ORIGINAL RESEARCH

Comparative Evaluation of Fluoride Release from Glass Ionomer, Compomer, and Giomer Sealants Following Exposure to Fluoride Toothpaste and Fluoride Varnish: An *In Vitro* Study

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Abstract

Introduction: Applying sealants to the deep pit and fissure area will be an excellent way to stop and slow down tooth caries from developing. Dental sealants that include fluoride are more successful at lowering dental cavities. It is anticipated that exposure to fluoride from dental sealants of various origins may enhance the fluoride release from dental sealants. Therefore, this study's objective was to investigate the amount of fluoride released after using fluoride toothpaste and fluoride varnish from different sealants.

Materials and methods: Using only a fluoride ion selective electrode, the initial release of fluoride was detected every 24 hours for 15 days. After every measurement, the saliva was refreshed. The samples were split into three identical subgroups and given the respective regimes on the 15th day—subgroup A was given fluoride toothpaste every morning and evening, subgroup B was provided fluoride varnish once, and subgroup C was not given any fluoride regime at all. After another 15 days of fluoride exposure, the fluoride release was monitored.

Results: With notable variations across groups over the initial 15 days, glass ionomer sealants (GIS) released more amount of fluoride, second by giomer sealant, and third by resin sealant ($p = 0.00$). All dental sealants that have been tested released more fluoride when using fluoride toothpaste, with giomer sealants surpassing GIS, followed by resin sealants ($p = 0.00$). Giomer and resin sealants, fluoride varnish treatment dramatically improves fluoride release in GIS ($p = 0.00$).

Conclusion: The release of fluoride among all dental sealants is improved by using fluoride toothpaste daily and fluoride varnish just once.

Keywords: Dental sealants, Pit and fissure caries, Topical fluorides.

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Introduction

Dental caries is a slow-moving, irreversible microbiological condition that attacks the hard tissues of the tooth. It results in the organic substances disintegrating and the inorganic substances demineralizing, which results in the creation of cavities.[1] Its morphological makeup promotes microbial binding and plaque persistence; the pits and fissures of occlusal surfaces are very sensitive regions for the development of dental caries.[2] Dental sealants in pits and fissures provide a physical barrier that prevents caries from forming and progressing.[3] Fluoride is the most frequently used anticariogenic agent, with a wide range of modes of action that have a significant impact on caries prevalence decrease.[4] Fluoride was introduced to the tooth sealant to boost its physical effect.[5] Dental sealants come in many different varieties, including GIS, giomer sealants, and resin sealants with fluoride discharge and replenishing capabilities.[6] Recharging dental materials with fluoride is advised because fluoride levels drop from dental materials, causing sealants to retain a higher amount of fluoride release over time.[7] Dental sealants with improved fluoride release properties are projected to be more successful at avoiding dental cavities after exposure to a variety of fluoride sources.[8] A single fluoride treatment with a modest concentration or a high concentration fluoride regimen has been the main topic of the majority of investigations on increasing fluoride release to date.[9] However, the long-term effects of daily fluoride intake *via* fluoride toothpaste are unknown. This *in vitro* research examines the fluoride emission from various dental sealants following the use of fluoridated toothpaste at home and clinically applied fluoride varnish.

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Materials and Methods

The current study was held in the Department of Pedodontics and Preventive Dentistry, NIMS Dental College and Hospital, NIMS University, Jaipur, Rajasthan, India.

This study comprised three distinct groups of dental sealants—GIS (Fuji VII), resin sealant (Voco Twinky star), and giomer sealant (Shofu Beautisealant). Cheerio gel fluoride toothpaste (458 ppm) and GC Fuji Fluoride Varnish (750 ppm) were the subgroups utilized in this investigation.

Specimen Preparations

Using a stainless steel mold with a 10 mm width and 2 mm height, 30 samples of each material were created. After the components had been placed into the mold, the components were exposed to light using light-emitting diode curing equipment after the mylar strip was applied. The specimens were produced in accordance with the manufacturer's instructions. All samples received a mylar strip coating, which was then allowed to be set for 24 hours at 37°C in an incubator. After the initial 24 hours, the entire specimen was put in a sterile plastic box with 3 mL of synthetic saliva and placed in an incubator at about 37°C for an additional 24 hours. Synthetic saliva is the experiment's medium (pH 5.3).

Initial Fluoride Release Measurement

For the first 15 days, measurements of fluoride release were made once every 24 hours. The samples were removed from the container every 24 hours, cleaned, dried, and then put in 3 mL of fresh synthetic saliva for the following 24 hours. Synthetic saliva that had been administered during the previous day was used to acquire the measurements. To regulate pH and stop the synthesis of fluoride compounds, total ionic strength adjustment buffer III was used in a 1:10 solution. To measure fluoride release, an expandable ion analyzer and a fluoride ion selective electrode were utilized. Normalized fluoride solutions of 0.1, 1.0, and 10.0 ppm of fluoride were used in validating the fluoride electrode. Fluoride levels were measured using ppm.

Exposure to Regimens

The samples were divided into three subgroups ($n = 10$) on day 15 and subjected to the subsequent regime—for 2 minutes, twice a day, subgroup A was subjected to fluoride toothpaste for about 1000 ppm; subgroup B received a single dose of a 5-minute exposure to fluoride varnish (22600 ppm) on day 15; and subgroup C is the control group, which received no fluoride exposure. Samples were placed in new synthetic saliva for the following 24 hours after each treatment.

Fluoride Release upon Regimen Exposure

The same method used for the initial fluoride release measurement was used to measure fluoride release once every 24 hours for the following 15 days after exposure to the regimens.

Statistical Analysis

Statistical Package for the Social Sciences 16.0 Windows was used to analyze all the data. To ascertain if the distributed data was normal, the Shapiro–Wilk test was carried out. A one-way analysis of variance has been performed to evaluate fluoride emission values with a significance level of 0.05.

Results

The first fluoride release statistics from the evaluated dental sealants following 15 days are displayed in Figure 1. These dental

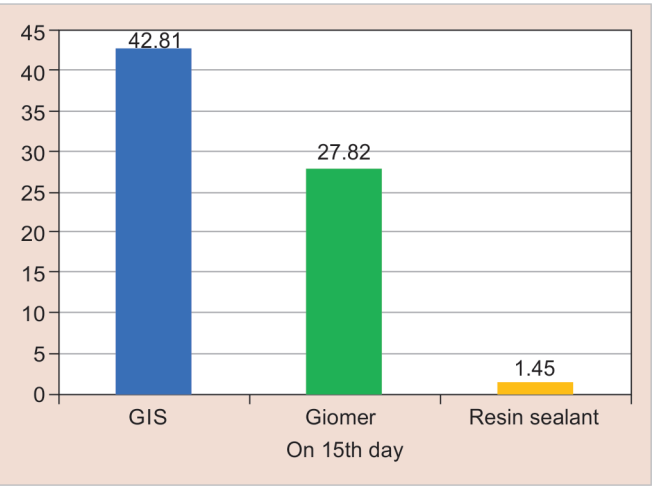

Fig. 1: The initial release of fluoride from various dental sealants

sealants release higher fluoride ions during the 1st day, which is accompanied by a steady decline and consistent fluoride leakage till the 15th day. GIS released the largest cumulative mean fluoride during the first 15 days (mean standard deviation—42.81 ± 1.91 ppm), second by giomer sealants (27.82 ± 1.66 ppm), and third by resin sealants (1.45 ± 0.11 ppm). The first fluoride produced by dental sealants changed in a statistically significant manner ($p = 0.00$).

The average mean fluorides emitted from dental sealants 15 days resulting from exposure toward both regimens are displayed in Figure 2 (below). All dental sealants released significantly more fluoride after being exposed to the fluoride regimen ($p = 0.00$) vs the control group. It was discovered that fluoride toothpaste significantly increased the fluoride release from resin, glass ionomer, and giomer sealants ($p = 0.00$). After being subjected to fluoride varnish, GIS emitted the most fluoride, followed by giomer sealants and resin sealants ($p = 0.00$).

Discussion

The usage of dental sealants is one of the most crucial fundamental methods for avoiding dental cavities. The fortification of dental structure and encouragement of remineralization are benefits of fluoride incorporation.[9]

According to the study's findings, each of the sealants under examination may emit fluoride in artificial saliva and also release more fluoride while subjected to various fluoride dosages. To assess variations in fluoride release brought about by regular dental hygiene practices, fluoride toothpaste was administered to the samples every day for 15 days. Fluoride varnish, on the contrary, was only applied once to measure the efficacy of professional prophylaxis.

In the first 15 days of the investigation, GIS released the most fluoride, followed by giomer sealants and resin sealants.

According to Wiegand et al., GIS is made up of polyalkenoic acid and glass that contains fluoride called fluorosilicate. These components interact with acids and bases, so glass ionomer materials emit greater levels of fluoride.[10]

The burst effect, according to Poggio et al., is the term used to describe a greater quantity of fluoride released from GIS in the first 24 hours as a result of quick dissolving from the outer surface into solution.[8]

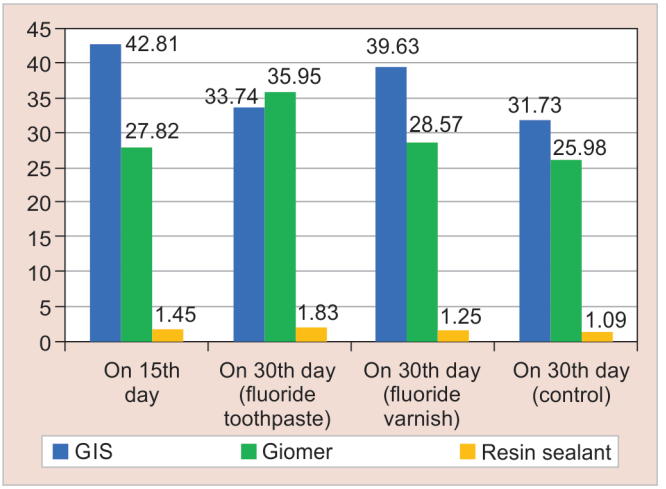

Fig. 2: Displays the total mean fluoride emitted *via* dental sealants 15 days after being exposed to both regimes

Glass ionomer sealants (GIS) emitted the maximum quantity of fluoride when compared to resin sealants and giomer sealants, according to previous research by Dionysopoulos et al.[3]

The least quantity of fluoride was emitted by the resin sealant (Voco Twinky Star). According to research by Wiegand et al., fluoride is supplied to the fluoride salts in the form of a polymer matrix of resin that dissolves in water and then diffuses further into the external environment.[10] GIS often releases more fluoride ions than resin sealants, according to Poggio et al.[8]

Itota et al. explain this result by noting that glass ionomer matrix production and acid–base reaction are absent in resin sealants.[4] Although it was less than what was released by GIS, the initial fluoride created by giomer sealants was far more than that released by resin sealants. Both Nandlal and Dhull say giomer sealant creates a long-lasting glass ionomer phase using surface prereacted glass ionomer (S-PRG) technology, which, when combined with polyalkenoic acid, yields a urethane resin that contains silica. The leading reason is this response to giomer sealant's improved fluoride release capabilities.[2]

According to Shimazu et al., the glass ionomer matrix that surrounds the glass filler particle is what gives giomer sealants their superior performance and the ability to create greater fluoride than resin sealants.[11]

In comparison to the control group, fluoride toothpaste significantly increases the fluoride emission from all dental sealants. Because of its superior permeability and tenacious character, fluoride toothpaste, thus, according to Mousavinasab and Meyers, has a better ability to induce more fluoride emission from sealants.[7]

After being treated with fluoride toothpaste, giomer sealant showed increased fluoride release. Due to the inclusion of S-PRG filler, giomer sealants have the highest fluoride rerelease potential, according to earlier investigations by Dionysopoulos et al.[3]

Nandlal and Dhull assert that giomer releases more fluoride when fluoride exposure increases. GIS showed effective fluoride release after being subjected to fluoride toothpaste.[2] Itota et al. come to the conclusion that fluoride's capacity to remain permanently in the aqueous surface of GIS is what causes the higher fluoride release.[4]

Resin sealants emitted the least quantity of fluoride when exposed to fluoride toothpaste, but statistically higher than all other tested sealants. According to Wiegand et al., the material's preliminary fluoride release capability often affects the amount of fluoride released following exposure to fluoride sources.[10]

All evaluated dental sealants' fluoride release is significantly increased by fluoride varnish. The greatest fluoride was released by GIS after being exposed to fluoride varnish. According to Poggio et al., the capacity to construct polysalt matrices and the ability to absorb fluoride from highly concentrated solutions are responsible for the increased fluoride emission from GIS.[8] Next, resin sealant showed elevated fluoride release, which was statistically substantially greater than the control grouping, followed by giomer sealant.

Conclusion

In the first 15 days, GIS emitted the most fluoride, followed by giomer sealants and resin sealants, and these groups differed considerably from one another. After 15 days, daily fluoride toothpaste exposure effectively increased fluoride release from all dental sealants, with giomer sealants demonstrating greater efficacy over GIS and resin sealants. Fluoride release from all studied sealants is reinforced by a single application of fluoride varnish; however, it is highest in GIS, followed by giomer and resin sealants.

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