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Comparison of Gluma® bond strength to primary vs. permanent teeth

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Abstract

The purpose of this study was to measure the shear bond strength of Gluma®/Lumifor® (Gluma and Lumifor — Columbus Dental, St. Louis, MO) to the occlusal dentin of primary first and second molars, permanent first and second molars and premolars. The data were examined for differences using a one-way analysis of variance and Duncan's Multiple Range test. The shear bond strength, (kg/cm^2, x ± SEM) to primary molars was 85.6 ± 13.7, to permanent molars was 110.1 ± 9.3, and to premolars was 124.0 ± 9.3. Gluma/Lumifor provides moderately good bonding to dentin. The bond strengths of Gluma/Lumifor to primary molars was statistically significantly lower than to permanent teeth.

Introduction

Recent advances in composite resin and dentin adhesives technology have resulted in a greater acceptance and use of these restorative materials. Dentin adhesives adhere to the tooth and the composite resin. Bonding composites to dentin would provide the advantage of eliminating or reducing marginal leakage, reducing recurrent decay, and maintaining tooth structure with more conservative cavity preparations (Craig 1989). Buonocore et al. (1956) developed a methacrylate-based dentin adhesive that was capable of bonding to the inorganic phase of dentin, but it yielded clinically unacceptable bond strengths. Later, some investigators evaluated acid etching of dentin and micromechanical bonding as a retentive means to bond composite to dentin (Lee et al. 1973; Torney 1978). Although micromechanical bonding was not effective for dentin bonding, researchers evaluated the chemical components of dentin to develop a chemical bonding agent. Now, several dentin bonding agents have become commercially available for attaching composite resin to dentin (Munksgaard and Asmussen 1984; Eliades et al. 1985; Asmussen and Bowen 1987; Suzuki and Finger 1988). Several investigators examined shear bond strength of commercially available bonding agents (Reinhardt et al. 1987; O'Brien et al. 1988; Tao et al. 1988). The new Gluma® (Columbus Dental, St. Louis, MO) bonding system to dentin gave encouraging results (Hansen 1987; Munksgaard and Irie 1987; Asmussen et al. 1988; Munksgaard and Irie 1988).

Although long-term clinical testing is the only realistic basis for a definite assessment of a material or a technique, in vitro testing is an indispensable tool for evaluating and predicting clinical performance. The purpose of this study was to measure the shear bond strength of Gluma/Lumifor® (Columbus Dental, St. Louis, MO) to the occlusal dentin of primary first and second molars, and to compare these to the bond strength of permanent first and second molars and premolars.

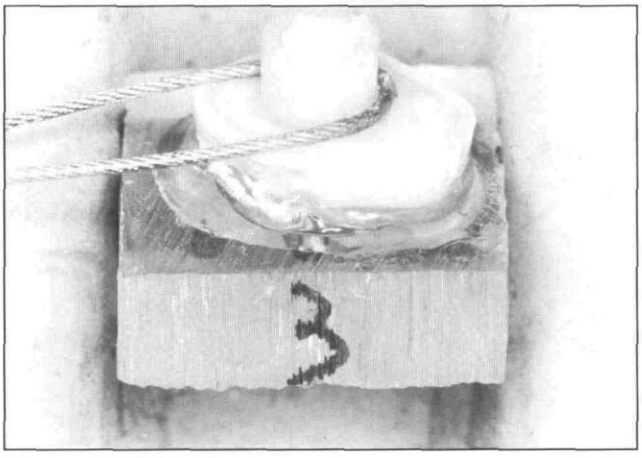
Materials and Methods

Thirty-six carious, nonrestored human teeth that had been extracted for different reasons, and had been stored at room temperature in an aqueous solution of 0.1% thymol, were used in this study. They included 12 primary molars, 12 permanent first and second molars, and 12 premolars. No teeth were extracted because of the extent of dental decay. Any carious lesions present were incidental to the reason for extraction. Premolars were extracted for orthodontic reasons. Most first permanent molars were extracted because of ectopic eruption of maxillary second molars, which caused resorption of the distal of the first molar. One carious maxillary second molar was extracted to permit eruption of a well-formed third molar into its position in the arch. The primary second molars were extracted because they were locking out erupting first permanent molars. The occlusal surfaces of the crowns were cross sectioned using a low speed diamond saw until all traces of carious dentin were removed. The teeth then were mounted in self-curing acrylic to facilitate handling. The Gluma® bonding system was used according to the manufacturer's instructions except the dentin sealer was light cured for 20 sec (O'Brien et al. 1988; Retief and Denys 1989) before the Lumifor composite resin was applied. Each specimen was washed well in running tap water and the exposed surface dried with oil-free compressed air. The Gluma cleanser was applied to the dentin surface with cotton pellets for 30 sec using a gentle rubbing action. The specimen was washed well for 15 sec and dried with oil-free compressed air. Gluma primer then was applied to the dentin surface for 30 sec and thoroughly blown dry with air to spread the primer evenly over the surface. The surface was not rinsed with water. Next, Gluma sealer was applied to dentin surface and the excess removed by gentle blowing with air. The dentin sealer was light cured for 20 sec before the Lumifor composite was applied. This was the only deviation from the manufacturer's instructions and was done to be consistent with common laboratory bonding practice (Retief and Denys 1989; Grim 1990). The manufacturer's instructions are to place the composite over the unpolymerized adhesive and then light cure the composite, which then is supposed to cure the adhesive. Most laboratories cure the adhesive first. A nylon cylinder 3 x 3 mm (ID) was used as a matrix for composite and held on the dentin surface by Scotch® tape (Figure). The Lumifor was placed in two increments which were light-cured for 40 sec each. The teeth were stored in isotonic saline at 37°C for 24 hr before shear bond strength was measured. A shear load was applied to the bonded cylinder at a crosshead speed of 1 mm/min on an Instron® (Instron Universal, Canton, MA) testing machine. The shear bond strengths were expressed in kg/cm^2. The data were analyzed for differences using a one-way analysis of variance and Duncan's Multiple Range test.

Table. Gluma bond strengths to primary and permanent teeth

Tooth Tape	*Range*	*Shear Bond Strength (kg/cm²)* *Mean*	*SD*	*CV*	N
Primary molars	41–170.5	85.6	47.4	0.55	12
Permanent molars	46–154	110.1	32.3	0.29	12
Premolars	93.5–185.5	124.0	32.2	0.26	12

Groups linked by vertical line are not statistically different from one another but are significantly different ($P < 0.05$) from groups not linked by line.



Tooth specimen mounted on Plexiglas® block for testing. Composite resin was within cylindrical nylon matrix in center of tooth. The adhesive bond was stressed to failure using a wire loop positioned at the base of the cylinder.

Results

The results of the shear bond strength measurements in kg/cm^2 are presented in the Table.

The shear bond strength of primary molars averaged 85.6 ± 47.4 ($x \pm$ SD kg/cm^2) and ranged between 41 and 170.5 kg/cm^2. The shear bond strength of permanent first and second molars averaged 110.1 ± 32.3 kg/cm^2 and ranged between 46 and 154 kg/cm^2 while for premolars averaged 124.0 ± 32.2 kg/cm^2 and ranged between 93.5 and 185.5 kg/cm^2. The coefficient of variation per cent of primary molars was 55.37, while for permanent molars was 29.34 and for premolars was 25.97. Analysis of variance and Duncan's Multiple Range test indicate that the bond strength of Gluma/Lumifor to primary molars was statistically significantly lower than to permanent first and second molars and premolars ($P = .05$).

Discussion

Composite resin restorations for primary molars have been advocated in recent years (Oldenburg et al. 1985; Tonn and Ryge 1985). Gaps around composite fillings frequently form as a consequence of inadequate bonding between resin filling and the cavity walls (Finger and Ohsawa 1987). Such gaps allow penetration of microorganisms, and subsequently enhance the possibility of inflammation of the pulp, marginal discoloration, and recurrent decay. Laboratory studies have shown that the Gluma dentin bonding system promotes a bond between dentin and restorative resins which reportedly minimizes the formation of contraction gaps (Munksgaard and Irie 1987). In addition, recent data indicated that Gluma has a distinct in vivo antibacterial effect that seems to prevent bacterial growth in tooth/restoration interfaces (Felton et al. 1989).

It is known that smear layers could limit the ultimate bond strength of some dentin adhesives (Tao et al. 1988). In this study, the application of Gluma cleanser to dentin removed the smear layers. This has been documented in another study (O'Brien et al. 1988). In our study, variation of shear bond strengths between primary and permanent teeth could be caused by the difference in prepared dentin depth due to structural differences in the depth of central grooves between primary and permanent teeth. Teeth with deep central grooves must be ground deeper into the dentin to remove all traces of enamel, compared to teeth with shallow grooves. Even thin veneers of enamel can give erroneously high bond strengths and must be avoided. Some teeth had carious lesions on their occlusal surfaces that had to be ground through to create a flat, sound dentin surface suitable for bonding. Thus, the prepared dentin surfaces were variable distances into the dentin or from the pulp. This contributed to the relatively high coefficient of variation seen in the results. There were wide variations in remaining dentin thickness. These variations could be due to different levels or depths of dentin used following removal of dental decay. This suggestion has been documented by other investigators who correlated dentin adhesive bond strength to dentin depth (Suzuki and Finger 1988). The bond strengths of composite restorative resins to noncarious teeth and sound dentin treated with Gluma dentin bond have been determined in several recent studies. In one study, the shear bond strengths of the dentin-polymer bond promoted by Gluma and various resins were evaluated (Munksgaard et al. 1985) and found to be approximately 150 kg/cm2. The shear bond strengths of six dentin bonding agents to dentin were determined by Eliades et al. (1985). The authors reported that the shear bond strength to Gluma-treated dentin was 130 ± 35 kg/cm^2, which was significantly greater than the shear bond strengths of the other five dentin bonding agents evaluated. The mean bond strength of the Gluma/Lumifor restoration system to excavated carious teeth and sound dentin obtained in the present study was 85.6 kg/cm^2 for primary molars, 110.1 kg/cm^2 for permanent first and second molars, and 124.0 kg/cm^2 for premolars. The bond strengths to permanent molars obtained in this study were not appreciably different from those reported by Retief and Denys (1989) using permanent molars.

Munksgaard et al. (1985) correlated the bond strength of Gluma to flat occlusal dentin with the amount of gap formation around similar Gluma/composite restorations placed in proximal Class I cavities. They obtained an inverse linear regression between shear bond strength and marginal gaps with a correlation coefficient of 0.85. Extrapolating that line to a theoretical gap of zero yielded a bond strength of 168 kg/cm2. That is, if a bond strength of approximately 170 kg/cm^2 could be obtained, there should be no microleakage around it because the bonding was perfect. If a lower bond strength was achieved, then there would be a slight marginal gap around the restoration. Very low bond strengths (i.e., 20–30 kg/cm^2) were associated with wider gaps. Our bond strengths were about midway between the lowest and the highest bonds found by Munksgaard and Asmussen (1985) which suggests that they would permit some microleakage, but not excessive amounts. Thus, we conclude that Gluma/Lumifor provides moderately good bonding to dentin.

Further study of composition and structure of dentin in primary teeth may provide insight into the differences in bond strength between primary and permanent teeth.

Conclusions

Gluma/Lumifor provides moderately good bonding to dentin. The bond strengths of Gluma/Lumifor to primary molars were statistically significantly lower than to permanent teeth.

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Smokeless tobacco sales increasing

A resurgence of sales of smokeless tobacco product can be traced to tobacco promoters changing their marketing pitch, according to the Federal Trade Commission (FTC). Tobacco promoters are turning to auto races, rôdeos, monster truck shows and tractor pulls, avoiding media centers in favor of small towns and rural areas.

Most tobacco ad dollars are going to public entertainment and direct mail, instead of newspapers and billboards. The most disturbing trend is in sales of moist snuff, now the most popular and dangerous form of smokeless tobacco. While oral cancer has been shown to occur several times more frequently among smokeless tobacco users, than among nonusers, it may occur as much as 50 times more frequently among long-term snuff users, says Dr. Louis Sullivan, secretary of the Department of Health and Human Services.

In 1988–89, the tobacco industry redirected its advertising efforts and increased the ad budget from $68.2 million to $81.2 million. Sales of smokeless tobacco products increased by more than two million pounds, and total revenues jumped from $901.6 million to $981.6 million, according to the FTC.