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### Original article

# Effect of priming agents on shear bond strengths of resin-based luting agents to a translucent zirconia material

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#### ABSTRACT

**Purpose:** The purpose of the present study was to evaluate the effect of priming agents and artificial aging with thermocycling on shear bond strengths of two resin-based luting agents to a translucent zirconia material.

**Methods:** A total of 308 pairs of translucent zirconia disk specimens were divided into seven treatment groups: Alloy Primer (ALP), Clearfil Ceramic Primer Plus (CCP), Meta Fast Bonding Liner (MFB), MR. bond (MRB), Super-Bond PZ Primer Liquid B (PZB), V-Primer (VPR), and an unprimed group (UP). The specimens in each group were bonded with Panavia V5 Universal (UNI) and Opaque shade (OPA). Shear bond strengths ( $n = 11$  each) were tested before and after 5000 thermocycles. The data were analyzed with the Kruskal–Wallis test and the Steel–Dwass test.

**Results:** For both 0 and 5000 thermocycles, the ALP (47.8 and 41.5 MPa, respectively) and CCP (45.8 and 42.3 MPa, respectively) groups showed significantly higher bond strengths than other groups in the UNI luting agent. For the OPA luting agent, CCP group (45.8 MPa) exhibited the highest pre-thermocycling bond strength in all groups. The ALP (32.4 MPa) and CCP (36.5 MPa) groups had significantly higher post-thermocycling shear bond strengths than other groups. In several groups, the shear bond strengths of the UNI luting agent were significantly higher than those of the OPA luting agent before and after thermocycling.

**Conclusions:** Application of priming agents containing hydrophobic phosphate monomer (MDP) yielded the durable bond strengths of resin-based luting agents to a translucent zirconia material.

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## 1. Introduction

Porcelain laminate veneers (PLVs) have been demonstrated to provide stable clinical longevity, excellent esthetics [1,2], and are more conservative compared to ceramic restorations [3]. The main reasons for failure associated with PLVs are fracture and debonding [1,2]. Previous studies have demonstrated that the weakest area of PLVs was the ceramics/luting material interface, resulted in the fracture or debonding of the PLVs [4,5]. Silica-based ceramics such as feldspathic porcelain and lithium disilicate ceramics have been used for PLVs due to their superior optical properties. The bond between silica-based ceramics and resin-based luting agent is well documented with numerous in vitro studies. For the surface

treatment of silica-based ceramics, the acid etching with HF acid (5% for 30–60 s) and subsequent application of a silane are recommended to obtain durable bond [6–8].

Zirconium dioxide (zirconia) ceramics have been widely used as a framework material for tooth-supported or implant-supported bi-layered ceramic restorations and monolithic ceramic restorations owing to their excellent biocompatibility, enhanced strength, and inherent esthetic properties. However, the zirconia material has lower translucency compared with silica-based ceramics due to absence of a glass matrix in the dense sintering polycrystalline [9]. Monolithic zirconia restorations have some advantages in terms of simple procedure, cost reduction, diminished preparation depth, and reducing the chipping risk of veneer [10]. On the other hand, a drawback of monolithic zirconia restorations could be that they are less translucent than silica-based ceramics, which leads to undesirable esthetic outcomes [10].

To improve the possibility of esthetics, the new “high translucent” zirconia material has been recently introduced to the market. The translucent zirconia material has different

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optical and mechanical properties, and indicated for monolithic restorations with limited clinical application in anterior or premolar region and conservative tooth preparation [11–13]. Since the new zirconia material has lower translucency than feldspathic porcelain, the laminate veneer used the translucent zirconia material offers an advantages over feldspathic porcelain with regard to masking undesirable colors of abutment tooth. The adhesive capacity and compatibility of resin-based luting agents to zirconia materials have improved with the science and technology. However, there is still no relevant surface treatment to zirconia materials for a predictable bonding behavior in clinical use [14,15]. Furthermore, only limited data are available regarding the shear bond strengths of resin-based luting agents to translucent zirconia materials.

The purpose of the present study was to evaluate the effect of various priming agents for zirconia surface treatments and artificial aging with thermocycling on shear bond strengths of two resin-based luting agents to a translucent zirconia material. The null hypotheses tested were that (1) the application of different priming agents would not affect bond strength between luting agents and a translucent zirconia material, (2) artificial aging with thermocycling would not influence the bond strength, and (3) there is no difference in bond strength between two luting agents.

## 2. Materials and methods

The materials used in the present study and their components are listed in Table 1. A total of 308 pairs of translucent zirconia disk specimens (11.0 and 8.0 mm in diameter and 2.5 mm in thickness) were fabricated from a translucent zirconia material (Katana Zirconia UT, Kuraray Noritake Dental Inc., Tokyo, Japan) using computer aided design-computer aided manufacture (CAD-CAM) technology. All specimens were wet-ground with 600-grit silicon carbide abrasive paper (Tri-M-ite Wetordry sheets, 3M, St. Paul, MN, USA) to create flat zirconia surface, followed by ultrasonically cleaned in distilled water with an ultrasonic bath (UT-106, Sharp Corp., Osaka, Japan) for 5 min and dried with oil-free air spray (Air Duster AD400FL, Orientic Inc., Misato, Japan).

The zirconia specimens randomly divided into seven groups ( $n = 44$ ) and assigned one of the following priming agents: Alloy Primer (ALP; Kuraray Noritake Dental Inc.), Clearfil Ceramic Primer Plus (CCP; Kuraray Noritake Dental Inc.), Meta Fast Bonding Liner (MFB; Sun Medical Co., Moriyama, Japan), MR. bond (MRB; Tokuyama Dental Corp., Tokyo, Japan), Super-Bond PZ Primer Liquid B (PZB; Sun Medical Co.), V-Primer (VPR; Sun Medical Co.), including an unprimed group (UP) as a control. All priming agents contained at least one adhesive functional monomer. The functional monomers were 10-methacryloyloxydecyl dihydrogen phosphate (MDP) for ALP and CCP, 11-methacryloyloxy-1,1-undecane dicarboxylic acid (MAC-10) for MRB, 4-methacryloyloxyethyl trimellitate anhydride (4-META) for MFB, 3-trimethoxysilylpropyl methacrylate (3-TMSPMA) for CCP and PZB and 6-(4-vinylbenzyl-*n*-propyl)amino-1,3,5-triazine-2,4-dithione (VBATDT) for ALP and VPR.

A piece of tape in thickness 50  $\mu\text{m}$  with circular hole 5.0 mm in diameter was positioned on the surface of the 11.0 mm diameter zirconia specimens to define the bonding area. The surface of each zirconia specimen was applied one of the six priming agents with a microbrush (Micro Tip Applicator, GC Corp., Tokyo, Japan) according to the manufacturer's instruction, except for UP group.

After surface treatment of the specimens, half of 11.0- and 8.0-mm-diameter disk specimens in each priming agent group ( $n = 22$ ) were bonded with Panavia V5 Universal shade (UNI; Kuraray Noritake Dental Inc.) at a load of 5 N. Excess luting agent was removed with a microbrush (Micro Tip Applicator, GC Corp.). The specimens were then light-cured from four sides for 10 s each, a total of 40 s with a polymerization unit (Optilux501, Kerr Co., Orange, CA, USA). After light-polymerization, a consistent weight of 5 N was applied on the top of pairs-disk specimens for 3 min.

The remaining 11.0- and 8.0-mm-diameter disk specimens were applied with Panavia V5 Opaque shade (OPA; Kuraray Noritake Dental Inc.). After removing excess luting agent, the bonded specimens were auto-polymerized at a constant pressure of 5 N for 10 min.

**Table 1**  
Materials assessed in the present study.

Materials/trade name	Abbreviation	Manufacturer	Component
Zirconia ceramics			
Katana Zirconia UT		Kuraray Noritake Dental Inc., Tokyo, Japan	ZrO <sub>2</sub> : 87–92%, Y <sub>2</sub> O <sub>3</sub> : 8–12%, others
Resin-based luting agent			
Panavia V5 Universal	UNI	Kuraray Noritake Dental Inc.	A paste; Bis-GMA, TEGDMA, hydrophobic aromatic dimethacrylate, hydrophilic aliphatic dimethacrylate, silanated barium glass filler, fluoroaluminosilicate glass filler, colloidal silica, accelerator, initiator B paste; Bis-GMA, hydrophobic aromatic dimethacrylate, hydrophilic aliphatic dimethacrylate, silanated barium glass filler, silanated aluminium oxide filler, accelerator, dl-Camphorquinone, pigments
Panavia V5 Opaque	OPA	Kuraray Noritake Dental Inc.	A paste; Bis-GMA, TEGDMA, hydrophobic aromatic dimethacrylate, hydrophilic aliphatic dimethacrylate, silanated barium glass filler, fluoroaluminosilicate glass filler, colloidal silica, accelerator, initiator B paste; Bis-GMA, hydrophobic aromatic dimethacrylate, hydrophilic aliphatic dimethacrylate, silanated barium glass filler, silanated aluminium oxide filler, accelerator, dl-Camphorquinone, pigments
Priming agent			
Alloy Primer	ALP	Kuraray Noritake Dental Inc.	MDP, VBATDT, acetone
Clearfil Ceramic Primer Plus	CCP	Kuraray Noritake Dental Inc.	MDP, 3-TMSPMA, ethanol
Meta Fast Bonding Liner	MFB	Sun Medical Co., Moriyama, Japan	4-META, MMA
MR. bond	MRB	Tokuyama Dental Corp., Tokyo, Japan	MAC-10, MMA
Super-Bond PZ Primer Liquid B	PZB	Sun Medical Co.	3-TMSPMA, MMA
V-Primer	VPR	Sun Medical Co.	VBATDT, acetone

Bis-GMA: bisphenol-A-diglycidyl methacrylate, TEGDMA: triethylene glycol dimethacrylate, MDP: 10-methacryloyloxydecyl dihydrogen phosphate, VBATDT: 6-(4-vinylbenzyl-*n*-propyl)amino-1,3,5-triazine-2,4-dithione, 3-TMSPMA: 3-trimethoxysilylpropyl methacrylate, 4-META: 4-methacryloyloxyethyl trimellitate anhydride, MMA: methyl methacrylate, MAC-10: 11-methacryloyloxy-1,1-undecane dicarboxylic acid.

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