Clinical Comparison of the Bond Failure Rates Between Fluoride-Releasing and Non-Fluoride-Releasing Composite Resins

CHUN-HSI CHUNG, DMD, MS
ANNALISA PIATTI, MD, DDS

Although composite resins generally have a low incidence of bond failures, they increase the likelihood of plaque accumulation, and thus the risk of demineralization of the surrounding enamel.[1-3] Indeed, it has been reported that 50% of orthodontic patients with bonded or banded appliances have experienced enamel demineralization or "white spots" on at least one tooth.[4] White spots are not only unesthetic, but they remineralize poorly and therefore may increase the risk of developing carious lesions several years after debonding.[5,6]

The effect of fluoride in caries prevention has been well documented.[7,8] Daily brushing with a fluoridated dentifrice and daily rinsing with a fluoride mouthrinse have been reported to inhibit the formation of white spots during orthodontic treatment.[9] Because patient compliance is often inadequate,[10] however, fluoride-supplemented composite resins, which have the ability to release a constant low dosage of fluoride, have become widely used for orthodontic bonding. Recent studies have shown that a fluoride-releasing composite resin can reduce white spot formation,[11-13] although some authors have found no difference compared to non-fluoride-releasing composites.[14-16]

The release of fluoride incorporated in the composite resin is probably due to two different mechanisms. First, fluoride diffuses into the oral cavity through material dissolution (for example, of NaF), which may have the effect of weakening the structure of the composite resin and thus decreasing its bond strength.[17,18] Second, fluoride may leach out of the material by ion exchange with other anions in the oral environment, as proposed by Rawls and Zimmerman.[19] According to them, this type of fluoride-exchanging resin should maintain its physical properties, since the fluoride is given up in exchange for other anions.

The purpose of this study was to compare the clinical bond strength of an ion-exchange fluoride-releasing composite resin, Phase II,* with that of the same composite without fluoride.

Dr. Chung

Dr. Piatti

Dr. Chung is an Assistant Professor and Dr. Piatti is a former resident, Department of Orthodontics, School of Dental Medicine, University of Pennsylvania, 4001 Spruce St., Philadelphia, PA 19104.

Materials and Methods

Twenty-three subjects (six male and 17 female) were randomly selected from among patients who required fixed appliance therapy at the Orthodontic Clinic of the University of Pennsylvania. The average age at the beginning of treatment was 14, with a range from 11 years to 21 years, 2 months.

For each patient, one quadrant in each arch was randomly assigned to the fluoride-releasing Phase II group, and the contralateral quadrants were bonded with the non-fluoride-releasing

*Registered trademark of Reliance Orthodontic Products, P.O. Box 678, Itasca, IL 60143.

Phase II. Molars were banded and therefore were not included in the study.

All brackets** were bonded by one operator (Dr. Piatti). Among the 23 patients, 15 had brackets on both arches; seven had brackets on the mandibular arch only, and one received only maxillary brackets. Out of a total of 370 brackets, 186 (77 maxillary and 109 mandibular) were bonded with the fluoride-releasing Phase II, and 184 brackets (75 maxillary and 109 mandibular) were bonded with the non-fluoride-releasing Phase II.

The bonding procedure was as follows:

1. The tooth surface was cleaned with non-fluoride-containing, oil-free pumice paste in a prophy cup on a slow-speed handpiece, rinsed thoroughly with water, and dried.
2. The tooth surface was etched with 37% phosphoric acid for 60 seconds, rinsed with water, and dried thoroughly.
3. A drop of sealant A and a drop of sealant B were mixed and applied in a thin coat to the enamel surface. Equal amounts of paste A and paste B of the Phase II were mixed and applied to the base of the bracket and the tooth surface.
4. Excess adhesive was removed carefully with an explorer, taking care not to disturb the bracket placement.
5. After 10 minutes of setting, all bonded brackets were checked to make sure there were no occlusal interferences. Archwires were then placed.

Any bond failures were recorded at one, three, and six months after bonding. New brackets were bonded after failures, but were not included in the analysis. The chi-square test was used to determine the significance of differences between groups, at a level of $p < .05$.

Results

Seven of the 23 patients had at least one bond failure within six months (Table 1). Only two failures (one for each composite) occurred within one month. Four more (two for each adhesive) were found between one and three months. Ten bond failures (six with the fluoride-releasing Phase II and four with the non-fluoride-releasing Phase II) occurred between three and six months after bonding. Statistical analysis showed no significant difference in the bond failure rates between the fluoride-releasing and non-fluoride-releasing groups.

More failures were noted in the mandibular arch than in the maxillary arch, but there was no significant difference between the two composites (Table 2). There were more premolar bond failures than incisor or canine bond failures in both groups, with no significant differences among the failure locations.

Discussion

Our data clearly showed that at one, three, and six months after bonding, there was no statistical difference in failure rates between the fluoride-releasing Phase II and the non-fluoride-releasing Phase II. Both composites had bond failure rates of less than 1% at one month, less than 2% at three months, and less than 5% at six months. Similar results were reported by Underwood and colleagues,[11] who found the clinical failure rates at 12 months for a fluoride-exchanging resin and non-fluoride-releasing Concise*** were 10.8% and 7.3%, respectively, with no statistical difference between them.

Among the seven patients with bond failures within six months, five had two or fewer failures, one had three failures, and one had five failures. This last patient was found to have more careless eating habits (for example, eating hard food) than would be considered acceptable. Still, the failure distributions over time were similar between the fluoride-releasing and non-fluoride-releasing groups.

Most of the bond failures for both materials occurred between three and six months. This contradicts the findings of Sonis and colleagues[12] and Turner,[15] who found that more than 80% of their failures occurred within the first month

**MiniTwin, registered trademark of Ormco/"A" Company, 1717 W. Collins Ave., Orange, CA 92867.

***Registered trademark of 3M Unitek, 2724 S. Peck Road, Monrovia, CA 91016.

TABLE 1
DISTRIBUTION OF BOND FAILURES AMONG PATIENTS USING FLUORIDE-RELEASING (F) AND NON-FLUORIDE-RELEASING (NF) PHASE II

	1 Month		1-3 Months		3-6 Months		Total at 6 Months	
Patient No.	F	NF	F	NF	F	NF	F	NF
2	UL4				LR5		2	0
4					LR5	LL5	1	1
5				UL1, LR5			0	2
10						UR5	0	1
13						LR2	0	1
17		LR5	LL4		UR1, UR5	UL1	3	2
22			LR5		UL1, LR1		3	0
TOTAL	1	1	2	2	6	4	9	7

Note: The other 16 patients did not have any lost brackets at 6 months.

TABLE 2
BOND FAILURE RATE BY TOOTH TYPE USING FLUORIDE-RELEASING AND NON-FLUORIDE-RELEASING PHASE II

	Fluoride-Releasing				Non-Fluoride-Releasing			
	No. Placed	No. Failed 1 month	No. Failed 3 months	No. Failed 6 months	No. Placed	No. Failed 1 month	No. Failed 3 months	No. Failed 6 months
Overall	186	1 (0.5%)	3 (1.6%)	9 (4.8%)	184	1 (0.5%)	3 (1.6%)	7 (3.8%)
Maxillary	77	1 (1.3%)	1 (1.3%)	3 (3.9%)	75	0	1 (1.3%)	3 (4.0%)
Mandibular	109	0	2 (1.8%)	6 (5.5%)	109	1 (0.9%)	2 (1.8%)	4 (3.7%)
Premolars	72	1 (1.4%)	3 (4.2%)	6 (8.3%)	72	1 (1.4%)	2 (2.8%)	4 (5.6%)
Canines	38	0	0	0	36	0	0	0
Incisors	76	0	0	3 (4.0%)	76	0	1 (1.3%)	3 (4.0%)

after bonding. It should be noted, however, that Sonis used a light-cured composite resin, which is more technique-sensitive than the chemically cured resin used in our study. Although Turner used chemically cured Concise, the data were collected from several operators practicing in three different treatment centers, which could affect their reliability. In our study, only one operator placed all the brackets, and we removed any potential occlusal interferences after bracket placement. This may also help explain our low bond failure rate within the first month.

As in studies by Zachrisson[20] and by Trimpeneers and Dermaut,[21] we found that more bond failures occurred on premolars than on incisors and canines. The differences were not statistically significant in our study, which may be related to a smaller sample size.

Dubroc and colleagues found that fluoride-releasing Phase II reduced demineralization at the site of application and at distant sites in the experimental rat model.[22] The amount and duration of this fluoride release remain to be precisely quantified. Nevertheless, our study demonstrates that a fluoride-exchanging composite resin such as Phase II is clinically strong enough for use as an orthodontic bonding adhesive.

ACKNOWLEDGMENTS: We would like to acknowledge the help of Drs. Francis K. Mante and Solomon H. Katz and the contributions of Reliance Orthodontic Products.

REFERENCES

1. Zachrisson, B.U.: JCO Interviews Dr. Bjorn U. Zachrisson on iatrogenic damage in orthodontic treatment, Part 1, J. Clin. Orthod. 12:102-113, 1978.
2. Mizrahi, E.: Enamel demineralization following orthodontic treatment, Am. J. Orthod. 82:62-67, 1982.
3. Øgaard, B.; Rølla, G.; Arends, J.; and ten Cate, J.M.: Orthodontic appliances and enamel demineralization, Part 2: Prevention and treatment of lesions, Am. J. Orthod. 94:123-128, 1988.
4. Gorelick, L.; Geiger, A.M.; and Gwinnett, A.J.: Incidence of white spot formation after bonding and banding, Am. J. Orthod. 81:93-98, 1982.
5. Årtun, J. and Thylstrup, A.: A 3-year clinical and SEM study of surface changes of carious enamel lesions after inactivation, Am. J. Orthod. 95:327-333, 1989.
6. Øgaard, B.: Prevalence of white spot lesions in 19-year-olds: A study on untreated and orthodontically treated persons 5 years after treatment, Am. J. Orthod. 96:423-427, 1989.
7. Schrotenboer, G.H.: Fluoride benefits—after 30 years, J. Am. Dent. Assoc. 102:473-474, 1981.
8. Carlos, J.P.: The prevention of dental caries: Ten years later, J. Am. Dent. Assoc. 104:193-197, 1982.
9. O'Reilly, M.M. and Featherstone, J.D.B.: Demineralization and remineralization around orthodontic appliances: An in vivo study, Am. J. Orthod. 92:33-40, 1987.
10. Geiger, A.M.; Gorelick, L.; Gwinnett, A.J.; and Griswold, P.G.: The effect of a fluoride program on white spot formation during orthodontic treatment, Am. J. Orthod. 93:29-37, 1988.
11. Underwood, M.L.; Rawls, H.R.; and Zimmerman, B.F.: Clinical evaluation of a fluoride-exchanging resin as an orthodontic adhesive, Am. J. Orthod. 96:93-99, 1989.
12. Sonis, A.L. and Snell, W.: An evaluation of a fluoride-releasing, visible light-activated bonding system for orthodontic bracket placement, Am. J. Orthod. 95:306-311, 1989.
13. Basdra, E.K.; Huber, H.; and Komposch, G.: Fluoride released from orthodontic bonding agents alters the enamel surface and inhibits enamel demineralization in vitro, Am. J. Orthod. 109:466-472, 1996.
14. Eliades, T.; Viazis, A.D.; and Eliades, G.: Enamel fluoride uptake from an experimental fluoride-releasing orthodontic adhesive, Am. J. Orthod. 101:421-424, 1992.
15. Turner, P.J.: The clinical evaluation of a fluoride-containing orthodontic bonding material, Br. J. Orthod. 20:307-313, 1993.
16. Trimpeneers, L.M. and Dermaut, L.R.: A clinical evaluation of the effectiveness of a fluoride-releasing visible light-activated bonding system to reduce demineralization around orthodontic brackets, Am. J. Orthod. 110:218-222, 1996.
17. Chan, D.C.N.; Swift, E.J.; and Bishara, S.E.: In vitro evaluation of a fluoride-releasing orthodontic resin, J. Dent. Res. 69:1576-1579, 1990.
18. McCourt, J.W.; Cooley, R.L.; and Barnwell, S.B.: Bond strength of light-cure fluoride-releasing base-liners as orthodontic bracket adhesives, Am. J. Orthod. 100:47-52, 1991.
19. Rawls, H.R. and Zimmerman, B.F.: Fluoride-exchanging resins for caries protection, Caries Res. 17:32-43, 1983.
20. Zachrisson, B.U.: A posttreatment evaluation of direct bonding in orthodontics, Am. J. Orthod. 71:173-189, 1977.
21. Trimpeneers, L.M. and Dermaut, L.R.: A clinical trial comparing the failure rates of two orthodontic bonding systems, Am. J. Orthod. 110:547-550, 1996.
22. Dubroc, G.C.; Mayo, J.A.; and Rankine, C.A.N.: Reduction of caries and of demineralization around orthodontic brackets: Effect of a fluoride-releasing resin in the rat model, Am. J. Orthod. 106:583-587, 1994.