Scientific Article

In vitro evaluation of an adhesive monomer as a bonding agent for orthodontic brackets to primary teeth and nickel-chromium ion crowns

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Abstract

The adhesive monomer, Clearfil New Bond, was used to enhance the bond strength between orthodontic brackets and primary molars, premolars, and NiCr crowns. Twenty specimens of each had this dental adhesive applied according to the manufacturer's instructions in addition to a chemically cured composite material. The remaining specimens (20 each) were bonded without the adhesive monomer. Shear bond strengths were determined using a universal testing machine. Fracture sites were examined to determine the type of bond failure. All bond strengths were significantly increased with the addition of Clearfil New Bond (P ≤0.0001). The shear bond strength to NiCr crowns with the addition of the adhesive monomer was 7.76 kg. This is comparable to the shear bond strength observed for primary molars (8.66 kg) and premolars (8.65 kg) without adhesive monomer. The observed decrease in adhesive bond failures with the addition of Clearfil New Bond indicated a stronger shear bond strength between the tooth surface and the bracket base. Clearfil New Bond can significantly increase the shear bond strength of orthodontic brackets to both primary molars and premolars. Additionally, it was shown that orthodontic brackets can be successfully bonded to Ni-Cr crowns at strengths comparable to primary or permanent enamel. (Pediatr Dent 17:204–6, 1995)

In 1955, Buonocore demonstrated that the bond strength of polymeric dental resins to enamel could be increased significantly by etching the enamel surface with 85% orthophosphoric acid.[1] Since then, bonding of composite resins to enamel has become widely used for numerous dental procedures. With the advent of the etched cast restoration in 1982,[2] research has been devoted to developing materials that would eliminate the electrochemical etching of cast metals.[3,4]

One such material is the adhesive monomer Clearfil New Bond (J. Morita, Tustin, CA), This adhesive monomer contains phenyl-P (2-methacryloxyethyl phenyl hydrogen phosphate), MDP (10-methacryloxydecyl dihydrogen phosphate), and a silane. This material has been shown to bond to NiCr alloy.[5] It is believed that bonding to metal occurs between oxygen atoms of the phosphate groups of the adhesive monomer and surface metal oxides.[6] It has been postulated that the strengths of the different adhesive bonds vary depending on the affinities of the individual metal oxides to the reactive phosphate groups of the adhesive monomer.[7]

Previous reports of decreased bond strength to primary enamel have been attributed to the increased organic content of primary enamel.[8–11] The use of Clearfil New Bond may improve the bond strength. A chemical interaction is believed to occur between the phosphate groups and calcium within the hydroxyapatite crystals with the addition of Clearfil New Bond.[12, 13] This may enhance the bond strength to primary enamel when mechanical retention is insufficient.

This investigation explored the potential of Clearfil New Bond to bond stainless steel orthodontic brackets to permanent and primary teeth and NiCr crowns. To date, no such investigation has been reported in the literature.

Methods and materials

Clearfil New Bond was utilized as a surface treatment in an attempt to enhance the bond strength between stainless steel orthodontic brackets with 100-gauge mesh backing (American Ortho, Sheboygan, WI) and primary molars (Group 1), premolars (Group 2), and NiCr crowns (Group 3). Each group consisted of 40 samples. Twenty samples from each group were treated with the adhesive according to the manufacturer's instructions prior to bonding with a "no-mix", chemically cured composite material (Right-On, T.P. Orthodontics Inc, LaPorte, IN). The remaining 20 samples in each group were bonded without the surface treatment.

The teeth and crowns were embedded in autopolymerizing acrylic resin (Dentsply Co, Milford, DE). Before bonding, each specimen was thoroughly cleaned with a slurry of flour of pumice and water. All specimens were etched for 60 seconds with "Right-On"

etchant solution (37% phosphoric acid), rinsed with water spray for 20 sec, and gently dried with an oil-free air syringe.

The brackets then were bonded with the chemically curing composite. Excess material was removed with an explorer. Following bonding, specimens were stored in tap water at room temperature. All specimens were then thermocycled between 5 and 55°C water baths for a total of 1,440 1-min cycles. After thermocycling, the shear bond strength was determined with an Instron Testing Machine (Instron Engineering Corp, Canton, MA) at a cross-head speed of 0.5 mm per min (Figure). Specimens that debonded during manipulation or thermocycling were recorded as zero.

The fracture sites were examined using a stereoscopic light microscope (Datco Inc, Clearwater, FL). Bond failures were categorized as: cohesive (within the composite resin), adhesive (composite-specimen surface interface), or a combination.

The data were subjected to a three-by-two factorial analysis of variance (ANOVA), at the $P \leq 0.05$ level, to determine any significant differences in bond strengths.

Results

Results are presented in Table 1. All NiCr crown samples without the adhesive monomer (Group 3) debonded during thermocycling or manipulation prior to testing. The mean shear bond strength of NiCr crowns with the addition of the adhesive monomer was 7.76 kg. This bond strength is comparable to the bond strength to primary molars and premolars without the adhesive monomer (Groups 1 and 2).

A two-way ANOVA between Groups 1 and 2, shows no significant difference between the shear bond strength of primary molars and premolars ($P \leq 0.5028$). However, there was a significant difference between the bond strength of groups treated vs. not treated with adhesive monomer ($P \leq 0.0001$).

A two-way ANOVA for all data shows a significant difference in the shear bond strengths between treated and nontreated groups ($P \leq 0.0001$), and between primary, permanent, and NiCr groups ($P \leq 0.0001$).

With the adhesive monomer there was a decrease in the frequency of adhesive bond failures and an increase in frequency of cohesive failures (Table 2).

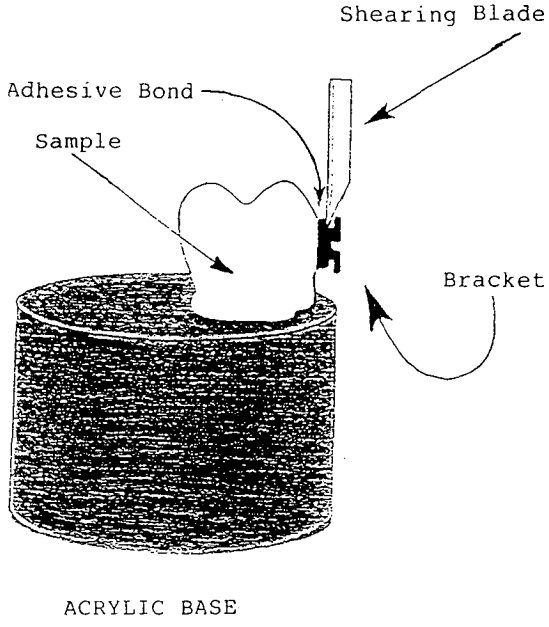

Figure. Samples mounted with bracket perpendicular to shearing blade of testing instrument.

Discussion

In this investigation the adhesive monomer, Clearfil New Bond, was evaluated in vitro to determine whether it could produce bond strengths to primary enamel and NiCr crowns comparable to conventional composite resin bonding systems to enamel.

This material improved the shear bond strength of orthodontic brackets to both primary molars and premolars. Additionally, it was possible to achieve bonds to NiCr crowns comparable in strength to the composite resin controls.

The increased frequency of the cohesive failures as well as the decreased frequency of adhesive failures with the addition of adhesive monomer indicated that failures occurred within the composite resin rather than at the composite-bracket base or composite-specimen surface interface.

This is the first in vitro investigation demonstrating bonding of orthodontic brackets to primary NiCr crowns at strengths comparable to conventional composite bonding. Adhesives that successfully bond to

Table 1. Mean shear strength (kg) to fracture bond

Group	*NM/M**	*N*	*Mean*	*SD*
1	NM	20	8.66	3.80
	M	20	12.82	3.90
2	NM	20	8.65	3.44
	M	20	11.71	3.65
3	NM	20	0	–
	M	20	7.76	3.50

* NM = Without adhesive monomer.
M = With adhesive monomer.

Table 2. Frequency of failure site*

Group	*NM/M*	*Adhesive*		*Cohesive*		*Combination*	
1	NM	10/20	(50%)	6/20	(30%)	4/20	(20%)
	M	1/20	(5%)	14/20	(70%)	5/20	(25%)
2	NM	7/20	(35%)	4/20	(20%)	9/20	(45%)
	M	2/20	(10%)	9/20	(45%)	9/20	(45%)
3	NM	20/20	(100%)	0/20	(0%)	0/20	(0%)
	M	1/20	(5%)	14/20	(70%)	5/20	(25%)

* Percentage in parentheses.

metal-based restorative materials, such as NiCr crowns, could be advantageous for: bonding orthodontic attachments to both restored and unrestored teeth;[14, 15] bonding attachments to orthodontic bands that already are cemented in place; bonding difficult teeth with poorly mineralized or defective enamel; and bonding composite directly to primary stainless steel anterior crowns. Additionally, higher bond strengths achieved with the use of adhesive monomers may reduce the surface area necessary for successful bonding.

Conclusion

1. Clearfil New Bond can significantly increase the shear bond strength of orthodontic brackets to both primary molars and premolars ($P \leq 0.0001$).
2. Orthodontic brackets can be successfully bonded to NiCr crowns at strengths comparable to bonds to primary or permanent enamel in vitro ($P \leq 0.0001$).

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