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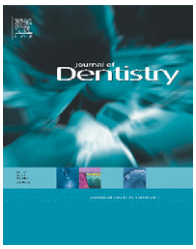

Inhibition of enamel mineral loss by fissure sealant: An *in situ* study

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ABSTRACT

Objectives: This study evaluated the effect of fluoride and non-fluoride sealants on hardness decrease (HD) and marginal adaptation (MA) on enamel substrates after cariogenic challenge.

Methods: Occlusal enamel blocks, from human third molars, were randomly divided into six groups ($n = 12$), according to occlusal fissures condition (S – sound; C – caries-like lesion; CF – caries-like lesion + topical fluoride) and sealants (F – FluroShield; H – Helioseal Clear Chroma). Lesion depths were 79.3 ± 33.9 and 61.3 ± 23.9 for C and CF groups, respectively. Sealants were placed on occlusal surface and stored at 100% humidity (37 °C; 24 h/d). HD was measured by cross-sectional microhardness analysis at the sealant margin distances: −1 (under sealant), 0 (sealant margin), 1, 2 (outer sealant). Sealant MA was observed by polarized light microscopy and scored according to: 0 – failure (no sealant MA or total sealant loss); 1 – success (sealant MA present). MA and HD were analysed by ANOVA-R and mixed model analysis, respectively.

Results: For HD (ΔS), F values (6900.5 ± 3686.6) were significantly lower than H values (8534.6 ± 5375.3) regardless of enamel substrates and sealant margin distances. Significant differences were observed among sealant margin distances: −1 (5934.0 ± 3282.6) < 0 (8701.5 ± 6175.7) = 1 (8473.2 ± 4299.4) = 2 (7761.5 ± 4035.1), regardless of sealant and substrate. MA was similar for all groups ($p \geq 0.05$).

Conclusion: MA was not affected by sealant type or substrate condition, whereas enamel HD was favourably impacted by fluoride in the sealant. In addition, sealants were more effective as a physical barrier than as its chemical potency in reducing enamel HD.

Clinical significance: Sealing with a fluoride material is a recommended procedure to prevent caries of occlusal permanent molars in high-caries-risk patients, even though those exhibiting white spot lesions, since the enamel hardness decrease when fluoride sealant was used *in vitro*.

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1. Introduction

Even though the prevalence of dental caries has declined remarkably in most industrialized countries over recent decades, population subgroups continue to experience a high incidence of dental caries.[1,2] In primary and permanent teeth, the fissure region in the occlusal surfaces of molars is the most susceptible caries site.[1,3] Biofilm stagnation is promoted there because the morphology (shape, depth, and narrowness of fissures) prevents self-cleaning by food, tongue, cheeks and lip and makes cleaning by other measures difficult.[4]

Common non-drilling strategies to prevent caries progression include the application of fluoride as well as education in oral hygiene and proper diet. However, these approaches have limitations in non-compliant individuals.[5] Therefore, the prudent use of non-invasive fissure sealants is currently one of the most effective ways to protect against caries development on the occlusal surfaces of high-caries-risk children and adolescents.[6,7] This population frequently presents white spot lesions, however, while the diagnosis of initial caries in occlusal fissures is extremely difficult, the decision as to whether the fissure is sound or not must be made before the application of sealants.

Traditionally, the tooth surface with questionable active caries has been contraindicated for sealant treatment since a sealed demineralized area will no longer remineralize.[8] Thus, it has been accepted that it may be necessary to remineralize the caries lesion before applying the sealant. Since the early non-invasive intervention has the benefit of being suitable for all patients, a current approach suggests that operative intervention should not be a management option for the non-cavitated lesion. Thus, within the context of the minimal intervention approach, infiltrating regimens should be considered for treatment of demineralized enamel areas in non-compliant individuals. Once the material is cured, a mechanical support of the fragile enamel framework in the lesion is achieved, promoting obturation of porous and arrest of lesion progression.[9] Because the extent of demineralization cannot be estimated clinically, another contemporary protocol for the treatment of white spot lesions recommends the use of sealants, not only as a preventive treatment for sound fissures, but also to arrest caries progression by sealing over active caries lesions.[6,7] Although the proposing of infiltrants regimen is to occlude the tiny pores within the lesion body with low viscous light curing resins, white spot lesions remineralization before sealing applying is an approach to heal that area. However, whether early pit and fissure carious lesions can be sealed effectively to the levels of sound or remineralized fissures has not been sufficiently investigated. Even so, the use of fluoride-containing resin sealants on white spot lesions may be a viable approach to arrest hardness decrease in all high-caries-risk children and in adolescent patients even those who are non-compliant. Fissure sealants that provide fluoride will be important not only as passively (*via* physical barrier between the tooth and the oral environment), but also as active cariostatic agents, possibly providing increased caries inhibition (since the fluoride inhibits demineralization and favours the remineralization processes).[10,11]

The key consideration for sealant procedural success is adequate adhesion, while an important parameter for clinical success is the materials' marginal adaptation. Absence of marginal adaptation may imply that there is no occlusal surface isolation from oral microorganisms and, consequently, an increased risk for the development of dental caries.[12] Also, the presence of a marginal gap can lead to marginal staining, which can be considered the first sign of resin-based material failure.[13] Furthermore, the lack of marginal adaptation might generate interfacial stresses that potentially cause de-bonding of the sealant from the tooth.[14]

Sealant performance can be influenced by the high cariogenic challenges present in the oral environment. One of the methods that simulate this situation is the *in situ* study, which assesses the capability of dental materials to enhance remineralization and/or inhibit demineralization of tooth enamel in a controlled cariogenic environment.[15] Also, considering the structure of the different enamel conditions, such as caries-like lesions or remineralized caries-like lesions, no study has hitherto focused on sealant application on different occlusal enamel substrates in an attempt to prevent the progression of the initial lesion, particularly in high-caries-risk children.

Therefore, the aim of this *in situ* study was to evaluate the effect of fluoride and non-fluoride containing sealants on enamel hardness decrease under different enamel conditions (sound, caries-like lesions and caries-like lesions + topical fluoride application) all under different distances from the sealant margin. The first null hypothesis was that there are no statistically significant differences in the enamel hardness decrease with fluoride and non-fluoride containing sealants under those enamel conditions. The second null hypothesis was that there are no significant differences in marginal adaptation using different sealants on enamel substrates.

2. Materials and methods

This study was conducted after approval from the Ethics Committee of Piracicaba Dental School, State University of Campinas (protocol #046/2006).

2.1. *Experimental design*

Twelve healthy volunteers (22–31 years old) took part in the study after signing their informed consent form. The study involved a factorial 2 × 2 design of caries induction by biofilm accumulation and sucrose use. The three factors under evaluation were: (1) enamel substrates (S = sound; C = caries-like lesion; CF = caries-like lesion + topical fluoride application), (2) sealant materials' performance (F = FluroShield or H = Helioseal Clear Chroma) and (3) the distances from the sealant margin. During two phases of 14 days each, the volunteers wore acrylic palatal devices containing six dental occlusal enamel blocks each, to which 20% sucrose solution was applied extra-orally 8×/day (Fig. 1D and E). New enamel blocks were placed for the second 14 days phase. All volunteers and blocks sites were held constant for the two phases. The blocks were placed as close as possible to the