The Ability of Zinc Phosphate and Hydro Phosphate Cements to Seal Band Spaces

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An excellent band fitness and a safe sealing of the space between band and tooth are essential to the orthodontists using fixed appliances to prevent carious lesions and to give optimal hygiene conditions.[1,2,3,4] Zinc phosphate cement is the material most widely used for this purpose.

Many workers have studied the chemical and physical qualities of various types of phosphate cements, and also its usefulness in restorative dentistry.[5,6,7,8,9] However, the knowledge about its properties as related to orthodontic practice is limited. The cement liquids are essentially aluminum phosphate phosphoric acid and, in some cases, zinc phosphate.[10] These liquids have a low pH, and the possibility of decalcification of the enamel surface during cementation of orthodontic bands exists. However, in an earlier work the author showed that enamel surfaces which had been covered with zinc phosphate cement for three months were more resistant to decalcification than uncovered surfaces.[11] Initially, this protecting effect was thought to originate from some sort of fluorine-complex in the cement itself but, according to the specification of the manufacturer, there is no fluorine in the cement. Consequently, the protection against decalcification must be caused by chemical changes of the cement while situated in the mouth, probably because of inflow of substances from the mouth fluid.

The purpose of the present study was:

1. To investigate the density of the zinc phosphate cement, i.e., if it is possible for low molecular substances to penetrate the space between band and tooth.
2. If such an entrance exists, at what rate and to what extent does it happen.

MATERIALS AND METHODS

One hundred and twenty premolars, extracted for orthodontic reasons, were used. The study was divided into four groups with thirty premolars in each. Orthodontic bands were fitted to each of the teeth, sixty being cemented with zinc phosphate cement (Svedia Phosphate Phosphatine) and sixty with hydro phosphate cement (Unitek Hydromix). The cementing procedure and the ratio between liquid and powder were kept at the same level for all the teeth within the same group.

In the period between extraction and cementation the teeth were kept in neutral formalin.

When the cement was dry and excess removed, thirty teeth cemented with zinc phosphate cement and thirty cemented with hydro phosphate cement were placed in a 0.5 per cent methylene blue solution.

The teeth were removed from the solution at intervals varying from five minutes to forty-eight hours. One zinc phosphate-cemented and one hydro phosphate-cemented tooth were removed at the same time. They were at once embedded in rapidly polymerizing acrylic and cut longitudinally in buccopalatinal direction. Then they were placed under a microscope and photographed with 40 x enlargement on Kodak Ektachrome film.

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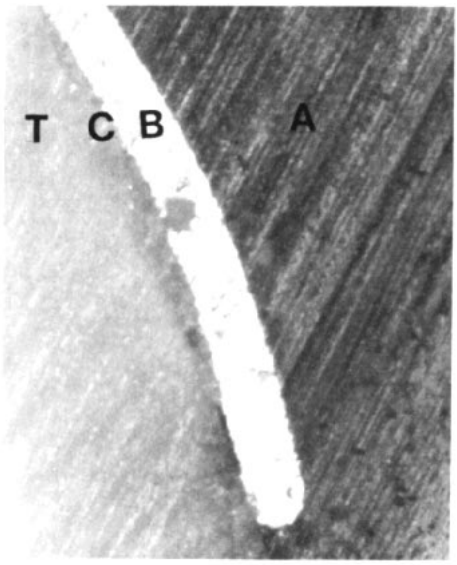

Fig. 1 The gingival part of the cement space after five minutes in a 0.5 per cent methylene blue solution. A = acrylic, B = band, C = cement, T = tooth.

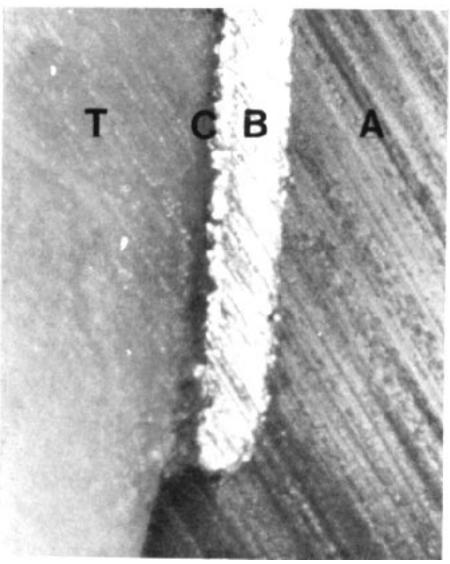

Fig. 2 The gingival part of the cement space after fifteen minutes in a 0.5 per cent methylene blue solution.

The total cement area was calculated and the areas stained with methylene blue were measured in per cent of the total.

The remaining teeth were placed in a P^{32} solution and removed after varying intervals. They were also embedded in acrylic and cut in the same way as the others. Autoradiographs were made by placing them on Kodak Safety films for two hours. The exposed areas indicated the degree of P^{32} uptake.

Results

The photographs taken after the teeth had been for five minutes in the methylene blue solution all showed inflow of colour at the occlusal and gingival margins (Fig. 1). Totally a mean of forty-eight per cent of the area was stained in the zinc phosphate cement group, and fifty-two per cent in the hydro-phosphate cement group. The standard deviation was 2.6 and 2.5, respectively. Thus there was no statistically significant difference between the groups.

After fifteen minutes in the solution most of the cement layer was blue in both groups (Fig. 2), and calculation of the stained area as a percentage proved useless.

After two hours in the solution the whole cement layer was blue. A subjective viewing gave the same result as to colour intensity for both groups. Forty-eight hours in the solution did not seem to give a greater colour intensity than did two hours.

Autoradiographs of teeth which had been for five minutes in the P^{32} solution showed radiation at the gingival and occlusal margins (Fig. 3).

The area of exposure increased steadily and, when the teeth had been for two hours in the solution, there was total exposure along the cement area (Fig. 4).

It was impossible to distinguish be-

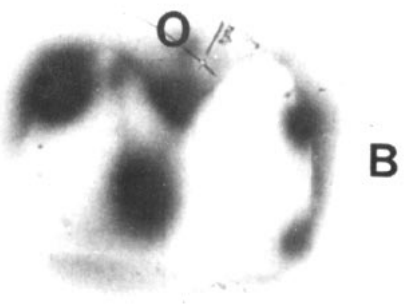

Fig. 3 Autoradiograph of a tooth after five minutes in a P^{32} solution. B = buccal, O = occlusal.

tween autoradiographs originating from zinc phosphate cement and hydro phosphate cement.

Discussion

Zinc phosphate cement is unsuitable for permanent fillings because of its tendency to shrinking, leakage along the margins and washing out from the cavities.[8,9,10]

It was not unexpected, therefore, that similar results were found in relation to orthodontic band cementation. However, the inflow of both methylene blue and P^{32} took place at a much faster rate and to a greater extent than would be expected from clinical experience. One would think that this great inflow of water soluble substances would result in loosening of the bands but, fortunately, this does not happen. There was no assignable difference between zinc phosphate cement and hydro phosphate cement, both seemed to be penetrated immediately by water solutions of low molecular substances.

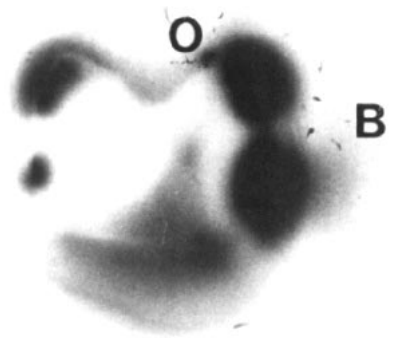

Fig. 4 Autoradiograph of a tooth after two hours in a P^{32} solution.

However, it must be remembered that this study does not show the exact timing of the inflow of the methylene blue solution, as approximately two hours passed from the time the tooth was removed from the solution until the photographs could be taken.

During this period it is possible that colour substances already absorbed by the cement penetrated new areas. It is likely that this source of error is greatest for the teeth first removed from the solution. The same holds true also for the P^{32} solution. Further, the exposed area is not an exact reproduction of the area penetrated by the P^{32} solution. There are different reasons for this. The film emulsion has a certain thickness. The result is blurring of the autoradiographs. Radiation from the deeper layers of the cement will give the same result, even if this source of error is reduced by shielding from band material and enamel.

It is necessary to stress, therefore, that the methods used are unsuitable for a qualitative evaluation of the penetration of methylene blue and P^{32} into the phosphate cement. This, too, has only a limited interest. The clinically important fact is that low molecular substances rapidly penetrate the cement layer.

This information can possibly be used in the clinic by administering fluoride solutions to the patients, as this study shows that substances with molecules comparable to fluorine can penetrate the cement layer.

Norman et al.[12,13] have revealed that fluorine can be released from dental

materials and increase the fluoride content of the enamel. They also found a relationship between the amount of fluoride in the material and the absorption of fluoride by the enamel.

Hallsworth and Weatherell[14] showed that enamel exposed to silicate restoratives had a high fluoride content.

Newman and Cimaconi[15] found that topical application of a solution of acid fluoride phosphate gave higher fluorine content than covering for two to three months with an adhesive containing sodium monofluorophosphate. Thus, there exists some information about the effect of fluorine combined with dental materials, but there is still little information about a possible long-term effect of a covering with phosphate cement, combined with regular topical use of fluoride solutions, as might be possible for patients under orthodontic care.

Conclusions

This study shows that zinc phosphate cement and hydro phosphate cement absorb methylene blue and P^{32} when placed in a water solution. This result sustains the hypothesis that the cement layer can be penetrated by fluorine ions which possibly act as a fluoride depot and increase the enamel resistance to decalcification.

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