The Effects of Topical Fluoride Applications Underneath Loose Orthodontic Bands

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INTRODUCTION

The potential for topical fluoride applications in caries-prevention programs is well recognized.

Volker[1] was the first to show that topical application of fluoride prevented enamel solubility. Clinical studies[2,3,4,5,6] have demonstrated a highly significant reduction in the incidence of dental caries following the topical application of the tooth surfaces with fluoride solution. A variety of fluoride forms other than solution (fluoride dentifrices, tablets, and mouth-washes) have been tried by many authors[7,8,9,10] to determine the most effective form, chemical and/or physical, of decreasing the enamel surface demineralization. Phillips et al.[11] showed that stannous fluoride was the most effective process for increasing enamel hardness. In reviewing the results of sixteen two-year tests on stannous fluoride and sodium fluoride, Brudevold[12] found the means for caries reduction were 32% for SnF_2 and 31% for NaF. Further comparison showed stannous fluoride being unstable and having a discoloring effect on tooth surfaces.[13]

Phillips et al.[14] discovered that fluoride solution with low pH of 2.6 was not injurious to the tooth surface during topical fluoride application, whereas the enamel solubility was reduced. Malaowalla et al.[15] demonstrated that the lower the pH and the higher the fluoride concentration, the greater was the interaction of fluoride ion with synthetic apatite. In 1963 Brudevold et al.[16] introduced the acidulated phosphate fluoride and showed that, at a low pH (approximately 3.0), the fluoride penetration into sound enamel was increased, although the enamel dissolution decreased. In addition, Brudevold also demonstrated no etching of the enamel surface after prolonged exposure. Bodden et al.[17] concluded acid phosphate-fluoride to be more effective than stannous fluoride.

The purpose of the present study primarily was to assess the enamel demineralization protective effect of acid phosphate-fluoride underneath loose orthodontic bands. However, it was also intended to set forth experimental data showing that enamel demineralization is proportionately related to the period of time the enamel was under attack.

MATERIAL AND METHOD

Thirty-one patients from the orthodontic clinic at the University of Pittsburgh were utilized in the sample; all were Caucasians of both sexes between the ages of 11 and 15 years.

The extrinsic factors of the independent and dependent variables were neutralized in the study by using each individual as his own control.

Both maxillary first bicuspids were cleaned with rubber cup and pumice in the usual manner. For the experimental group the bicuspid (randomly selected) on either side of the arch was isolated with cotton rolls and dried with compressed air. The fluoride solution was applied with cotton pellets for five (5) minutes. After the fluoride

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treatment an orthodontic band was loosely fitted on the tooth by using finger pressure only and cemented with oxyphosphate cement. To create initial band looseness, slight parallel forces to the long axis of the tooth were applied after the cement had set. The bicuspid on the opposite side of the arch was loosely banded without fluoride pretreatment (control group).

Following the extractions, after three, four, and six-week intervals, the teeth were rinsed in both tap and distilled water, transferred to jars containing moist gauzes with thymol crystals, and refrigerated.

The tooth area covered by the orthodontic band was marked with a lead pencil on the buccal surface and the band was removed. Each of the teeth was examined with the naked eye and a score was given according to its buccal surface appearance:

0° = intact surface

1° = limited greyish, with or without accentuated perikymata

2° = well-accentuated perikymata, in some areas confluencing into white spots

3° = pronounced white spots (demineralization).

The scoring was performed by two graduate students of the orthodontic department. Each examiner performed two judgments with one day intervals. The experiments were organized as a blind study. The jars containing the teeth were randomly numbered from 1 to 62. None of the examiners (or the investigator) was aware if the examined tooth were an experimental or control item.

After removal of the band, a tin-foil strip (3 x 4 mm in size) was placed on the enamel at the area covered previously by the orthodontic band and the tooth was covered with melted inlay wax. Eventually the foil strip was carefully taken off, revealing a 3x4 mm "window" on the enamel buccal surface (Fig. 1).

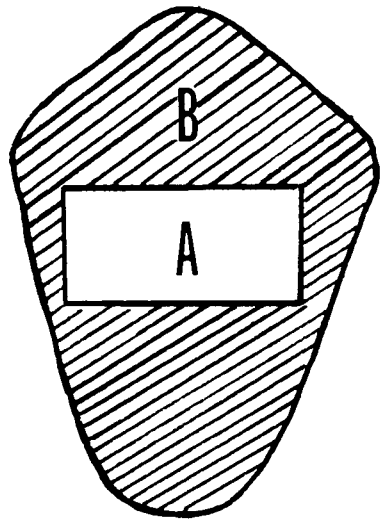


Fig. 1 A. Enamel surface (e.g., "window") exposed to the radioactivity. B. Enamel surface covered with inlay wax.

The tooth samples were immersed in individual jars containing radioactive mineralizing solution (20 ml) wherein the enamel "window" was exposed to 32_P isotopes (20 mc).

The teeth remained in the isotope solution at room temperature for a period of 12 hours without agitation. Eventually, the enamel samples were rinsed with distilled water and immersed for two minutes in cups containing 20 ml of 0.1 M HCl; one ml (1cc) of the cup solution was pipetted into vials containing 15 ml of a scintillation fluid, then placed into an LS-150 Beckman liquid scintillation counter, and the radioactivity of each vial measured in counts per minute (cpm).

Results

The visual appearance scoring revealed enamel surface lesions on twenty-four pairs of teeth, both experimental and control. The remaining seven pairs of teeth (0°-0°) did not exhibit any

observable enamel surface change (Fig. 2).

The mean radioisotope uptake of 32_p for the experimental group was found to be 721.69 cpm with a standard deviation of 335.13 cpm. The mean for the control group was found to be 1143.22 cpm with a standard deviation of 685.80 cpm. The student's paired method showed a significant difference at the 0.002 level of confidence.

The correlation of white spots (visual appearance) with isotope uptake by dichotomizing the visual scoring showed a biserial coefficient value of 0.16, which is not significant. The Pearson correlation coefficient between white spots and isotope uptake showed a correlation of value of $r = 0.25$, also insignificant.

The time effect in three levels was tested with two one-way analyses of variance. The F ratio for the experimental group was 0.14, whereas the F ratio for the control group was 0.32. Both ratio values were insignificant at the 0.05 level of confidence.

Discussion

The present study has demonstrated that a five-minute topical application of acidulated fluoride solution gives a significant degree ($P<0.002$) of enamel demineralization prevention underneath loose orthodontic bands for at least six weeks. Although some of the study teeth showed distinct demineralized lesions, the majority exhibited an almost intact appearance underneath the loose orthodontic bands. The reliability of the "white-spot" assessment by visual scoring was very low, averaging 56% for intrajudgment and 49% for interjudgment.

A certain difference between the experimental and control teeth with regard to the 32_p uptake is shown in Figure 2. With the exception of nine cases, the 32_p uptake was higher in the control teeth than in the experimental. It is worthy to note that in many cases a difference was registered in radioactive uptake between experimental and control teeth indicating enamel demineralization in undetectable levels for visual scoring.

Correlation between 32_p Uptake and Visual Scoring

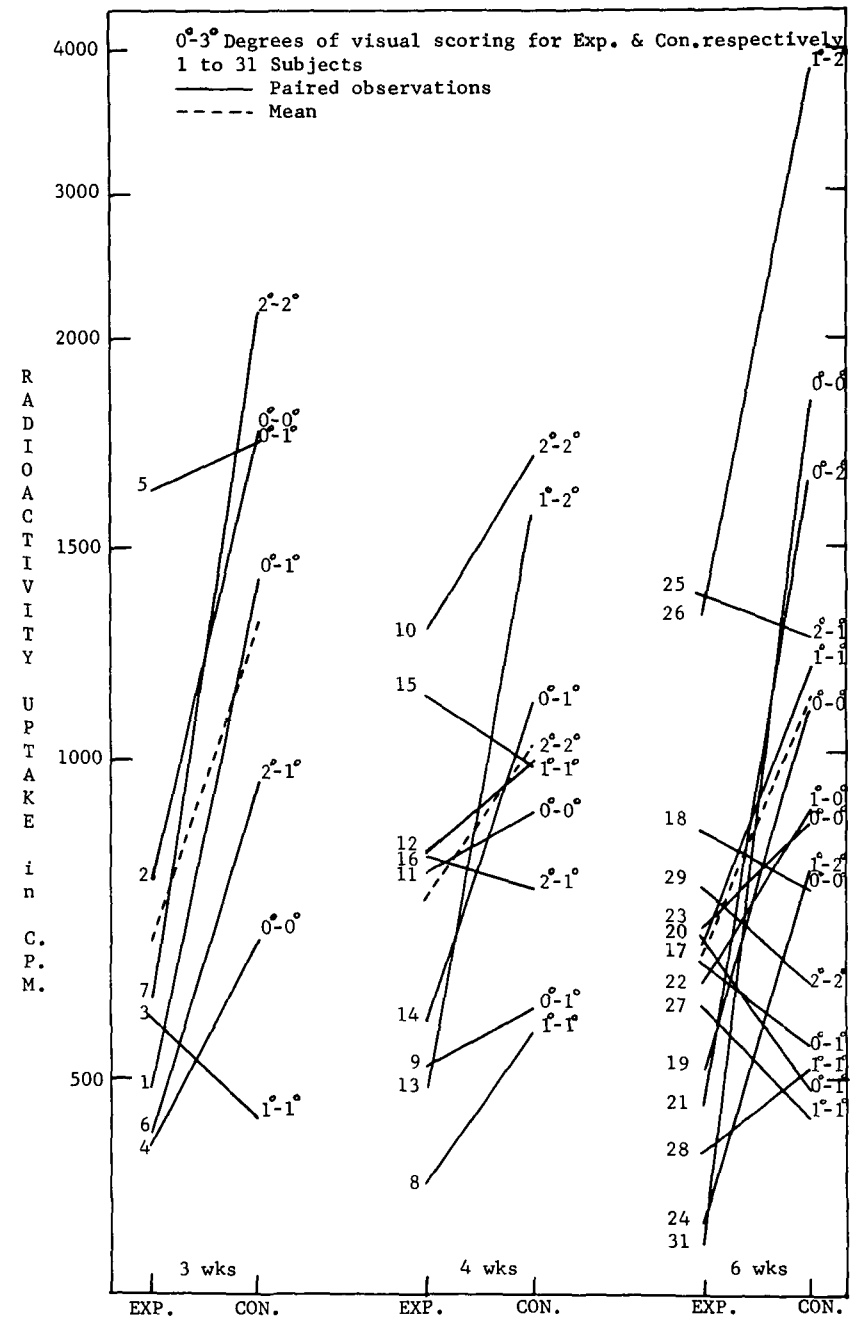
The correlation of the white spots (visual scoring) with the radioactive uptake was found insignificant. In previous studies, however, this correlation was found to be highly significant, and the scoring method had been introduced as approximately similar in sensitivity to the polarized light microscopy.[18] The technique followed here for the visual scoring (fast dryness 10 sec., and naked eye examination under light) was quite different from that introduced by Von der Fehr.[18,19]

The reason for modifying the method was to facilitate and/or simplify the visual scoring examination so that the detection and evaluation of enamel demineralization (white-spot formation) would be readily feasible for any orthodontist in his everyday practice. However, in a later publication it was concluded that the visual scoring method was not as sensitive and reliable as the 32_p uptake.[19]

More data are needed for a complete analysis of the reliability and relationship between the two methods. Although it was found that the 32_p uptake was a more sensitive and objective method than the visual scoring, it is believed that the technique of visual scoring in this experiment is less reliable than that introduced by Von der Fehr.

Time Effect

The time-effect findings were not those expected. In the literature reviewed, enamel demineralization was proportionately related to the plaque



	EXP.	CON.	EXP.	CON.	EXP.	CON.
Average	711.6	1326.2	773.2	1033.7	695.4	1143.5
S.D.	404.3	591.1	301.4	374.7	314.5	875.6

Fig. 2

formation and the period of time the enamel was attacked. In this study the time effect in three levels proved to be insignificant at the 0.05 level of confidence for both the experimental and control teeth.

Summary

The effect of five-minute topical fluoride acid solution was tested in vivo on a two-group study of sixty-two maxillary first premolar teeth. Half of the teeth were treated with Brudevold's solution; the remaining teeth served as controls. Both experimental and control teeth were loosely banded with orthodontic bands.

The rate of enamel demineralization was assessed by two methods in vitro after the teeth were extracted: visual appearance scoring and 32_P uptake registration.

The results obtained showed a significant inhibition of enamel demineralization underneath loose orthodontic bands for at least six weeks in 70% of the cases. The difference between experimental and control surfaces, as it was registered with the 32_P uptake, was highly significant ($P<0.002$). On this basis a five-minute topical fluoride application prior to the orthodontic banding may be valuable for prevention of demineralization in case of band looseness for at least six weeks in 70% of the cases.

The visual appearance scoring showed a very low percentage of agreement either on intrajudgment or interjudgment. The time effect on enamel demineralization, as manipulated in three, four, and six weeks, did not prove to be significant.

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Acknowledgment

The authors wish to express their appreciation to Dr. Theodore Koulourides, Senior Scientist, for his valuable help, and the Institute of Dental Research, University of Alabama in Birmingham for providing the facilities for the radioisotope treatment.

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