Effect of topical fluorides on fissure sealants

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Summary

The purpose of this in vitro study was to compare of a 1, 4 and 8 min. immersions in acidulated phosphated fluoride gel (1.23% APF gel, Sultan Topex), a Fluoride Varnish (Fluor Protector® 1% difluorsilane, 0.1% fluoride) and water on surface topography of two different fissure sealants (Helioseal®Clear, Helioseal®F). 28 samples were prepared into seven groups. The surface topography of two scanning electron micrographs of each specimen was scored visually by two investigators. Inter rater reliability was r = 0.74 (intraclass correlation coefficient) for scoring all micrographs. No significant difference in intra-investigator scores was found. No significant differences in the mean visual scores were found among the 1-min treatment groups (APF gel and Fluoride Varnish). Significantly higher mean visual scores were found for all the specimens immersed for 8-min in APF gel (p=0.000). Significantly higher mean visual scores were found for Helioseal®F immersed for 8-min in APF gel (p=0.02).

Introduction

Sealants are covered pits and fissures on the occlusal surfaces of the posterior teeth at risk of developing caries. Children can also receive professional topical fluoride applications as frequently as every 6 months to control dental caries. Application of a fluoride solution to the tooth surface is known to be effective for the prevention of dental caries and is important in the dental treatment of children and adults APF solution which is used frequently for the prevention of dental caries, includes acid for the etching of the enamel and the consequent enhancement of fluoride uptake [1]. Fluoride containing varnishes were developed during the late 1960s and early 1970s in an effort to improve shortcomings of existing topical fluoride vehicles, such as fluoride gels or mouthrinses by prolonging contact of the fluoride with tooth enamel [2].

The possible adverse effects of topical fluoride treatments on fissure sealants have been the subject of many studies during the last decade. Considerable work has been conducted on the effect of professionally applied acidulated phosphate fluoride gel (APF gel) and fluoride varnish on sealants, which repealed. *In vitro* studies show that dental materials such as composite resin, sealants and glass ionomer materials are suscepti-

ble to surface change when treated with some topically applied fluorides [3, 4]. If significant deterioration of surface structure occurs this could cause loss of marginal integrity of restoration, requiring replacement of the sealants.

However there is limited information on the effect of APF gel and Fluoride Varnish on fissure sealants. The purpose of this *in vitro* study was to compare of a 1, 4 and 8 min immersions in a 1.23% acidulated phosphated fluoride gel (APF gel, **Sultan Topex,** Sultan Dental Products, USA), a **Fluoride Varnish** (Fluor Protector, Vivadent Ets. Schaan, Liechtenstein) on surface topography of two different fissure sealants (**Helioseal® Clear, Helioseal®F,** Vivadent Ets. Schaan, Liechtenstein).

Materials and methods

The fissure sealants used in this study were Helioseal®Clear, Helioseal®F (Vivadent Ets. Schaan, Liechtenstein) and the topical fluorides were acidulated phosphated fluoride gel (1.23% APF gel, Sultan Topex, Sultan Dental Products, USA), a fluoride varnish (Fluor Protector®, 1% difluorsilane, 0.1% fluoride, Vivadent, Schaan, Liechtenstein). Helioseal®F consists the monomer matrix consists of Bis-GMA, urethane

dimethacrylate and triethylene glycol dimethacrylate. The filler are highly dispersed silicon dioxide and fluorosilicate glass (Filler particle size wt. 40.5%). Helioseal®Clear consists of Bis-GMA, urethane dimethacrylate and triethylene glycol dimethacrylate. Sealants cylinders (12.56 mm in diameter) were prepared. The hardened samples were stored in distilled water at 37°C for 24 hours before polishing and topical fluoride treatment. 28 samples of two fissure sealants were prepared into seven groups of four specimens (two photographed) each. The specimens were immersed individually in approximately 10 ml of 1.23% APF gel and fluoride varnish for 1 min, rinsed with distiled water and reimmersed for three more 1 min immersions (a total of 4 min) and seven more 1 min immersions (a total of 8 min). Following treatment, all specimens were stored dry until they were examined by SEM (Philips XL-20). The raters and the electron microscopist were blinded as to the treatment groups. All specimens were sputter coated with palladium and gold and examined using the scanning electron microscope. Each specimen surface was observed and photographed twice, once in the center and once approximately 1-2 mm from the edge of the specimen at 250x magnification.

Each micrograph (two micrographs per specimen) was randomly coded and evaluated visually by two raters for surface defects. Rater scored the topography on each micrograph using the following criteria and two separate days by each rater to determine intrarater reliability. A micrograph of a nontreated specimen was selected as a reference for a score of 1 and a picture of a specimen showing extensive surface defects was selected as a reference for a score of 4.

Scores (Kula K., Kula J T. [5]):

1 - Surface similar to nontreated specimen (small defects found throughout the surface);

2 - Surface shows either more or larger defects than nontreated specimen but not as much as 3;

3 - Surface shows somewhat fewer or smaller defects than 4 but more or larger than 2;

4 - Surface shows large defects covering extensive surface.

Statistical Analysis

The intraclass correlation coefficient was used to determine inter rater reliability.

Paired t tests were used to determine intrarater reliability.

Data from visual scoring were analyzed for significant differences using One Way ANOVA.

Results

There was no significant differences between the first and second scoring of either rater.

Inter rater reliability was **r = 0.74** (intraclass correlation coefficient) for scoring all micrographs.

The surface topography of two scanning electron micrographs of each specimen was scored visually by two investigators.

There was no significant difference between Fissure Sealants treated for 1 min and 4 min, immersed in APF or FP *(Table 1-2).*

Table 1. Mean Visual Scores (Mean ± SD) of Fissure Sealants Surfaces immersed for 1 min in APF gel and Fluoride Varnish

| Fissure Sealants	Water Mean ± SD	APF gel Mean ± SD	Fluor Varnish Mean ± SD
Helioseal®Clear	1.38 ± 0.49	1.21 ± 0.41	1.30 ± 0.43
Helioseal®F	1.50 ± 0.51	1.58 ± 0.41	1.49 ± 0.44

Table 2. Mean Visual Scores (Mean ± SD) of Fissure Sealants Surfaces immersed for 4 min in APF gel and Fluoride Varnish

Fissure Sealants	Water Mean ± SD	APF gel Mean ± SD	Fluor Varnish Mean ± SD
Helioseal®Clear	1.38 ± 0.49	1.69 ± 0.95	1.31 ± 0.47
Helioseal®F	1.50 ± 0.51	1.87 ± 0.61	1.31 ± 0.47

Figure 1a shows the SEM of Helioseal® Clear surfaces in distilled water. The surface smooth and intact and the matrix was undisturbed. Helioseal® Clear was treated for 1 min with APF gel showed minimal evidence of change *(Figure 1b).* Porosity was limited and randomly distributed. There was no significant difference between the mean visual scores of specimens for 4 min immersed in APF gel or in water *(Figure 1c).*

Significantly higher mean visual scores were found for Helioseal®Clear immersed for 8- min in 1.23% APF gel (p = 0.000) *(Table 3, Figure 1d).*

Table 3. Mean Visual Scores (Mean ± SD) of Fissure Sealants Surfaces immersed for 8 min in APF gel and Fluoride Varnish

Fissure Sealants	Water Mean ± SD	APF gel Mean ± SD	Fluor Varnish Mean ± SD
Helioseal®Clear	1.38 ± 0.49	2.66 ± 0.75*	2.00 ± 1.02**
Helioseal®F	1.50 ± 0.51	2.67 ± 0.51*	1.67 ± 0.51

*(P = 0.000)
**(P = 0.02)

Figure 1a. Micrograph of Helioseal®Clear surfaces in distilled water
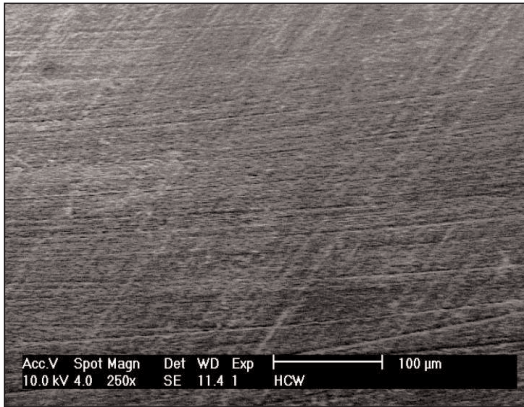
Figure 1b. Micrograph of Helioseal®Clear surfaces treated in the APF gel for 1 min
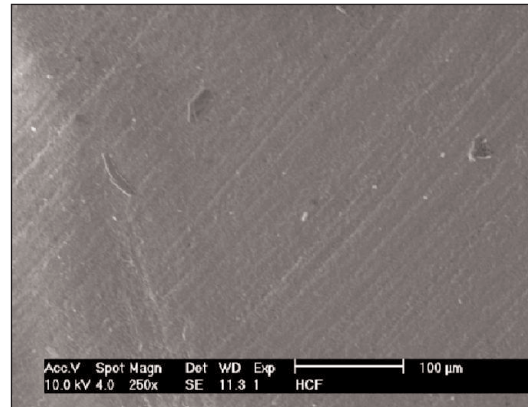
Figure 1c. Micrograph of Helioseal®Clear surfaces treated in the APF gel for 4 min
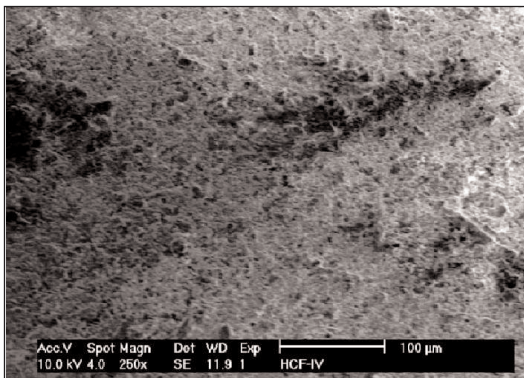
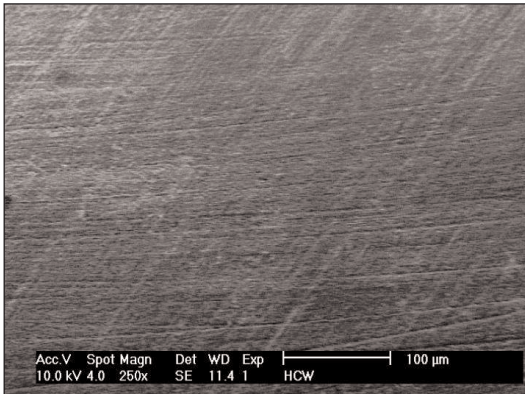Figure 1d. Micrograph of Helioseal®Clear surfaces treated in the APF gel for 8 min
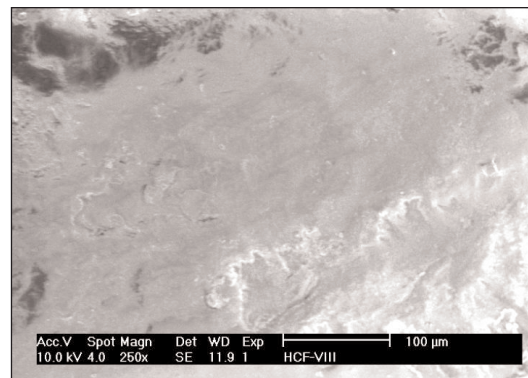
Figure 2a shows the SEM of Helioseal®Clear surfaces in distilled water. Helioseal®Clear treated in Fluoride Varnish for 1 min immersins showed no significant differences *(Figure 2b).* There were no significant di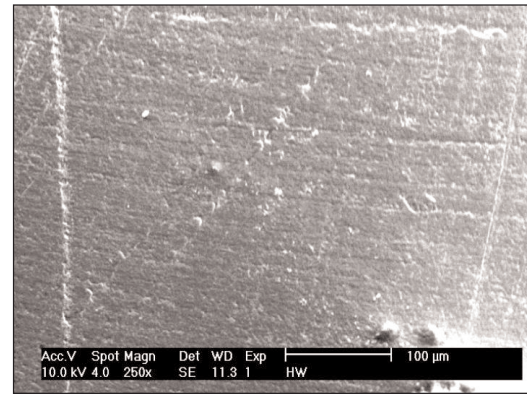fference between the mean visual scores of specimens for 4 min immersed in Fluoride Varnish or in water *(Figure 2c).* Significantly higher mean visual scores were found for Helioseal®Clear immersed for 8 min in Fluoride Varnish (p = 0.02) *(Table 3, Figure 2d).*

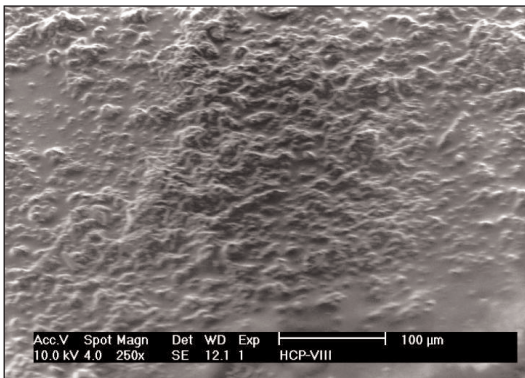**Figure 2a. Micrograph of Helioseal®Clear surface indistiled water**

Figure 2b. Micrograph of Helioseal®Clear surface treated in the Fluoride Varnish for 1 min

Figure 2c. Micrograph of Helioseal®Clear surface treated in the Fluoride Varnish for 4 min

Figure 2d. Micrograph of Helioseal®Clear surface treated in the Fluoride Varnish for 8 min
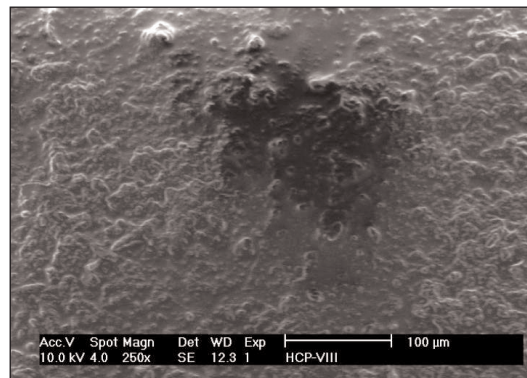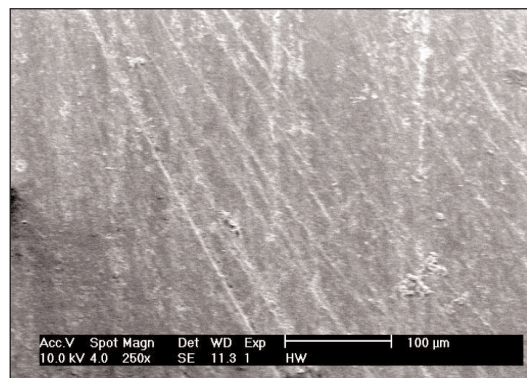

Figure 3a shows the SEM of Helioseal®F surfaces in distilled water. Similar morphological characteristics to 1 min immersed APF gel and water are evident *(Figure 3b)*. There was no significant difference between the mean visual scores of specimens for 4 min immersed in APF gel or in water *(Figure 3c)*. Helioseal®F matrix degradation with APF was signicant *(Figure 3d)*. Voids are seen on all micrographs as a result of matrix dissolution. Generalized dissolution of the reinforcing particles, increased interparticle spacing and a high frequency of craters and fissures. The surface showed more dehydration cracks.
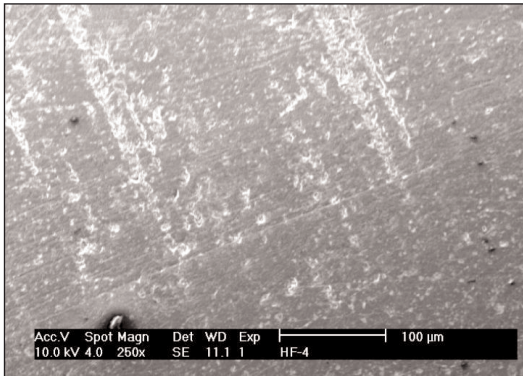
Figure 3a. Micrograph of Helioseal®F surface in distilled water
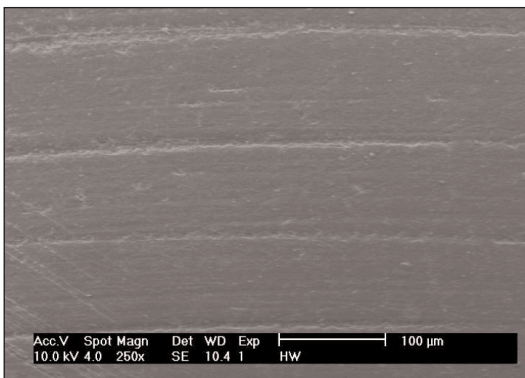
Figure 3b. Micrograph of Helioseal®F surface treated in the APFgel for 1 min

Figure 3c. Micrograph of Helioseal®F surface treated in the APF gel for 4 min

Figure 3d. Micrograph of Helioseal® F surface treated in the APFgel for 8 min
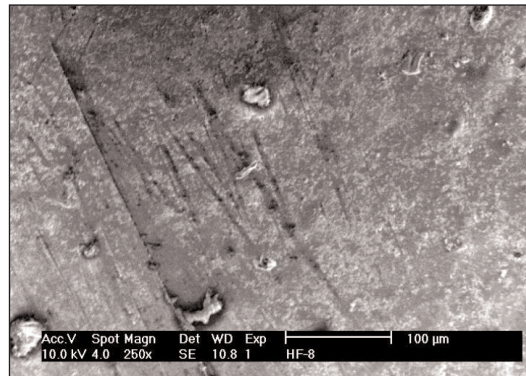

Figure 4a shows the SEM of Helioseal®F surfaces in distilled water. There was no significant difference between the mean visual scores of specimens for 1 or 4 min immersed in FP or in water *(Figure 4b).* Minor dehyration cracks were seen *(Figure 4c).* Generalized matrix swelling was observed for 8 min immerssion. The matrix was disticly altered and appared swollen with numerous voids and cracks. Generalized matrix changes that resulted in a swollen or expanded matrix appearance were detected. Significantly higher mean visual scores were found for Helioseal®F immersed for 8 min in 1.23% APF gel (p = 0.000) *(Table 3, Figure 4d).*
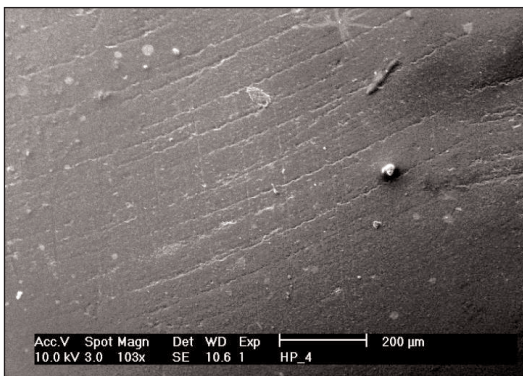
Figure 4a. Micrograph of Helioseal®F surface in distilled water
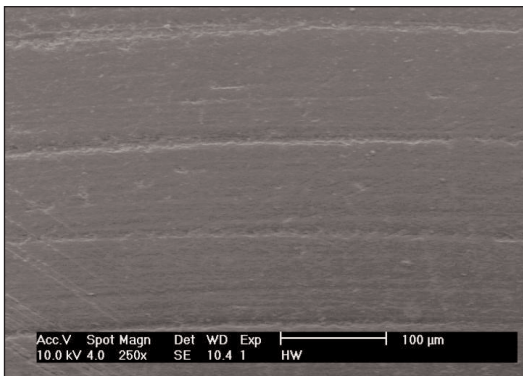
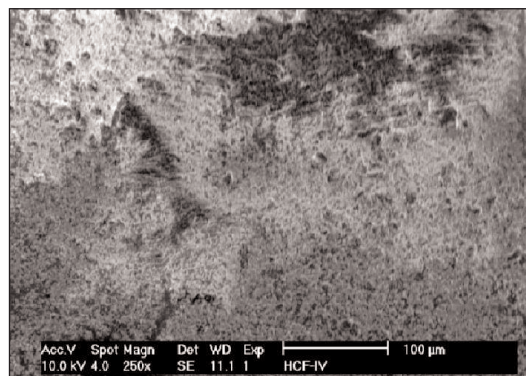**Figure 4b. Micrograph of Helioseal®F surface treated in the Fluoride Varnish for 1 min**
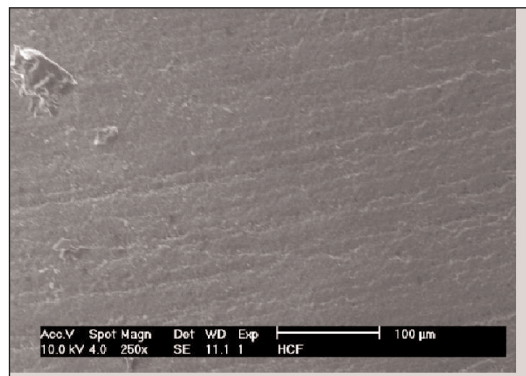
Figure 4c. Micrograph of Helioseal®F surface treated in the Fluoride Varnish for 4 min

Figure 4d. Micrograph of Helioseal®F surface treated in the Fluoride Varnish for 8 min

Discussion

Our study shows that a 1 and 4 min treatment with either a APF or Fluoride Varnish does not result in significant visual changes. Increases in visual scores of sealants are detected due to increased exposure to Fluoride products. Increases in visual scores of sealants with increased exposure to Fluoride products. El-Badrawy WA et al. found that the APF and the non-proprietary gel had a significant effect on both Glass ionomer matrix and particles and on the composite particles. The neutral sodium fluoride had no significant effect on the materials [6]. Both the resin-modified glass-ionomer cements and the polyacid-modified resin composites showed erratic behaviors concerning their micromorphology when subjected to fluoride gel application [7].

APF gel had the most deleterious effect on all of the glass ionomer cements. It was concluded that Glass ionomer cements do not provide significantly improved resistance to APF gel although their matrix is generally resistant to erosion [8]. Although showing greater resistance to the APF gel than conventional glass-ionomer cements, resin-modified glass-ionomer materials revealed characteristic immersion and erosion behavior, substantiating their differentiation from a hybrid material containing a preponderance of resin [9]. The presence of acids such as hydrofluoric acid and phosphoric acid in the APF agents may cause surface changes of the dental materials [3-5]. Hydrofluoric acid also added to increase the fluoride concentration in topical APF agents [10]. After APF gel application, mean surface roughness (Ra) measurements and SEMs showed that roughness increased significantly, generally from the resin composite and compomers to the conventional glass ionomer cements (p < 0.05) [1]. The lower specific gravity of the APF foam compared with the gel thus this foam contains less hydrogen ion and fluoride ion than gel. Confirming this statement, the fluoride ion concentration required for enamel uptake or caries reduction may be lower for a foam.

Kula et al. [11] demonstrated that composite resins treated for 4 min immersions in 1.23% APF gel or foam had significantly greater mean visual scores than did specimens treated in 2.0%

NaF gel. Neuman E. & Garcia-Godoy F. [10, 12] show that APF treatment increases the surface roughness of the GIC, which could become an area to harbor the colonization of *Streptococcus mutans*. And such colonization could potentially increase the risk of peridontal disease and secondary caries. Significantly higher mean visual scores were found for the specimens immersed for 8 min in APF gel and Fluoride Varnish compared with specimens immersed in water. Fissure Sealants surface loss increases with increased exposure to Fluoride agents. The varnish remains on the tooth surface for several hours even after *in vitro* demineralization challenge and sonication [13, 14]. Surface degradation of glass ionomer cements appears to be related the size and type of filler particles and voids present.

Papagiannoulis L et al. [4] showed the microfilled composite was the least affected material regardless of the fluoride agent used. The APF agent attacked inorganic fillers in the composite materials. Microfilled material surfaces were insensitive to the agent in comparison with macroinorganic filled material surfaces. Kula et al [15] showed the degree of visual change and degradation of filler particles appeared to be related to their composition and size. Unfilled sealants exhibited no surface changes visually or on micrographs following any treatment. Filled sealants and the glass-ionomer sealant exhibited visually apparent changes depending on the treatment. SEM inspection of filled sealants with visually apparent changes showed loss of filler particles whereas the glass-ionomer sealant exhibited apparent destruction both of the matrix and the filler particle.

However, significant loss of weight was found with filled sealant specimens, but not unfilled sealant specimens, treated with 1.23% APF gel as compared with the specimens treated with water. The results of this *in vitro* study indicate that preventive therapies that combine use of topical fluorides and sealants may cause deterioration of filled sealants and glass-ionomer sealant material, but not unfilled sealants [16]. Macroorganic fillers in composite materials were strongly attacked by the APF solution [17]. The surfaces of the specimens immersed APF gel show more particle loss than the specimens immersed in Fluoride Varnish. Generalized

matrix swelling was observed after immersed Fluoride Varnish. The matrix was distinctly altered and appared swollen with numerous voids and cracks. The surfaces of the specimens immersed Fluoride Varnish show less particle loss than the specimens immersed in APF gel. Following treatment with APF gel, a honeycomb appearance of a flat matrix was evident. Small particles totally eroded. Matrix dissolution: a halo appearance surrounding the glass particle. Effect of resin contraction, air entrapment, or reaction to the APF gel. However, in vivo studies are needed to determine the effects of APF gel and Fluoride Varnishes on restorative materials.

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