Short Communication

Bond Strength of Acrylic Teeth to Denture Base Resin After Various Surface Conditioning Methods Before and After Thermocycling

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This study aimed to evaluate the durability of adhesion between acrylic teeth and denture base acrylic resin. The base surfaces of 24 acrylic teeth were flatted and submitted to 4 surface treatment methods: SM1 (control): No SM; SM2: application of a methyl methacrylate–based bonding agent (Vitacol); SM3: air abrasion with 30-µm silicone oxide plus silane; SM4: SM3 plus SM2. A heat-polymerized acrylic resin was applied to the teeth. Thereafter, bar specimens were produced for the microtensile test at dry and thermocyled conditions (60 days water storage followed by 12,000 cycles). The results showed that bond strength was significantly affected by the SM ($P < .0001$) (SM4 = SM2 > SM3 > SM1) and storage regimens ($P < .0001$) (dry > thermocycled). The methyl methacrylate–based adhesive showed the highest bond strength. *Int J Prosthodont 2007;20:199–201.*

Artificial acrylic teeth have long been used in the fabrication of complete dentures. More recently, with the increased use of implant therapy, the use of these teeth and resin denture bases has further increased. In implant dentistry, acrylic teeth could be used in either implant-supported or implant-tissue–supported dentures. Debonding of denture teeth from the denture base is a common mode of failure.[1] This problem is even more serious in implant-supported dentures, because the superior chewing capacity increases the risk of displacement of the artificial teeth from the denture base.

Several retention systems have been proposed in the literature for denture teeth, such as macromechanical (pins or diatoric undercuts),[2] micromechanical (high-energy abrasion),[3] or chemical adhesion methods (silanization).[4,5] This study evaluated the durability of adhesion between acrylic teeth and denture base acrylic resin after 4 different surface conditioning methods.

Materials and Methods

Four plates containing 6 artificial acrylic teeth each (N = 24) (VITA Triostat, Batch SZ 3D, VITA Zahnfabrik) were obtained. Initially, the base surfaces of all acrylic teeth were planed in a polishing machine (Extec) using silicone carbide papers with grits of 600, 800, and 1,000 under cooling (Figs 1a and 1b).

The teeth were fixed to a metallic base with wax and surrounded by polyvinyl chloride (PVC) rings (h = 18 mm, Ø = 17 mm) that were fixed to the base using cyanoacrylate adhesive. Consequently, dental plaster (Mossoro) was prepared following the manufacturer's instructions and poured inside the rings under vibration. After plaster setting, the assemblies were detached from the metallic base. The PVC rings were then sectioned with a carborundum disk and removed. Using the same PVC rings as in the matrix, melted wax was poured to create a virtual space to be filled by the denture base resin (Fig 1c).

The plaster-tooth-wax assemblies were positioned in a muffle base with the wax turned upward. Dental plaster was poured up to the plaster-wax border (Fig 1d). The plaster was allowed to set isolated (Cel-Lac, Dentsply), and the remaining part of the muffle was

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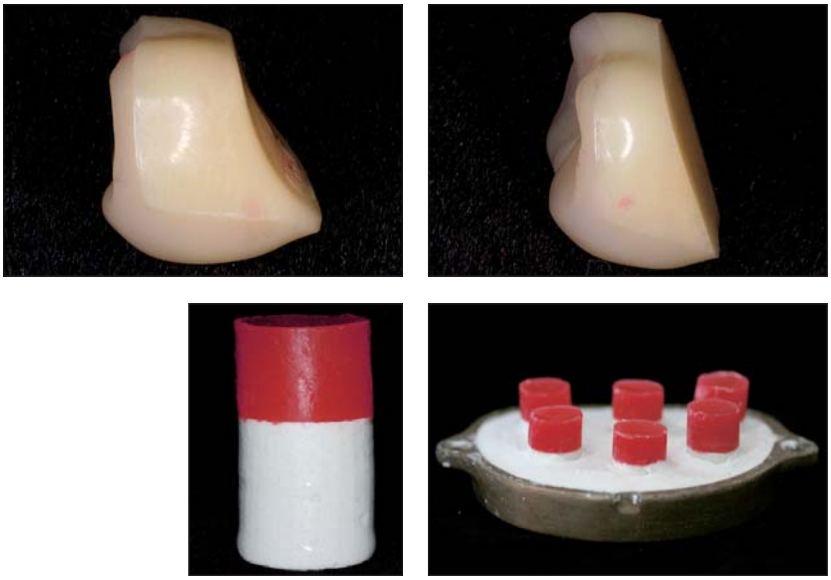
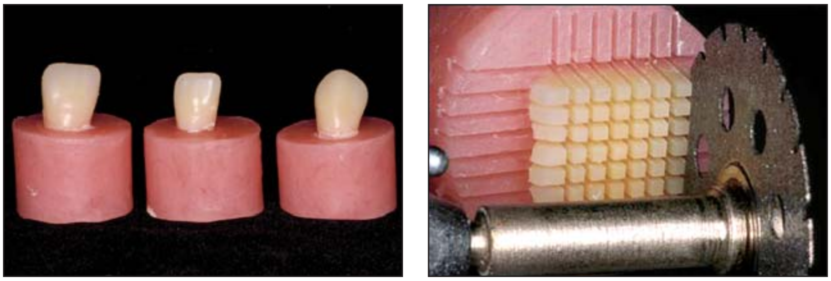


Figs 1a to 1d **(a)** Original and **(b)** planed acrylic teeth; **(c)** plaster-tooth-wax assembly; **(d)** plaster-tooth-wax assembly embedded in plaster in the muffle base.



Figs 2a and 2b **(a)** Tooth-resin assembly; **(b)** beam specimens.

Table 1 Experimental Groups

Surface conditioning method	Storage regimen	Group	No.
SM1	Dry*	1	25
	TC**	2	25
SM2	Dry	3	25
	TC	4	25
SM3	Dry	5	25
	TC	6	25
SM4	Dry	7	25
	TC	8	25

*Immediate testing after specimen production.
**Storage in water for 60 days followed by thermocycling (×12,000, 5°C to 55°C; dwelling time: 30 seconds; transfer time from one bath to the other: 2 seconds).
TC = thermocycled.

poured with common plaster. The muffle was then pressed (1,250 kgf) for 45 minutes. After setting, the muffle was placed in boiling water for 10 minutes. After opening the muffle, the wax was removed by thoroughly washing it with boiling water and anionic detergent (Limpol, Bom-Bril).

Surface Conditioning Method

The 4 sets of 6 teeth were randomly divided into 4 groups based on the surface conditioning method applied:

1. *SM1 (control):* No surface conditioning.
2. *SM2 (bonding agent):* Methyl methacrylate–based bonding agent (Vitacoll, Vita Zahnfabrik; batch no. 7819) was applied on the surface following the manufacturer's instructions and allowed to evaporate for 5 minutes.
3. *SM3 (chairside tribochemical silica coating + silanization):* Air abrasion with 30-µm aluminum oxide particles modified with silicon oxide (blasting protocol: pressure = 2.8 bar; distance = 10 mm; perpendicular to the post surface; time = 20 seconds) was applied to the tooth surfaces. Thereafter, a silane-coupling agent (ESPE-Sil, 3M ESPE) was applied and allowed to dry for 5 minutes.
4. *SM4 (chairside tribochemical silica coating + silanization + bonding agent):* Teeth surfaces were air abraded and silanized as in SM3, and a bonding agent was applied as described in SM2.

A heat-polymerized acrylic resin (Lucitone 550, Dentsply DeTrey; batch no. 32909) was prepared as recommended by the manufacturer and applied on the denture teeth in the space left after the removal of the wax. The muffles were pressed in a hydraulic press (1,250 kgf) for 8 hours, and resin was polymerized at 74°C for 9 hours and at 100°C for 1 hour. After this period, the muffles were kept in the equipment until the water reached room temperature. The specimens were removed from the muffle and stored in distilled water at 37°C for 7 days (Fig 2a).

Production of Beam Specimens

The specimens were bonded with cyanoacrylate glue (Super Bonder Gel, Loctite) to a metal base that was coupled to a cutting machine and then sectioned under water cooling in the x- and y-axes using a slow-speed diamond disk (no. 35070) (Microdont) in a cutting machine (Fig 2b).

The peripheral slices (0.5 mm) were eliminated because of irregularities at the interface. Twenty-five untrimmed bar specimens (adhesive area ± 0.7 mm^2, length ± 8 mm) were obtained from each tooth. Specimens were randomly divided into 2 storage regimens (dry and thermocycled), thus composing 8 experimental groups (Table 1).

Microtensile Bond Strength Test

The ends of each specimen were fixed with cyanoacrylate adhesive in an adapted device to perform the bond strength test (EMIC DL-1000, EMIC) (1 mm/min^{-1}): bond strength σ (MPa) = L/A, where L = load (N) for rupture of the specimen and A = interfacial area (mm^2) as measured with a digital caliper before testing. The bond strength data were analyzed using 2-way analysis of variance (ANOVA) ($\alpha = .05$) and Tukey post hoc test.

Results

The bond strength was significantly affected by the conditioning method ($P < .0001$) (SM4 = SM2 > SM3 > SM1) and storage regimens ($P < .0001$) (dry > thermocycled). The interaction was also statistically significant ($P < .0001$) (2-way ANOVA) (Table 2). Aging decreased the bond strength values in all experimental groups (Tukey test).

Table 3 and Fig 3 show the mean and standard deviations of σ considering the 2 factors of the study (storage and surface conditioning method).

Conclusion

1. Use of a methyl methacrylate–based adhesive on the denture tooth base seems to facilitate increased bond strength of the acrylic resin tooth to the denture base.
2. Water storage and thermocycling reduced the bond strength of acrylic resin teeth to denture base resin when compared with dry testing conditions.

Table 2 Two-Way ANOVA of Bond Strength Data

Source	*df*	SS	MS	F	*P*
Surface treatment	3	2,242.0	747.32	15.02	< .0001
Storage	1	5,545.0	5,544.99	111.45	< .0001
Between	3	1,257.8	419.28	8.43	< .0001
SE	192	9,552.6	49.75		
Total	199	18,597.4			

SS = Sum of square.
MS = Mean of square.

Table 3 Means and SDs of the Bond Strength Results (MPa)*

	Dry	TC	Total
SM1	26.4 ± 8.7[b]	23.1 ± 5.7[bc]	24.8 ± 7.4
SM2	38.0 ± 6.7[a]	26.5 ± 6.4[b]	32.2 ± 8.7
SM3	37.3 ± 7.7[a]	19.9 ± 5.3[c]	28.6 ± 10.9
SM4	38.2 ± 7.8[a]	28.3 ± 7.4[b]	33.3 ± 9.1
Total	35.0 ± 9.1	24.5 ± 7.0	

*Same superscript letters mean no significant difference.
TC = thermocycled.

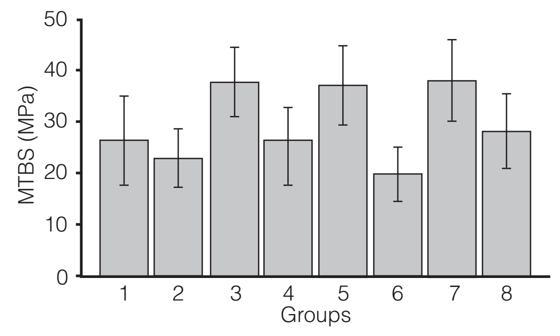


Fig 3 Means and standard deviations of the microtensile bond strength (MTBS) data for dry and thermocycled conditions.

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