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Bond strength of a chairside autopolymerizing reline resin to injection-molded thermoplastic denture base resins

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ABSTRACT

Purpose: This study evaluated the shear bond strength of a chairside autopolymerizing reline resin to injection-molded thermoplastic denture base resins.
Methods: Four kinds of injection-molded thermoplastic resins (two polyamides, a polyethylene terephthalate copolymer and a polycarbonate) and PMMA, as a control, were tested. The eight types of surface treatment: ((1) no treatment, (2) air abrasion, (3) dichloromethane, (4) ethyl acetate, (5) 4-META/MMA-TBB resin, (6) air abrasion and 4-META/MMA-TBB resin, (7) tribochemical silica coating, and (8) tribochemical silica coating and 4-META/MMA-TBB resin) were applied to each specimen. The chairside autopolymerizing reline resins were bonded to disks of the injection-molded thermoplastic denture base resins. All of the specimens were immersed in water for 4 months and then thermocycled for 10,000 cycles in water between 5 and 55 °C. The shear bond strengths were determined.
Results: The shear bond strengths of the two polyamides treated using air abrasion, dichloromethane and ethyl acetate and no treatment were exceedingly low. The greatest bond strength was recorded for the polyethylene terephthalate copolymer specimens treated with tribochemical silica coating and 4-META/MMA-TBB resin (22.5 MPa). The bond strengths of the other injection-molded thermoplastic denture base resins increased using 4-META/MMA-TBB resin.
Conclusions: Tribochemical silica coating and 4-META/MMA-TBB resin were the most effective surface treatments among all denture base resins tested.

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Table 1 – Denture base materials tested.

Constituent	Material	Manufacturer	Processing method	Lot number
Polyamide (Nylon 12)	Valplast	Valplast International Corp., NY, USA	Injection molding technique; heat processed at 215 °C for 20 min	091142
Polyamide (Nylon PACM12)	Lucitone FRS	DENTSPLY International Inc., PA, USA	Injection molding technique; heat processed at 300 °C for 17 min	100323A
Polyethylene terephthalate copolymer	EstheShot	i-Cast Co. Ltd., Kyoto, Japan	Injection molding technique; heat processed at 230 °C for 20 min	JGA
Polycarbonate	Reigning	Toushinyoukou Co. Ltd., Niigata, Japan	Injection molding technique; heat processed at 320 °C for 30 min	DMY29T
PMMA	Acron	GC Corp., Tokyo, Japan	Heat-polymerized, compression molding technique; heat-processed at 70 °C for 90 min, then at 100 °C for 30 min and bench cooled for 30 min	Powder: 1004123, Liquid: 1003191

1. Introduction

Removable partial dentures (RPDs) without metal clasps have recently been introduced into dental practice [1,2] due to their well-blended esthetics as well as the lack of allergies caused by the metal. Non-metal clasp dentures are referred to by their generic name of ''RPDs without metal clasps'' by the Japan Prosthodontic Society. They have typical retentive elements made with thermoplastic resin clasps [1,2]. Thermoplastic resins (polyamide, polyethylene terephthalate copolymer and polycarbonate) are used for RPDs without metal clasps because these thermoplastic resins have a higher elasticity than heat-polymerizing base resin (PMMA) [3–5]. Previous studies have found that [1] all of the thermoplastic resins had a significantly lower flexural strength at the proportional limit (FS-PL) and a lower elastic modulus than PMMA [2], the polyamide had low FS-PL and low elastic modulus [3], the polyethylene terephthalate copolymer had moderately high FS-PL and a moderate elastic modulus and [4] the polycarbonate had moderately high FS-PL and elastic modulus. Additional research demonstrated that at least one type of polyamide and polycarbonate had high pre-thermocycling impact strengths, but the post-thermocycling impact strengths were low [4,5]. The mechanical properties of thermoplastic resins were different from each other. It was shown in our previous study [6] that it was exceedingly difficult to bond polyamide to an autopolymerizing repair resin. Considering these findings, it can be presumed that some kinds of injection-molded thermoplastic denture base resins are also difficult to bond to other kinds of resin materials.

The application of chairside autopolymerizing reline resins seems to have increased recently because direct reline is more convenient and faster than indirect laboratory-processed reline systems. Takahashi et al. [7] evaluated the resistance to plastic deformation of a denture base resin relined with different types of denture reline materials and reported that relined denture bases demonstrated significantly lower flexural load at the proportional limit. Chai et al. [8] investigated the ability of the reline material to strengthen denture base resins and found that the strength of the relined denture base depends on the strength of the denture base resin and of the reline material [9]. The importance of the bonding of the reline material to denture base resin has been previously demonstrated [10], and it has also been suggested that the resulting bond strength might affect the overall strength of the relined denture base [9–12]. To the authors' knowledge, there is a lack of information on the bond strength of a chairside autopolymerizing reline resin to injection-molded thermoplastic denture base resins.

The purpose of the present study was to evaluate the bond strength of a chairside autopolymerizing reline resin to injection-molded thermoplastic denture base resins and to improve it using an effective surface treatment. The null hypothesis was that neither the injection-molded thermoplastic denture base resins nor the surface treatments would affect the bond strength between the chairside autopolymerizing reline resin and the injection-molded thermoplastic resins.

2. Materials and methods

2.1. Test specimen preparation

Four injection-molded thermoplastic resins, one heat-polymerizing denture base resin serving as the control and a chairside autopolymerizing reline resin (Tokuyama Rebase II, Tokuyama Dental Corp., Tokyo, Japan, lot 037030) were selected for this study (Table 1). Each kind of thermoplastic resin was polymerized according to the manufacturers' instructions. A total of 400 block specimens (10.0 mm × 10.0 mm × 3.0 mm) of each resin was prepared. Each specimen was embedded in an autopolymerizing resin material with an acrylic ring, and the surfaces of the injection-molded thermoplastic resins or the heat-polymerizing denture base resin were abraded with up to 400-grit silicon carbide paper under running water. The specimens were divided into eight groups according to the type of surface treatment given (n = 10):

(1) No treatment (controls)
(2) Air abrasion with 50 μm alumina (0.28 MPa, 10 s) (air abrasion)
(3) A 5-s application of dichloromethane (Wako Pure Chemical Industries, Ltd., Osaka, Japan, lot ALG5624) (dichloromethane)

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