

Effects of acidulated and neutral NaF solutions on bond strengths

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Abstract

The application of topical fluoride after acid-etching substantially reduces the risk of enamel opacities and caries, but fluoride treatment can reduce strength of the enamel-adhesive interface to a measurable extent. In this in vitro study there was a slight reduction (statistically inconsequential) in bond strength with the use of 2.0% aqueous NaF. In contrast, two acidulated solutions tested here both showed marked reductions (ca. 25%) in bond strengths.

Introduction

The physical obstructions of orthodontic bands and brackets, along with wires and elastics, commonly cause a patient's oral hygiene to degrade, particularly in areas immediately adjacent to the attachments (Horowitz and Heifetz 1970; Gwinnett and Coen 1979). Bonding techniques now in common use which acid-etch the enamel prior to band and bracket placement exacerbate this problem; the etched region is at enhanced risk of plaque accumulation and caries invasion (Kochavi et al. 1975). The localized demineralization resulting from plaque can result in enamel opacities as well as actual carious degradation (Shennon 1972; Lehman et al. 1981; Gorelick et al. 1982).

Bishara et al. (1989) have recently reported that the application of either a 2 or 4% NaF solution in 0.1 M H_3PO_4 does not significantly influence the tensile bonding strength of the adhesive material to the enamel surface. This nonsignificance does not agree with our clinical and laboratory impressions. This report describes the effects of fluoride solutions on bond strengths which, in our experiments at least, do statistically reduce the tooth-to-bond adhesion.

Materials and Methods

Forty extracted human premolars were divided into four equal groups. Teeth were sound and were stored in

water following extraction. Each tooth was mounted in an acrylic disk with only the facial surface exposed and positioned so that the direction of pull would be essentially in the tensile mode when mounted in an Instron Universal testing machine (Canton, MA). To mimic the clinical routine, each tooth was cleaned with a rubber cup and flour pumice for 10 sec, then rinsed in tap water and dried with compressed air. Etching of all teeth was achieved with 37% phosphoric acid for one min. Teeth then were rinsed for 30 sec and air dried.

Teeth in Group I were prepared following the manufacturer's instructions for Rely-a-Bond® adhesive and primer (Reliance Orthodontic Products, Itasca, IL). Group II teeth were treated with liquid acidulated sodium fluoride (2.0% in 0.15 M H_3PO_4). Teeth in Group III were treated with topical fluoride gel (1.23% NaF in 1.0% acidulated gel; Healthco, Boston, MA), while Group IV teeth were treated with a neutral solution of 2.0% NaF. Fluoride in Groups II through IV was applied with a cotton applicator and left on the tooth for three min, followed by rinsing for 15 sec with a water syringe, and then a thorough drying with an air syringe.

A Begg bracket with curved stainless steel mesh back (#256-650; TP Orthodontics Inc) was bonded to each tooth and left undisturbed for five min before the excess composite was removed. The adhesive was allowed to polymerize for an additional 15 min to ensure complete setting before being stored for one week in tap water. Brackets then were broken from the teeth in a tensile mode using the Instron® machine (Model TT-BM, Instron Corporation, Canton, MA; crosshead speed = 0.2 in/min), and shear strengths were converted to psi (bracket area = 0.0153 in²).

Differences in average shear strength among the four groups were assessed using a conventional one-way analysis of variance (Winer 1971) followed by application of the Scheffé test (Sokal and Rohlf 1981) to determine the source(s) of the statistical significance.

Results

Inspection of the tooth surfaces under a low-power microscope revealed that breakage in the controls was invariably at the bracket-adhesive junction. The aqueous 2.0% NaF-treated teeth exhibited a mix of bracket-adhesive and tooth-adhesive fractures, while teeth in the other two groups (fluoride gel and acidulated NaF) all exhibited major breaks at the tooth-adhesive junction.

Descriptive statistics are presented in Table 1. Assessment of intergroup differences yielded a statistically significant F-ratio ($F = 5.2$; $P = 0.004$). Interpretation of the post-hoc test indicated that the single source of significance was between the control and neutral NaF-treated groups, compared to the acidulated NaF gel and acidulated NaF liquid treatments.

If a protocol could be devised to measure the force required to invariably break the bond at the tooth-adhesive junction, the differences in strengths would be greater between the fluoridated and nonfluoridated series (Fig 1).

This statistical difference needs to be tempered with the observation that mean shear strength was reduced, more or less, in all three fluoride-treated series. The aqueous NaF group had an average reduction of 11% compared to controls; bond strengths were reduced 24% in the fluoride gel-treated series, and 25% with liquid acidulated NaF.

Discussion

The clinical application of these findings is focused on achieving a compromise between a strong bond at the adhesive-tooth interface and the benefits of fluoride treatment after acid etching. Several studies have determined that fluoride treatment after acid etching substantially reduces the risk of opacities and carious invasion (Bibby 1942; Knutson and Scholz 1944; Horowitz and Heifetz 1970; Zachrisson and Zachrisson 1971; O'Reilly and Featherstone 1987).

This work indicates that a clinically acceptable bond can be achieved with the use of 2.0% aqueous sodium

fluoride. Fluoride was applied to the etched surface and bond strength, essentially, was unaffected relative to controls, and with an average strength of 1570 psi, this regimen would seem to yield an adequate level of bonding. In contrast, the other media which involved H_3PO_4 exhibited lower bond strength. These differences are statistically lower, and in our view they represent clinically discernible differences as well. These findings disagree with the conclusion of Bishara et al. (1989) — that no difference was present between controls and treatment after etching with acidulated NaF.

An important consideration not dealt with here is whether the aqueous fluoride treatment regimen imparts enough fluoride to the enamel to optimize the cariostatic state. Extrapolation from the work of Grajower et al. (1979) and Thornton et al. (1987) indicates that acidic vehicles appreciably enhance fluoride uptake by the enamel. On the other hand, the present experiment discloses a significant reduction (ca. 25%) in bond strengths with such preparations.

Gwinnett et al. (1972) and Sheykholeslam et al. (1972) have clarified the source of reduced bond strength following fluoride treatment. Most fluoride salts (e.g.: sodium fluoride, titanium and zirconium tetrafluorides) produce a reaction product which a) inhibits the flow of resin into spaces in and around enamel prisms created by acid-etching, thus decreasing mechanical retention, and b) produces a reaction product-to-resin junction with weak bond strength. Stannous fluoride does not produce a reaction product but, as with the other fluoride salts tested, it reduces the wettability of the enamel, thus retarding resin flow,

TABLE 1. Descriptive Statistics for Shear Strength (psi) in the Four Treatment Groups

Group	Arithmetic Mean	Standard Error	Range
Controls without F solution	1771.8	79.5	1503–2190
2.00% neutral NaF solution	1567.5	107.5	859–2055
1.23% acidulated NaF gel	1339.9	99.4	963–1871
2.00% acidulated NaF liquid	1335.6	76.8	920–1626

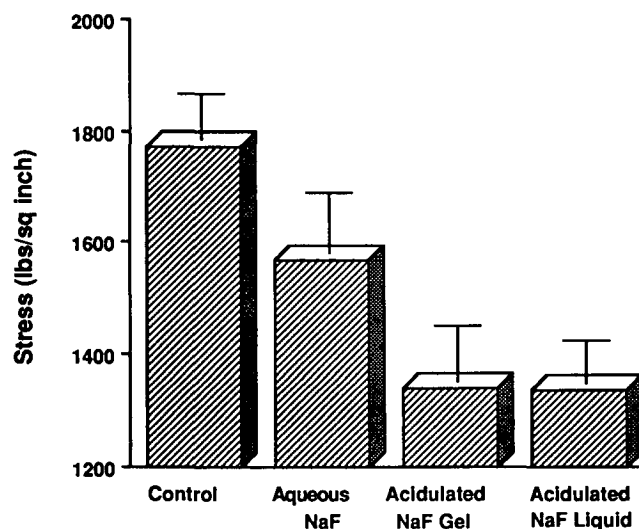


Fig 1. Histogram of the mean shear strengths (\pm standard errors) in the four groups (arranged in descending order). The differences among the groups are significant, because the two acidulated formulations had lower shear strengths, while the aqueous solution did not differ from the controls.

particularly resin tag formation by which much of a bond's strength is achieved.

In overview, the clinical issue is to identify a fluoride treatment that provides a substantive cariostatic effect while not significantly decreasing bond strength. Each of the three prebonding fluoride applications reduces shear bond strength to some degree, but the reduction is not significant here when using 2.0% aqueous NaF.

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Periodontal disease may signal AIDS

Some forms of advanced periodontal disease could be reliable early indicators of AIDS, according to research being conducted at the University of Medicine and Dentistry of New Jersey.

The study, which examines the signs and prevalence of periodontal disease among drug abusers who have AIDS, was reported in the March, 1990 issue of *Dental Economics*.

The lead researcher, Dr. Patricia Murray, associate professor of periodontics at the dental school, conducted a periodontal disease study of gay AIDS patients last year at the University of California at San Francisco's dental school.

"We found we were treating a large portion of HIV-positive patients who had advanced periodontal disease," noted Dr. Murray. "We developed treatments to eliminate periodontal disease and the associated threat of infection, which could prove fatal to patients with damaged immune systems."

She said her study results showed the periodontal disease type the HIV-positive patients had differs from the periodontal disease usually seen in the general public. She characterized the periodontal disease of the HIV-positive study participants as progressing rapidly, with accompanying oral lesions.

Dr. Murray's future research into periodontal disease's correlation with AIDS will focus on determining whether periodontal disease is an early warning for HIV infection.