, Standard deviation; Duncan grouping, Identical letters in the same column indicate that the values are not statistically different at 0.05 significance level.

[a] Quoted from the reference (2).

strengths of the three groups (None, ARS, and STB) were substantially affected by primary use of the temporary cement (categories f and g).

Figure 2 shows the control dentin surfaces treated with the five methods, while Fig. 3 exhibits the dentin surfaces cleaned after application of HYB temporary cement. Cement remnant can be seen in all photographs in Fig. 3. However, considerable differences in cement remnant were found between Fig. 3a (CON) and Fig 3b (RTB).

Discussion

Cleaning abutment tooth surfaces before cementing restoration is important for proper positioning of the restoration. One of the problems associated with ill-fitting restorations is derived from temporary cement remnants on the abutment surface. This study aimed to evaluate methods for removing polycarboxylate temporary cement from the dentin surface as well as to determine bond strength of adhesive resin to dentin primarily subjected to temporary cementation.

Shear testing results revealed significant differences between the CON-None and HYB-None groups. In addition, considerable amounts of cement can be seen on the dentin surface in Fig. 3a. The results suggest that the use of an excavator alone is insufficient to remove HYB temporary cement from the dentin surface, and an additional method is necessary. The current study therefore employed four additional methods for removing HYB cement from the dentin surface; an air-scaler (ARS) and a sonic toothbrush (STB) were used. Although the cleaning effects can be seen on the micrographs (Figs. 3d and e), the resultant bond strength was not particularly good. The results indicate that a 15-s application of either the air-scaler or the sonic toothbrush is insufficient to remove HYB cement from the dentin surfaces. Prolonged application, stronger vibration or both may be required to improve resin-dentin bond strength.

Bond strength after temporary cementation of the two groups associated with the rotational brush (RTB and RBP) was similar to that of the control. Electron micrographs after removal of the temporary cement exhibit orifices of dentinal tubules (Fig. 3b). The results suggest that the rotational brush effectively removed carboxylate cement remnant from the dentin surface. Both Fig 3c and

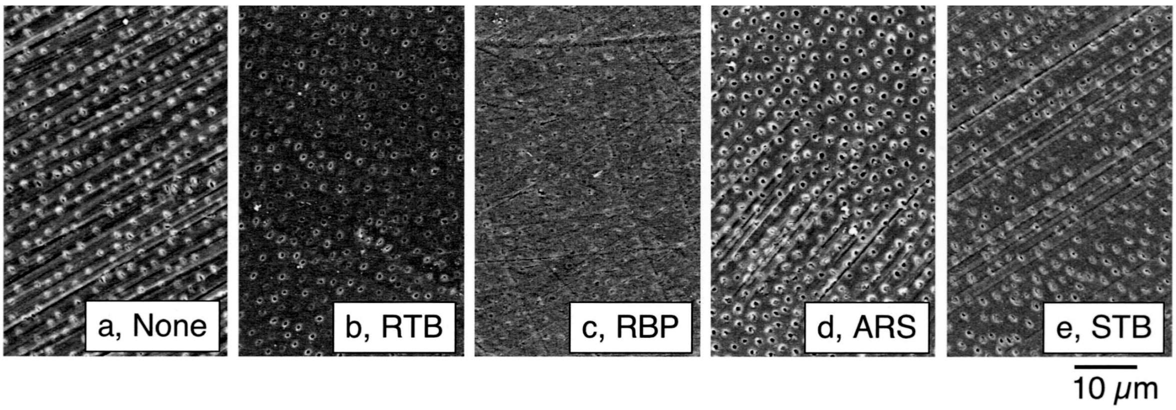

Fig. 2 Scanning electron micrographs of dentin surfaces after mechanical cleaning.

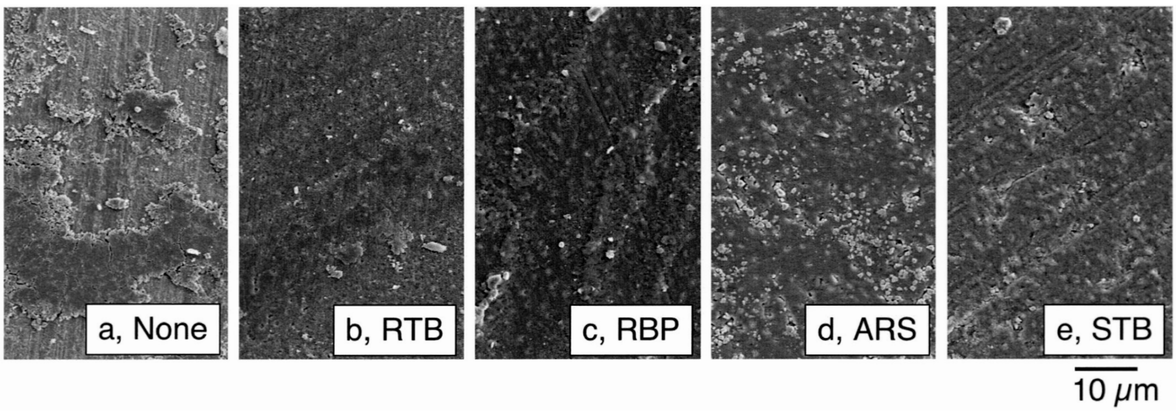

Fig. 3 Scanning electron micrographs of dentin surfaces subjected to temporary cementation and removal of cement with excavator followed by mechanical cleaning.

the slight reduction in bond strength of the HYB-RBP group (11.1 MPa) suggest that the use of prophylactic paste is not necessary for surface preparation of adhesive bonding. This is in agreement with the report of Paul et al. (7), although the materials employed differed from those in the current study. This is probably due to accumulation of prophylactic paste remnant on the dentin surface. Overall, HYB temporary cement was difficult to remove completely from the dentin surface through the use of conventional mechanical cleaning methods.

Within the limitations of the current experiment, it can be concluded that use of a rotational brush with running water is the best method to achieve consistent bond strength between the Panavia luting system and dentin primary subjected to temporary cementation with HYB cement.

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