Microleakage and penetration depth of three types of materials in fissure sealant: self-etching primer vs etching: an in vitro study

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Clinical preventive procedures must be done after a risk assessment. One of the risk factors is the occlusal morphology of the posterior teeth. These caries-free fissures must be sealed. This first in vitro *experimentation of the study evaluated the microleakage and the penetration depth of three types of materials by Vivadent: Helioseal F®, Tetric®, Tetric Flow®. The teeth were etched with phosphoric acid and bonded using a one bottle bonding in order to determine the best material for the sealing of the fissure. The depth of penetration of fuschine dye as well as that of the tested material was measured with a grid. The results, compared to the depth of the fissures, are expressed in percentage of penetration. The results were as follows: penetration of fuschine dye: 0 % for the 2 composites, 100 % for Helioseal F®; penetration of the materials: 96.90 % for Hélioseal F®, 70.82 for Tetric® and 86.10 for Tetric Flow® (significant difference, Wilcoxon test = 0.0105). In this first* in vitro *study, Tetric Flow® shows no microleakage and is more efficient when compared to Helioseal F® and Tetric® in obturating deep fissures of non carious bicuspids. The second experiment of the study evaluated the microleakage and the penetration depth of Tetric Flow® when it is bonded by two different methods: Group 1: total etch (phosphoric acid) and Scotch-bond 1® (3M), and Group 2: self-etching primer with Prompt® (Espe). There was no significant difference (p > 0.03) between classical bonding vs self-etching primer. The self-etching primer Prompt® is very efficient vs phosphoric acid in obturating the fissures of non carious bicuspids with Tetric Flow®. It is concluded that for prevention by sealing, using a flowable ceromer (Tetric Flow®) with the self-etching (Prompt®), is a really good technique.*

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INTRODUCTION

Fifty percent of the first permanent molars are decayed by the age of 12[1] because of the lack of information for protecting them and occlusal morphology. The best way to protect the occlusal surfaces from the carious process is to seal them. It is an old preoccupation of the profession,[2] but the new materials allow new practices to prepare the grooves even if the preventive aim is the same.[3,4]

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When and how to seal fissures today?

There are three main parameters when making a preventive treatment:[5-8] (1) risk assessment, (2) management, and (3) relevance of the intervention. The "bonding" of these three clinical parameters leads to the treatment of the patient, which includes the history, future assessment and a preventive approach to the dentistry.

Several factors are to be considered in order to determine the relevance of the preventive therapeutic, namely: the child, the ecology, morphology of posterior teeth and the moment of intervention.

Under the heading of the child, the following factors would include: age, medical status, cooperation, availability, closeness to orthodontic treatment.

The ecology of the carious process in order to assess the carious risk, includes: (1) dmf and DMF (history of the carious illness), (2) Plaque index, amount of cariogenic bacteria: inside the oral cavity, enamel presents permanent exchanges with salivary mineral ions, due to pH variations. Acid production by the microorganisms during their degradation of dietary fermentable carbohydrates induces enamel demineralisation, especially in those areas where bacteria are accumulated: pits and fissures.[9] (3) Saliva: pH, buffer capacity, flow, (4)

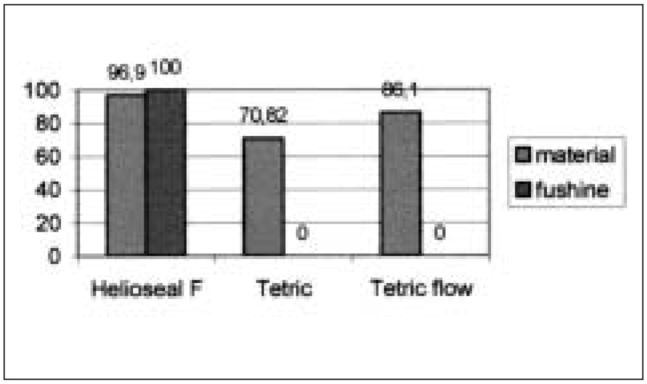

Figure 1. For each material (Helioseal F®, Tetric® and Tetric flow®), penetration of the material and of the fuschine inside the fissure (expressed in % of the total fissure depth on average).

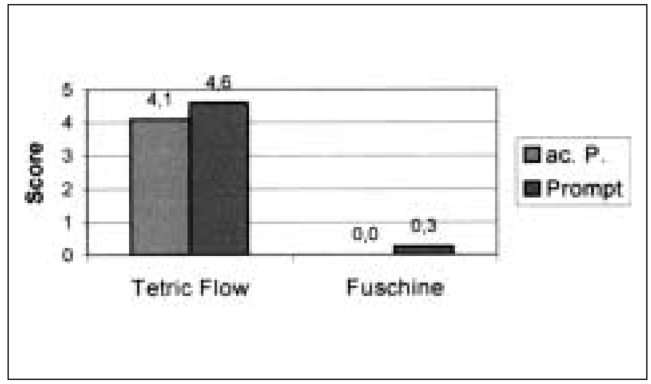

Figure 2. Penetration of Tetric flow® and fuschine depending the way of bonding (phosphoric acid or Prompt®, expressed in score of penetration on average).

Amount and frequency of sugar intakes, (5) Fluoride supplementation : topic and/or systemic

The basic factors to evaluate in the morphology of the posterior teeth include: (1) Variability of morphology over the entire fissure, (2) Preparation (bur, air-abrasion): improving the filling therefore the material adhesion.

The factors included in the moment of the intervention are: (1) Within the treatment planning, (2) By the eruption sequence.

The well-established benefits[10-15] of the pits and fissures sealants technique and the development of new dental materials have allowed a more conservative approach to the teeth. Therefore it is possible to prevent the treatment of Class 1 carious lesions or minimize it.[16] The results of this preventive technique proved the effectiveness of this process.[17] The results were even better[18] with the latest dental materials, which includes a ceromer, (ceramic optimised polymer).[19]

The objectives of this research were: (1) test the ceromer, to determine if this material could be recommended for the sealing therapy, and (2) if this material is acceptable, is it possible to apply it more efficiently.

MATERIALS AND METHODS

We have evaluated *in vitro* the microleakage and the penetration depth of three types of materials: a sealant (Hélioseal F® by Vivadent) (HS), an hybrid composite (Tétric® by Vivadent) (T), a flowing ceromer (Tétric Flow® by Vivadent)(TF). Twenty-four bicuspids fissures considered as non-carious were prepared according to the actual instructions: they were with a spray of sodium bicarbonate for sealant, and with a specific bur (Komet n° 8392.314.016) for the composite and the ceromer. The bonding of these materials was made following the instructions of the manufacturer. For TF, the bonding was made by two ways. Group 1: total etch (phosphoric acid) and fifth generation adhesive (Syntac®sc by Vivadent)(as for T). Group 2: self-etching primer **(**Prompt® by Espe). Then, fissures were sealed with the three materials. After a period of a week in a 2% solution of fuschine at 37°C, the 24 teeth in resin were sectioned in a bucco-lingual direction using an Isomet cutter. The sections allowed 106 microscopic observations at a 2.5 magnification. The microleakage and the penetration depth of the three materials were evaluated on longitudinal section teeth.

The depth of penetration of fuschine dye as well as that of the three materials was measured with a grid and the results, compared to the depth of the fissures, were expressed in percentage of penetration (no penetration = 0%, penetration = 100%). For the two TF groups, the results were expressed in score of penetration (no penetration = 0, total penetration = 5 : best result is 0 for fuschine dye and 5 for the composite).

Statistical analysis was done (Wilcoxon test, risk $\alpha = 3\%$).

RESULTS

The simple observation revealed various morphologies on the same fissure and showed fissures, which seemed healthy, but which are infiltrated in 70% of the cases.

About the hermeticity of HS, T, TF : Penetration of fuschine dye (on average): 0% for the composite and the ceromer, 100% for the sealant (Figure 1).

Penetration of the materials (on average): 96.9% for HS; 70.8% for T and 86.1% for TF. (significant difference, $p < 0.03$) (Figure 1).

The illustrations showed the total hermeticity for T and TF and the lack of hermeticity and homogeneity for HS (Photographs 1-2).

For the bonding of TF: we observed (on average): Fuschine: group 1 = 0 and group 2 = 0.3. There was no significant difference ($p > 0.03$). TF: Group 1 = 4.1 and group 2 = 4.6. There was a significant difference (group 1 < group 2, $p < 0.03$) (Figure 2).

The illustrations showed the good hermeticity of TF whatever the procedure of bonding selected. It also showed the better penetration of the ceromer when bonded with the self-etching primer. (Photographs 3-4).

Photograph 1. Tetric(bonded by total etch and fifth generation adhesive: good penetration inside the fissure and total hermeticity.

Photograph 2. Helioseal F(in fissure: very good penetration but lack hermeticity and homogeneity.

Photograph 3. Tetric flow® bonded by total etch and fifth generation adhesive: good penetration inside the fissure and total hermeticity.

Photograph 4. Tetric flow® bonded by self etching primer: better penetration inside the fissure (to compare with picture 3) and total hermeticity.

DISCUSSION

The therapeutic objective in protecting fissures is to use the most adaptable (to the fissures) sealant in the clinical situation. This is analysed according to the criteria previously presented. Sealing is performed not only in terms of the carious risk of the child, but also according to the depth of the localised infringement of the tissues concerned (enamel and/or dentin) when fissures are infiltrated.

Therefore for a:

- low carious risk without infiltration of the fissures, the sealant should be performed with the TF without preparation.
- moderate carious risk with the suspicion of caries or with an enamel carious lesion, the fissure is opened (bur 8392) and filled with TF.
- high carious risk with infringement localised in the enamel-dentinal area, the fissure is opened (bur 8392) and filled with T.

The use of HS corresponds to a very particular clinical situation, i.e. high carious risk requiring immediate protection of the fissure associated with the impossibility of isolating the tooth to perform satisfactory bonding.

Sealing performed with HS can only be temporary and as soon as the clinical evolution of the tooth is complete, it is again necessary to perform sealing according to our data. Therefore, in every clinical situation, it is possible to use a suitable material and an adequate operating technique to protect the fissure. Moreover, the advent of self-etching primers has presented considerable progress.

Like Hannig, we believe that "self-etching primers can provide an effective alternative to conventional phosphoric acid etchants in conditioning the enamel surface to secure a durable bonding and marginal seal of composite resin restorations".[20]

CONCLUSION

In this *in vitro* study, the flowable ceromer Tetric Flow® showed no microleakage and was more efficient when compared to Helioseal F® and Tetric® in obtruding deep fissures of healthy bicuspids.

The self-etching primer Prompt® was as efficient versus phosphoric acid in obtruding the fissures of non-carious bicuspids with the flowing ceromer Tetric Flow®.

This flowable material was recommended for preventive therapy. However, the classical bonding technique, which used phosphoric acid (total etch) and a one bottle bonding was a bit time consuming. It was very interesting to use a self-etching primer.

It was concluded that for preventive therapy by sealing, using a flowing ceromer (Tetric Flow®) with the self-etching (Prompt®), is a very good technique.

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