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ORTHODONTIC MODELS AND HYPOTHESES

[This section has been included in the journal to expedite communication between those individuals with a well thought out idea for research, and those individuals with the facilities to do research. For example, a busy clinician in private practice may have a good idea but may not have the time or facilities to do the research, but a professional researcher or postgraduate student may be looking for such a subject. The criteria for publication are that the idea has been well thought out and is supported by a literature search. The hypothesis and a suggested research design should be documented in detail. To supply MeSH words (Medical Subject Headings) and disciplinary-specific Key words would be an advantage for cataloguing the suggestions. Scholarly correspondence to improve previous suggestions will be considered for publication.]

CHILLING GLASS IONOMER CEMENTS TO IMPROVE STRENGTH AND ADHESION

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Key words: temperature dependence, ultrasonic scaler

Evidence for hypothesis

Many studies, such as Seeholzer and Dasch (1988) have recommended a cold slab but Mollenhauer (1987) recommended placing the glass ionomer components and mixing slab in the refrigerator prior to mixing to be able to incorporate 50% more powder than the manufacturer's recommendation - to increase the strength. However it is well known that Fuji™ Glass Ionomer cement liquid is an exception. An observation resulting from the practice of chilling Ketac™* is that the cement is not readily removed from the tooth surface after set with ultrasonic scalers with long or short stacks. Fricker is following on from previous research (1987, 1989) with a study on chilling the components and adding 50% more powder during mixing. This supersedes Christensen's study (1987) where 30% more powder was added than the manufacturer's recommendation. Fricker has also noted that the resulting material is far more difficult to remove.

Another observation is that the usual quantity of chilled liquid spreads three times more on a cold slab than with room temperature liquid on a room temperature slab. This raises the question of whether cooling reduces surface tension to aid wetting and adhesion. In fact, the first author has noticed a comparable phenomenon with cooling composites for bonding. Other orthodontists have similarly noticed that some composite resins, which have just been removed from the refrigerator, allow the brackets to drift down the tooth. This also supports the thought that freezing reduces the surface tension in some dental materials which in turn may enhance the wetting ability to aid adhesion.

Statement of hypothesis

Chilling glass iomomer cements, which have a water-based liquid, in the refrigerator, has three favourable consequences, namely, it allows the incorporation of more powder which increases the strength of the set material; it provides a quicker set in the mouth to minimise the time needed for moisture protection; and it increases the adhesion of the material to dental enamel. The clinical disadvantage is that working time is reduced in the oral environment. The procedure does not work with non-water hardening GICs.

Significance

In cementing orthodontic bands, there is a strong clinical impression that less loose bands occur with chilled GIC than non-chilled GICs. Because the adhesion to the enamel is enhanced, the cement-band interface then needs improvement. This can be achieved by welding metallic mesh to the inside of the band material for shimming.

Although removal of the cement following debanding is more difficult with ultrasonic scalers, particularly the newer ones with more frequent but softer oscillations, this increased adhesion could be exploited when the material is used as a fissure sealant. The latter can be combined with orthodontic band luting, simply by leaving some of the cement in the fissures following band seating, and covering it with foil until set. Longer term methods of sealing GIC from the saliva should be even more effective. Another advantage of the resistance to ultrasonic dislodgment is that patients with a rapid build-up of calculus during treatment can be ultrasonically scaled around the bands without the usual fear of loosening the band.

The fact that the chilled material sets more quickly once it is in the oral environment can be exploited in certain situations. For example, in the cementation of a fixed cuspid-to-cuspid retainer, sometimes the retainer has to be held in place until the luting agent has sufficient set and strength. The chilled GIC reduces this time, and presumably reduces the time needed for isolation from the saliva.

Suggested research design

Two parallel studies, one laboratory and one clinical, could be carried out.
Both investigations should use as controls the same brand of GIC used without chilling, and even a further group in a non-air conditioned room. Also in both studies the groups could be compared by a difference of means as well as exploratory data analysis, such as multiple notched boxplots (Velleman and Hoaglin 1981).

Laboratory investigation

There should be at least three aspects to the laboratory study. The first is the obvious increase in strength, already noted by Christensen with one third more powder incorporated. In this study with the chilled GIC, it will be found possible to increase the powder incorporation by 50% over the manufacturer's recommendation.

The other two procedures should investigate the curious observation that the adhesion to dental enamel is increased. To highlight the difference, the largest area possible that a area of GIC that can be cemented to all the specimens of extracted teeth for the study should be used. From clinical observation, it appears that the adhesive strength of the bond is greater than the cohesive strength

*ESPE, Seefeld, West Germany

of the material itself, therefore a shear force should be considered over a tensile force, but the site of the fracture should be noted in each specimen. Mount (1988) has devised a clever system for studying resin bonded to ionomer, but there is apparently a standard method being devised at an international level to determine shear strength values so that different results can be compared.

To simulate the most common clinical procedure there should be no special surface preparation of the enamel surface by 'conditioning' or etching. That is, exceptional procedures such as conditioning the surface of partially erupted canines in the palate may be disregarded.

The final phase of the laboratory study should attempt to determine the mechanism whereby the adhesion is enhanced since it is not intuitively obvious. It has been noted that the material 'runs' more once it has been scooped up from the cold slab and placed in the warmer orthodontic band. Presumably there is some rebound phenomenon, such that the surface tension of the material improves which allow the material to run into the microscopic surface crevices. Therefore, the surface tension could be studied at several time intervals after mixing, commensurate with cementing several bands, but mainly to test the *speculated* theoretical mechanism.

It would also be prudent to explore two other effects of chilling GICs. One is the effect on the film thickness which may also be improved; the other is the effect of the rate of set which determines the time needed for moisture protection - to test the possibility that it may be a improved procedure for crown cementation. The last effect was studied by Walls et al. (1988) using differential thermal analysis from the opposite point of view. That is, they found in one GIC that a 19% *reduction* in the powder:liquid ratio increased the 5% Tmax (exotherm) time by 5·3 minutes.

Clinical investigation

This could utilise two groups for the application of GICs as a fissure sealant into the occlusal grooves of buccal teeth.

The clinical controls could be the contralateral side on the lower arch in alternating sides for each presenting patient. The reason for the lower arch is that this arch tends to have more loose bands, and hence would highlight the differences between the experimental chilled fissure sealants and their controls. Fricker (1987) has shown this to be a valid approach compared to randomising the quadrants.

A timed prophylaxis or air polish should be the only surface preparation. The latter would be the more appropriate for getting into the occlusal grooves.

One group could be studied over a long period to evaluate the longevity of the sealants, whilst the other group could provide a short term study. This could be done by noting the lengh of time it took to remove the material from the buccal grooves by the same ultrasonic scaler. The number in each sample should be determined in consultation with a statistician.

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