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White spot formation under orthodontic bands cemented with glass ionomer with or without Fluor Protector®

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SUMMARY The purpose of this study was to determine whether an additional application of Fluor Protector® before band cementation with glass ionomer cement reduces white spot formation compared with band cementation with glass ionomer cement.

In the *in vitro* study, 80 premolars were divided in half, creating a control and a test group. All specimens were divided into four different groups to simulate different clinical situations and stored in a demineralizing solution to induce white spot formation.

In the *in vivo* investigation, 18 orthodontic patients were incorporated in the study. One lower and one upper first molar band (randomly selected) were coated with Fluor Protector® and then cemented with a glass ionomer cement (test group). The other two uncoated first molars were cemented with glass ionomer cement and served as the control group.

The application of Fluor Protector® in combination with Aquacem® did not contribute to a reduction of white spot formation underneath molar bands compared with the use of Aquacem® for banding.

Introduction

The presence of fixed orthodontic appliances makes tooth cleaning more difficult, so an increased prevalence of food impaction around brackets and underneath bands may occur.

The risk of decalcification in orthodontic patients can be reduced by meticulous oral hygiene and the use of fluoride. According to Årtun and Brobakken (1986), professional oral hygiene instruction for the duration of orthodontic treatment has been shown to be effective in reducing decalcification. However, they report that this approach is very labour intensive.

On the other hand, fluoride therapy enables the reduction of enamel demineralization (ten Cate and Duyster, 1983; ten Cate and Featherstone, 1991) and prevents plaque activity through blocking bacterial enzyme systems (van Loveren, 1992). Moreover, it assists enamel remineralization (Silverstone, 1978, 1985; Mellberg, 1988).

In an earlier study, Adriaens *et al.* (1990) showed the value of Fluor Protector® (Vivadent, Schaan/Liechtenstein), a fluoride containing varnish, underneath orthodontic bands in combination with oxyphosphate cement.

A caries preventive measure in orthodontic patients is the use of fluoride containing cements. Long-term fluoride release from glass ionomer cements has been investigated (Swartz *et al.*, 1984; Forsten, 1990; Verbeeck and de Moor, 1992; de Wilde, 1993; de Moor, 1995), which may contribute substantially to remineralization. However, these cements do not provide complete caries protection under loose bands or in areas where the cement is missing (Rezk-Lega *et al.*, 1991).

The purpose of this study was to determine whether an additional application of Fluor Protector®, before band cementation with glass ionomer cement, reduces white spot formation compared with band cementation with glass ionomer cement.

Materials and methods

In vitro study

Eighty extracted human premolars without any clinical sign of decalcification were selected. All teeth were cleaned with pumice and water, and cut in half bucco-lingually with a diamond disc. Thus, the control and test specimens were obtained from the same teeth (Verbeeck, 1986).

Several studies (Zachrisson and Zachrisson, 1971; Mizrahi, 1983) have shown that the majority of lesions are found on the buccal surfaces after orthodontic treatment. This indicates that this area is relevant for our study.

The teeth were coated with nail varnish, except a part of the buccal enamel (Figure 1), which was used as the test area.

The 80 premolars were divided into four groups (Table 1). Two groups were left unbanded whereas in the other two groups the premolars were banded. In Group 3 the premolars were banded and these were loosened after cementation. In addition, in an attempt to simulate the clinical situation where bands which are mostly the ones which loosen, but remain in place (Sadowsky *et al.*, 1981), the bands chosen in this investigation were too large.

In Group 4 bands which were also too large were fitted, but not cemented. Thus, in this group, the clinical situation, where all cement is dissolved, was simulated.

In Group 1, the buccal surface was coated with Fluor Protector®, whereas in the other groups, a combination of Aquacem® (De Trey-Dentsply, Konstanz, Germany) and Fluor Protector® was used (see Table 1).

In comparison with the four control groups where no Fluor Protector® was used, the test groups only differed by an extra application of Fluor Protector®.

All specimen teeth were stored individually in separate test tubes containing a demineralizing solution. The buffer was an acetic acid solution at pH 4 and was undersaturated with respect to calcium hydroxyapatite and enamel.

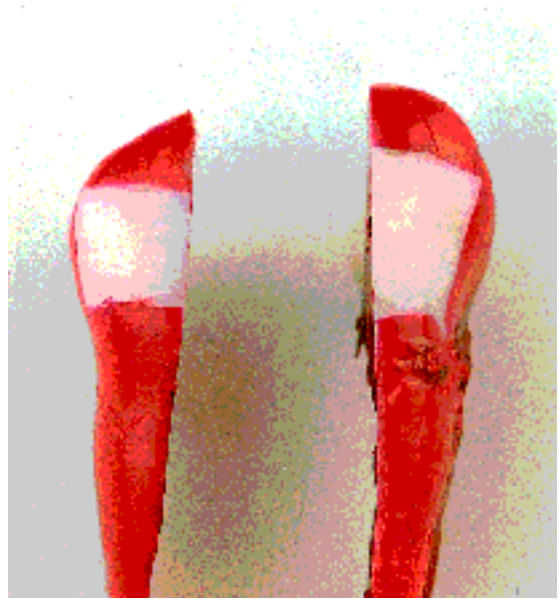

Figure 1 Divided premolars with the buccal test area. The surrounding tooth surface was coated with nail varnish.

The teeth in Groups 1 and 2 and the banded teeth (Figure 2) remained in the demineralizing solution for 16 and 36 weeks, repectively. These times have been found to be sufficient to induce white spots in these groups (Adriaens *et al.*, 1990). The solution was changed weekly.

At the end of the experiment, the bands and all traces of cement were removed from the enamel with a scaler and polished with Zircate® (The LD Caulk Division, Dentsply International Inc., Milford, USA). The buccal surfaces were inspected for white spot formation (Figure 3)

Table 1 Compilation of data from *in vitro* experiment.

Group	Test group		Control group		Experimental time (weeks)	χ^2
	Material used	Test score	Material used	Test score		
1 Without bands	FP	0/17	–	17/17	16	$P < 0.05$
2 Without bands	FP + A	2/17	A	3/17	16	NS
3 With too large bands (loosened)	FP +A	5/23	A	10/23	36	NS
4 With too large bands	FP + A	6/23	A	11/23	36	NS

FP, Fluor Protector®; A, Aquacem®.
NS, not significant; $P < 0.05$, significant at 95 per cent level.

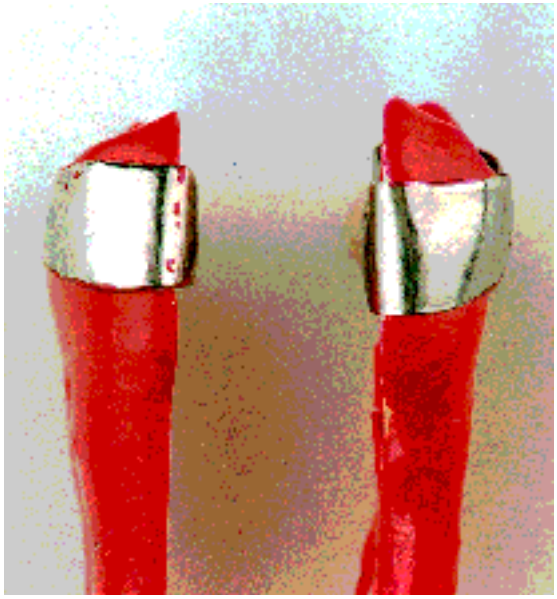

Figure 2 Divided premolars with orthodontic bands.

by four different observers and evaluated by means of the Chi-square test. Only the presence or absence of white spots was scored, independent of the size of the lesion. The score was positive where a white spot was identified on 'close up' slides.

In vivo study

Eighteen patients treated with fixed appliances over a period of approximately 2 years were selected. A total of 72 teeth (36 control and 36 experimental) were used.

The buccal surfaces of the first molars showed no clinical signs of decalcification at the beginning of treatment. The split mouth technique was used: teeth 16 and 36 as the test, and 26 and 46 as the control. All patients received personal oral hygiene instruction and were advised to use their normal toothpaste. The use of a toothpaste with fluoride is a standard recommendation given to all orthodontic patients. No mouth rinses or any other preventive measures were used. Since control and test teeth are present in the same oral environment, differences caused by various toothpastes were not considered important.

No band failures occurred during the course of the study.

Prior to banding, all teeth were rinsed and dried, and photographic slides were taken of the buccal surfaces of the first molars. Before

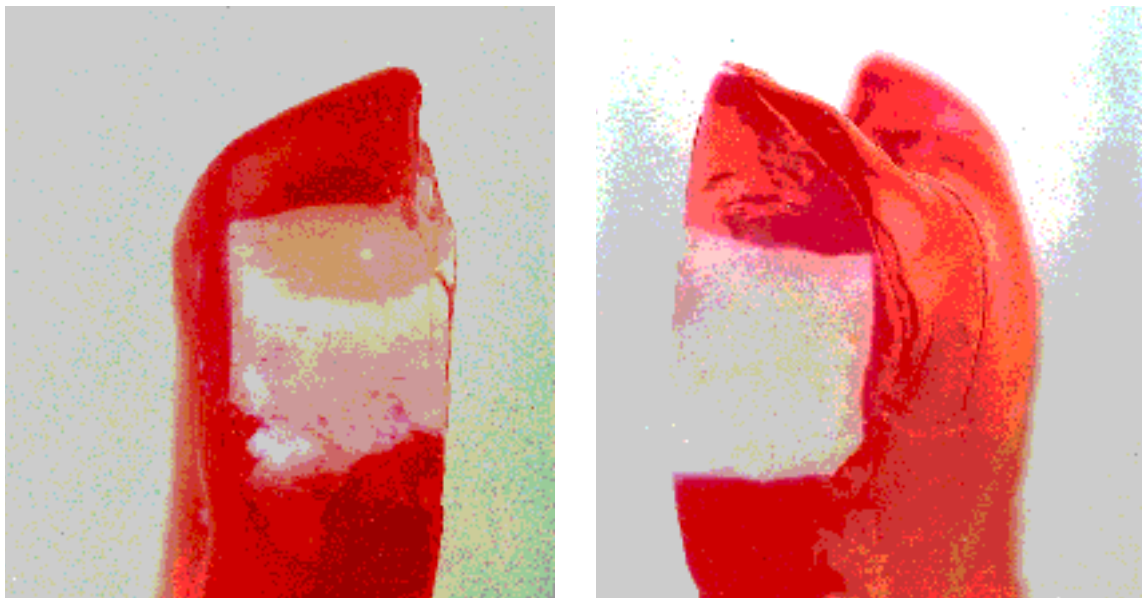

Figure 3 Divided premolar (left) with and (right) without white spot formation.

Table 2 Rating on white spot formation *in vitro* and *in vivo* for four observers.

Observer	*In vitro* experiment		*In vivo* experiment	
	No. of failures	Success rate percentage	No. of failures	Success rate percentage
1	12/106	89	22/159	86
2	12/106	89	27/159	83
3	17/106	84	28/159	82
4	17/106	84	29/159	82
	$\varepsilon = 58/424$	$\bar{x} = 86$	$\varepsilon = 106/636$	$\bar{x} = 83$

placement of the orthodontic bands, Fluor Protector® was applied on the buccal surfaces of 16 and 36 and the bands cemented with Aquacem®. At the end of the orthodontic therapy, the bands were removed by means of a band-remover. After rinsing and drying, photographs were again taken of the buccal surfaces of the first molars. The close-up slides were taken by the same photographer, scored for white spot formation by four observers and evaluated by means of the Chi-square test. Again, only the presence or absence of white spot formation was scored independent of the size of the lesion.

Reliability of the method

Inspection of white spot formation was carried out on slides imaging the buccal surface of the molars. All slides were randomly projected in an attempt to simulate a blind test and scored by four observers, in order to prevent bias. The whole series was scored twice by each observer with an interval of 3 weeks.

In the *in vitro* experiment, four groups were scored twice for white spot formation by four observers with an interval of 2 weeks.

Reliability was defined as the percentage of success in identical rating on white spot formation for each observer (Table 2).

The reliability of this study is not as high as that of Adriaens *et al.* (1990). This may be due to changes in the experimental set up and the difference in severity of white spot formation.

The World Health Organization (1977) have stated that examiners should attempt to achieve at least 80 per cent agreement between the results of duplicate examinations. The test carried out for reliability in this experiment showed an acceptable level.

Results

The results of the *in vitro* study are listed in Table 1.

No teeth in Group 1 (without bands) and 17 in the control group scored positive for white spot formation in the test. A significant difference was found between the control and the test group. In Group 2 (without bands), the score for white spots was two in the test and three in the control group, whereas in Group 3 (loosened bands) the score for white spot formation was five in the test and ten in the control group. In Group 4 (too large bands) the score for white spot formation was 6 in the test group and 11 in the control group.

In none of the last three groups was a statistically significant difference found. In all groups (2, 3, and 4) where Aquacem® was used in combination with or without Fluor Protector®, no significant differences were found. Fluor Protector® in combination with a glass ionomer did not improve caries protection in these cases.

For the *in vivo* experiment, the score for white spot formation was six in the test group and five for the control group out of 36 scored teeth in each group. These patients were evaluated before and at the end of orthodontic treatment which lasted approximately 2 years. Fluor Protector® applied before band cementing with glass

ionomer cement did not significantly reduce white spot formation.

Discussion

In spite of preventive measures, white spot lesions seem to develop underneath orthodontic bands. In the absence of fluoride, demineralization underneath poorly fitting bands is a progressive process. Visible white lesions may develop within 4 weeks (Ögaard *et al.*, 1988). Fast developing white spots are most often defects of the enamel surface, that may remineralize almost completely in the absence of fluoride within a few weeks of the cariogenic challenge being removed.

However, lesions developing during 2 years of orthodontic treatment remineralize extremely slowly (Ögaard and ten Bosch, 1994). Moreover, whilst high concentrations of fluoride will arrest the lesion, complete repair will not take place.

The results of the *in vitro* investigation are listed in Table 1.

In Group 1 (without bands), no tooth scored for white spot formation in the test and 17 in the control group, a finding which was significant. In this group, Fluor Protector® was shown to be effective in protecting enamel. This finding is in agreement with the study of Adriaens *et al.* (1990) who found comparable values.

Comparing the results of control Group 3 (bands loosened after cementation) with the same group in the study of Adriaens *et al.* (1990), where instead of glass ionomer cement, zinc phosphate cement was used for banding, the Chi-square test in this study showed no significant difference in white spot formation between both groups. In the *in vitro* study glass ionomer cement was not found to be more effective in the prevention of white spot formation than zinc phosphate cement. This is in contrast to the study of Copenhaver (1986) who reported a lower prevalence of white spots underneath bands cemented with glass ionomer cement. However, this conclusion is only valid for Group 3, where the bands which were too large were loosened after cementation.

The experimental conditions in Copenhaver's study (1986) are to some extent different from the results of this investigation. In his experiment the bands were not loosened after cementation. Moreover, the demineralization solution was not renewed weekly. The amount of released fluoride remained in place in his experiment, whereas in this study the newly released fluoride was removed every week. A difference in the cariostatic effect might therefore be the result.

This result seems also to be in contradiction with clinical experiments which clearly show the beneficial effect of glass ionomer cement as preventive measure for white spot formation. According to Kvam *et al.* (1983) and Maijer and Smith (1988) zinc phosphate cement leaches more easily than glass ionomer cement in an oral environment, resulting in the formation of gaps.

Direct contact between micro-organisms and enamel is more prone to cause demineralization than a surface sealed with glass ionomer cement. Moreover, a contact time of 1–2 years during orthodontic treatment might be more cariogenic than an experimental time of 36 weeks *in vitro*.

As far as the *in vivo* study is concerned, Fluor Protector® applied before banding with glass ionomer cement did not significantly reduce white spot formation.

Adriaens *et al.* (1990) compared the effect of Fluor Protector® in combination with zinc phosphate cement with a control group where only zinc phosphate cement was used. In the latter group they found white spot formation in 19 out of 52 teeth scored. Comparing these findings with those in this study by means of a Chi-square test, the use of glass ionomer cement shows a significant reduction of white spot formation. This finding is in agreement with a clinical study of Kvam *et al.* (1983) who found a significant difference between zinc phosphate cement and glass ionomer cement. They found only four decalcifications in a total of 28 molars banded with zinc phosphate cement and no white spot formation in the glass ionomer group. This conclusion was made after an observation period of 1 year.

Maijer and Smith (1988) also found less decalcification underneath bands cemented with glass ionomer cement compared with zinc phosphate cement. They indicated, however, that in the zinc phosphate group more than half of the decalcifications were associated with extended treatment periods.

Conclusions

The application of Fluor Protector® reduced white spot formation significantly in Group 1. However, in combination with glass ionomer cement underneath molar bands, Fluor Protector® was not able to improve caries protection either *in vitro* or *in vivo*. Therefore the combined use of Fluor Protector® and Aquacem® underneath molar bands is not recommended in an attempt to prevent white spot formation.

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