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Fluoride level in saliva after bonding orthodontic brackets with a fluoride containing adhesive

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The fluoride level in saliva is considered an important parameter in caries prevention. Elevation of the salivary fluoride level by a fluoride-releasing orthodontic bonding adhesive would most likely be beneficial in the prevention of enamel caries. In this study, the fluoride level in saliva was measured after bonding brackets with a visible light-curing adhesive containing fluoride (12.4 wt% total F). The fluoride released from the adhesive has been shown in a previous study to inhibit demineralization adjacent to orthodontic brackets in vivo. Twenty-four patients each had 20 brackets bonded and saliva samples taken before bonding (t = 0) and after 1, 3, and 6 months. The participants were requested to brush daily with a fluoride toothpaste during the study period. The saliva fluoride analysis was done with the microdiffusion method. The analysis of the saliva showed fluoride levels (\pm SD) of 0.011 \pm 0.007, 0.011 \pm 0.009, 0.0011 \pm 0.007, and 0.012 \pm 0.008 ppm at t = 0, 1, 3, and 6 months, respectively. There was no significant difference at the 5% level. The study indicated indirectly that the caries inhibiting effect of the orthodontic adhesive shown previously was most likely due to a localized fluoridation of the cariogenic environment rather than to an elevation of the fluoride level in saliva. (Am J Orthod Dentofac Orthop 1997;111: 199-202.)

Recent studies have shown that 50% to 75% of all orthodontic patients develop demineralization on the labial surfaces during fixed appliance therapy. Fluoride mouthrinses reduce the occurrence of lesions, although compliance is often poor. Fluoride-releasing bonding materials and cements have been introduced because they reduce the need for cooperation and have the potential to inhibit demineralization. Recent studies clearly show that fluoride-releasing orthodontic bonding systems reduce caries during fixed appliance therapy. 5-7

The mechanism of the cariostatic effect of fluoride has been debated for many years. The current view is that fluoride in the so-called liquid phase in the enamel or in plaque fluid and saliva inhibits demineralization and enhances remineralization. It is thus essential that fluoride is present in ionic form in the liquid phase during the caries process. It has

been claimed that oral fluoride measurements may prove valuable in estimating the likely cariostatic efficacy of a fluoride agents.⁸ To provide more information about the cariostatic effect of fluoride releasing adhesives, the current study was conducted to measure the time-dependent salivary fluoride level before and after bonding brackets of brackets with a fluoride-releasing adhesive.

MATERIALS AND METHODS Adhesive

The adhesive used, Orthodontic Cement VP 862 (Batch no. 418101), is a halogen light-curing adhesive (Vivadent). The composition is based on 30% urethane dimethacrylate and an aliphatic dimethacrylate, as well as 65% of a special glass filler with a particle size below 10 µm. The glass filler used is a fluoro aluminum silicate (12.4 wt% fluoride).

Subjects and Bracket Bonding

Twenty-four patients (average age 13.0 ± 0.8 years) who were scheduled to have fixed orthodontic therapy volunteered for the study. Each patient had 20 brackets bonded with the adhesive. About 32 mm² of the adhesive was in direct contact with saliva around the bracket base periphery.

The buccal enamel surface of the upper and lower dentition was pumiced, washed and dried, etched with 37% phosphoric acid (Saga Orthodontics) for 1 minute,

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and then dried again with compressed air. Saliva contamination was prevented using lip expanders. The adhesive Orthodontic Cement VP 862 was applied directly on the bracket base (Uni-Twin, 3M Unitek). Excess adhesive was removed with a scaler. The adhesive was cured with a polymerization light from a Heliolux II lamp (Vivadent). The adhesive was cured for 20 seconds along the tangential side of the tooth surface from the cervical part and subsequently 20 seconds along the tangential side of the tooth surface from the incisal part, according to the manufacturer's recommendations. Fluoride toothpaste is the basic caries prophylactic measure in Norway; therefore the patients were allowed to use a normal fluoridated toothpaste (0.1% F) during the experimental period. The patients were requested to brush in the morning and in the afternoon, but not in the morning on the sampling days. No other fluoride supplements were used.

Saliva Sampling

Unstimulated whole saliva samples were taken before bonding (t = 0) and after 1, 3, and 6 months. The saliva samples were collected with the patient sitting, swallowing, and allowing the saliva to pool in the mouth for 2 minutes. All saliva samples were taken from underneath the tongue in the morning before noon. The samples were stored in closed plastic tubes and frozen to -20° C, until analysis.

Saliva Fluoride Measurements

The fluoride content of the saliva samples was analyzed by the Taves⁹ microdiffusion method as described in detail by Zero et al. 10 Saliva samples were vortically spun and transferred into the microdiffusion dish of a Taves diffusion apparatus. The volume of the samples was adjusted to 3 ml with double deionized water, and 0.1 ml of 1.65 mol/l NaOH was added to the central trap. One milliliter of 6 mol/l HCI, saturated with hexamethyldisiloxane, was added to the sample before the dish was sealed. The samples were rotated for 18 hours on a rotary shaker at 80 rpm. At the end of the diffusion period, the NaOH traps were removed. The samples contained in the traps were dried at 65° C for 2 hours, and buffered with 1 rnl of 0.34 mol/l acetic acid to a final pH at 5.0. Fluoride was then measured by a fluoride ion-specific electrode (Model 960900, Orion Research, Inc.). The fluoride content (micrograms) was calculated from a standard curve constructed from standards microdiffused at the same time as the samples.

Fluoride Release In Vitro

Four cylindrical plastic molds, with a diameter of 12.7 mm and a height of 4.5 mm, were filled with the adhesive and covered with a microscope glass slide. The adhesive was light cured as described previously. The total surface area of the cylindrical samples was 4.33 cm². The samples were stored in well closed polyethylene containers in 2 ml of double deionized water at 37° C; the double deionized

water contained less than 0.005 ppm fluoride. The solutions were not stirred or agitated. The fluoride concentration of the double deionized water was measured with the fluoride specific electrode in 0.5 ml solution, using 50 µl TISAB buffer as a function of time. Calibration of the fluoride electrode was performed before each measurement with standard fluoride solutions containing 1, 10, 100, and 1000 ppm fluoride. After each fluoride measurement 0.5 ml double deionized water was added to the polyethylene container to keep the total volume at 2 ml. The sensitivity of the fluoride electrode was 0.005 ppm F⁻. The variation in fluoride release by the composite samples was approximately 6% of the mean values.

RESULTS

The fluoride concentration in parts per million (ppm) (\pm SD) in saliva before bonding (t = 0) and after 1, 3, and 6 months was of 0.011 \pm 0.007, 0.011 \pm 0.009, 0.0011 \pm 0.007, and 0.012 \pm 0.008 ppm, respectively. One-sample t tests adjusted for multiple comparison showed no significant differences (P < 0.1).

The in vitro fluoride released in water is shown in Fig. 1. The release after 1 month was 31 μ g cm⁻² and after 1 year was 146 μ g cm⁻². The figure clearly shows that fluoride was still released from the adhesive after 1 year.

DISCUSSION

The most common method to include a therapeutic agent in materials is to form a mixture or dispersion of a poorly soluble agent. The current adhesive contains glass fillers with a fluoro aluminum silicate as fluoridating filler.

In the current study, the participants were requested to brush daily with a fluoride toothpaste. This was done for ethical reasons because the length of the study period was 6 months. It was considered unlikely that the fluoride adhesive would prevent lesions from developing in locations like fissures and approximal surfaces far from the bonded area on the labial surfaces. However, O'Reilly and Featherstone¹² showed that carious lesions developed immediately adjacent to orthodontic brackets within a month, even when a fluoride toothpaste was used daily. The severe challenge in the plaque of orthodontic appliances appears to require more fluoride than that delivered by a normal fluoridated toothpaste to prevent caries.¹³ Furthermore, during severe challenges, even fluoride may have a limited effect, and no optimum fluoride level has been reported to exist.¹⁴ In a previous study,⁷ the current adhesive reduced lesion development adjacent to

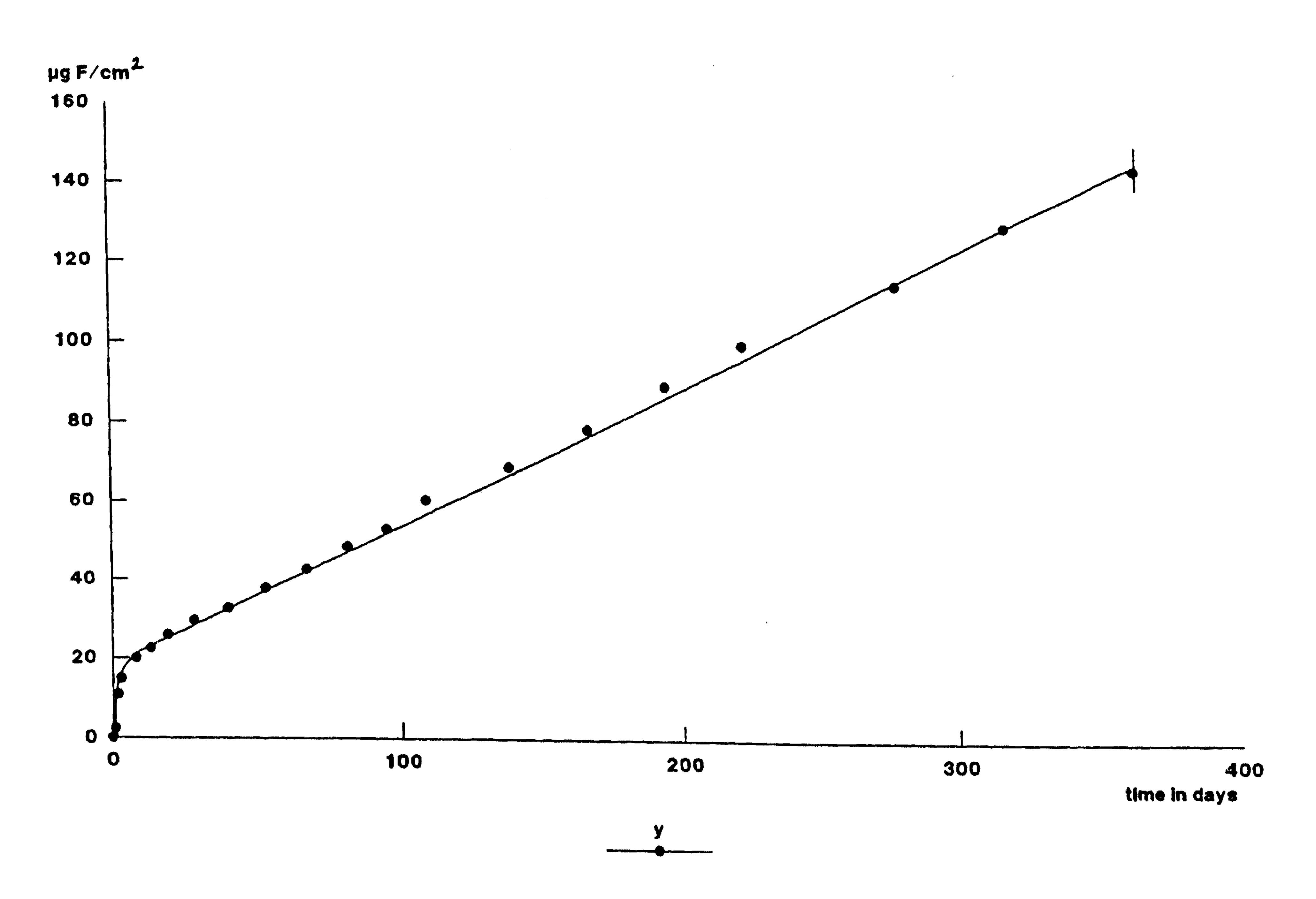


Fig. 1. Total amount of fluoride released in water from adhesive as function of time. After 8 to 10 days, curve shows linear release with linear correlation coefficient of 0.99. (Reprinted from Dijkman et al.²⁰ with permission from S. Karger AG, Basel.)

orthodontic brackets significantly, and simultaneously provided adequate bond strength.¹⁵

Some authors claim that the salivary fluoride level reflects the fluoride release from the fluoridating material and the cariostatic efficacy. Thus Koch and Hatibovic-Kofman¹⁶ observed that even after 1 year, the salivary fluoride level was increased after placement of glass ionomer restorations. The results may, however, be seriously questioned as the baseline levels in saliva before the experiment were found to be two to five times higher than considered normal in current literature.

Topical fluoride procedures increase the salivary fluoride level only for a relatively short time period. Topical fluoride applications two to four times a year reduce caries significantly without a permanent elevation of salivary fluoride level. 17,18 The current study also clearly showed that no elevation of salivary fluoride occurred during the 6-month bonding period, even if a fluoride toothpaste was used regularly and despite the cariostatic potential of the adhesive reported in a previous study. This supports the findings of Hallgren et al. 19 who bonded orthodontic brackets and cemented bands with a glass ionomer cement. Even if the salivary fluoride concentration was doubled during the first day after bonding, no significant differences from baseline values were found after 1 week or 1 month. In vitro

fluoride release in water may not necessarily reflect the potential release of fluoride in the oral cavity. In a recent study,⁷ it was demonstrated that fluoride release from the VP 862 adhesive was pH dependent and much greater than expected from dissolution experiments in water.

CONCLUSION

The current study clearly showed that a fluoride-releasing adhesive for bonding orthodontic brackets in combination with a fluoride toothpaste did not increase the salivary fluoride level after bonding. Because this adhesive previously has been shown to inhibit lesion development adjacent to brackets, it is concluded that the cariostatic potential of the adhesive most likely is due to release of ionic fluoride to the local environment rather than to an elevation of the fluoride level in saliva.

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AAO MEETING CALENDAR

1997 — Philadelphia, Pa., May 3 to 7, Philadelphia Convention Center

1998 — Dallas, Texas, May 16 to 20, Dallas Convention Center

1999 — San Diego, Calif., May 15 to 19, San Diego Convention Center

2000 — Chicago, Ill., April 29 to May 3, McCormick Place Convention Center (5th IOC and 2nd Meeting of WFO)

2001 — Toronto, Ontario, Canada, May 5 to 9, Toronto Convention Center

2002 — Baltimore, Md., April 20 to 24, Baltimore Convention Center

2003 — Hawaiian Islands, May 2-9, Hawaii Convention Center

2004 — Orlando, Fla., May 1-5, Orlando Convention Center