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In Vitro Analysis of Hydrophilic and Conventional sealants - A comparative study

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Abstract

Background : According to World Health Organization, sealing pit and fissures of teeth is one of the most efficient, least invasive ways to completely protect the tooth from carious phenomenon on the occlusal surface. Testing in vitro is essential for quickly delivering the knowledge required about the effectiveness of more recent sealant brands. Consequently, the current study aimed to assess as well as contrast viscosity and resin tag length on permanent molars of conventional and hydrophilic sealants.

Materials and Methods : A sample of extracted third molars, twenty in number, were split to form two groups at random, one receiving conventionally used sealant (Clinpro 3M ESPE), and the other receiving hydrophilic sealant (UltraSeal XT Hydro). The occlusal surface of each tooth underwent an acid etchant pretreatment before the appropriate sealants were applied. Afterwards thermocycling and longitudinal sectioning were applied to both groups. For the purpose of measuring the length of the resin tag, A scanning electron microscope (SEM) was used to examine the sectioned tooth specimens. Viscosities were determined using an Anton Paar viscometer. The variation between the the average resin tag length of sealants from Groups I and II was compared using an independent t-test.

Results : When compared to Group I (7.49+/- 0.94m), Group II's mean resin tag length was found to be longer (10.07+/- 1.01m), and this difference was statistically significant (P = 0.001). Groups I and II were found to have viscosities of 0.8 megaPascal (MPa) and 0.6 MPa, respectively.

Conclusion : On the basis of the investigation's findings, it can be established that sealants belonging to Group II generated resin tags of sufficient length and had lower viscosities than Group I sealants. Thus, a hydrophilic sealant outperformed a conventional sealant in terms of performance.

Keywords : pit and fissure sealants, scanning electron microscope, resin tag, viscosity

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INTRODUCTION

The occlusal surfaces of primary and permanent posterior teeth, especially,pits and fissures frequently harbor dental carious diseases and cavities. According to the literature,pits and fissures are the source of around 90% of carious lesions(1). Pit and fissure sealants are regarded by the World Health Organization as the key preventive measure, one of the most potent and less intrusive tools accessible to guarantee complete protection and preservation from the carious phenomenon(2). From the perspective of secondary prevention, there is substantiation suggesting sealants can slow the growth of non cavitated carious lesions.(3)

The sealant material specifically must possess a substantial degree of wettability and a degree of viscosity in terms of chemical and physical properties to facilitate penetration into the micro - cracks of the etched enamel(4).The "coefficient of penetration" used to describe this attribute is directly related to the surface tension of the liquid and indirectly proportional to the material's inherent viscosity(5).So, it is obvious that a sealant's coefficient of penetration would increase with decreasing viscosity, which will also increase retention and efficacy. Pit and fissure sealants made of resin are retained by the resin and enamel micromechanical interlocking. The penetration of resin into the resin tags that create porous enamel is what mechanically holds the sealant in place(6). Length of the resin tag and the penetration of sealants are both influenced by the viscosity of the sealant. This calls for the justification for the current investigation.

Newer varieties of pit and fissure sealants are still being developed in spite of the paucity of information concerning the microleakage characteristics of such materials.Laboratory in vitro testing are essential for quickly delivering the information required about the effectiveness of new goods(7). Despite the fact that only a few in vitro studies also looked at the penetration capacity (resin tag) property of Clinpro 3M ESPE sealant in comparison with other sealant materials, no correlative research has been conducted contrasting the viscosity and length of the resin tag of the above mentioned pit and fissure sealants. As a result, the current investigation's objective was to assess and contrast resin tag length and viscosity on permanent molars of conventional and hydrophilic sealants.

MATERIALS AND METHODS

An experimental randomized in vitro research was conducted to compare two distinct pit and fissure sealants. Using the G*Power 3.1.2 programme, sample size estimation was done referring to the research (2, 8). As a result, the sample size was determined to be ten teeth for each group for a total of 20 samples.

The Institutional Ethics Committee granted ethical approval. A third party not associated with the study created the assignment schedule using block randomization which was generated by a computer ,the block size being five, well in advance.Each block contained two letters and all the molars were separated into two different groups, each of which had ten molars (A, B). The present study examined Group I which is the sealant that is conventionally used(Clinpro 3M ESPE), and Group II, a hydrophilic sealant (UltraSeal XT Hydro).

In this investigation, human third molar teeth that had recently undergone orthodontic or surgical extraction were employed. Only teeth with its occlusal surface intact were included in the study. Teeth which had developmental defects and occlusal surface caries were excluded from the study.

After soaking the teeth in 5% sodium hypochlorite, they were cleaned. Calculus and residual periodontal tissue were eliminated. Following that, cavities and any other potential fissures or flaws were microscopically inspected on all of the teeth. Specimens that didn't meet the requirements for inclusion were discarded, while those that did were kept in a solution of 10% formalin pending later use.SEM was utilized for measuring resin tags, and sealants' viscosity was measured with Anton Paar viscometer.The teeth's occlusal surfaces were treated with 37% orthophosphoric acid for 30 seconds, followed by a water rinse. After that, the teeth were made to dry with a gentle air stream that was oil free to provide the enamel's characteristic icy white chalkiness for the Clinpro 3M ESPE sealer (Group I). The normal drab, frosty characteristic of the etched surface is not preferred with UltraSeal XT Hydro (Group II). Instead, the surface must be just barely damp ,softly dry exhibiting a glossy appearance. Following this, the sealant was applied and allowed to cure for about 30 seconds.

Following that, 500 cycles of thermocycling with dwell time set at 30 s were performed on both groups at a temperature ranging from 5°C-55°C. With a diamond wheel with a thickness of 0.02 mm, all of the molars were longitudinally sectioned through the center of the sealant in a mesiodistal direction. The teeth were then divided into sections, and the root portion was removed. A carbide stone was used to polish the tooth portions.After application of 37% phosphoric acid for a time of 15 seconds to etch away any enamel mineral components not covered by sealants, the polished pieces were cleaned and kept in distilled water. Using the heat lamp, the tooth parts were fully dried. On brass rings, tooth specimens were mounted using carbon-based nonconductor tape. The regions where no scanning was required were then subjected to this.

These mountings were then subjected to hoover evaporation at 200–300 for 30 min inside an ion–sputtering system. The sections that had been subjected to gold-sputtering were then put inside a SEM with a capacity of 20 kV, and pictures of them were taken. The lengths of the resin tags were then determined. Each photograph's average was calculated.

By means of dilution of the sealant with methyl methacrylate monomer liquid, the viscosity was evaluated. Then, the viscosity of the liquid monomer was assessed. The liquid was put in the Lovis 2000 M, DMA 5000 M, and Anton Paar sample holders of the viscometers. Drawn from its bottle, 0.5 ml of the sealant is diluted with 5 ml of methyl methacrylate. A syringe was used to transfer the necessary amount of liquid (about 1 ml), and caution was taken to avoid the bubble formation in the tube to avoid measuring inaccuracies. The capillary had a diameter of 1.59 mm and an inaccuracy of 0.01% within this range of viscosity values. The sealant was carefully monitored to ensure that there was little light exposure.

Statistical analysis

The Statistical Package for the Social Sciences (SPSS) programme was used to evaluate the data once they had been entered into a Microsoft Excel spreadsheet. (IBM SPSS Statistics,Version 20.0, Armonk, NY: IBM Corp).The data were presented and summarised using descriptive statistics. To check whether the dataset is normal, the Shapiro-Wilk test was put to use. To contrast the variation in mean resin tag length across the two groups, an independent t-test was utilised. The cutoff point for statistical significance was fixed at P 0.05.

RESULTS

Table 1 displays the resin tag length values for each sample. According to Table 2, the mean difference between the two groups was 2.58, with a t-value of 5.88. The mean difference in resin tag length between the two groups, which was confirmed by an independent t-test to be statistically highly significant at P = 0.001, indicates that Group II sealant (10.07+/- 1.01 µm) is superior than Group I sealant (7.49+/- 0.94 µm).

At room temperature, Group I sealant was much more viscous than Group II, with viscosity readings of 0.8 MPa and 0.6 MPa, respectively. In contrast to Group II, which had a lower viscosity measurement of 0.74 m and a higher resin tag length measurement of 10.09 MPa.s, Group I displayed a higher viscosity reading of 0.94 m with a lower resin tag length of 7.49 MPa.s.

Table 1: Values of resin tag length in Group I and Group II

Tooth specimen	Group I	Group II
1	7.45	10.64
2	8.24	9.77
3	7.6	8.3
4	6.55	10.78
5	7.27	10.49
6	5.39	9.87
7	8.65	8.80
8	8.35	10.67
9	7.34	11.79
10	7.74	9.20
Mean	7.49	10.09

Table 2: Mean difference between Group I and Group II with respect to resin tag length

Groups	Mean +/- SD	Degree of freedom	Mean difference	t	P
Group I	7.49±0.94	9	−2.58	−5.88	<0.001
Group II	10.07±1.01	9			

DISCUSSION

Cueto and Buonocore conducted the initial clinical investigation into sealant retention in 1967. One year after applying the sealant, they discovered an 86.3% decrease in cavities. (9) Pit and fissure sealants have thus been discovered as an excellent addition to oral healthcare prophylactic methods in the reduction of occlusal surface caries beginning as well as further progression(10).The physical blockage of the pits and fissures is primarily responsible for the cariostatic features of sealants. This stops new bacteria from colonizing the pits and fissures and also stops fermentable carbohydrates from getting inside those bacteria that are still inside the pits and fissures(10). According to studies, there is a direct link between sealants and the lack of caries(11). The viscosity of the material and resin tag creation are crucial factors that must be taken into consideration for a sealant to be considered successful and held for a long duration of time. Laboratory in vitro testing are essential for quickly delivering the information required about the effectiveness of new materials.

The thermocycling process was applied to tooth specimens to simulate the temperature felt intraorally. Thermocycling is a technique that is frequently used in dentistry research, especially when evaluating the efficacy of adhesives(12). By exposing the restored teeth to extremely high temperatures that are comparable to intraoral temperatures, it seeks to thermally stress the adhesive joint at the interface between tooth and restoration.

Viscosity is a liquid's resistance to flowing. The internal frictional forces inside the fluid regulate this resistance to flow. Centipoise or MPa units are used to express viscosity. A fluid with high viscosity moves slowly(13). The penetration of sealants is also influenced by the sealant's viscosity. Anton Paar viscometer, has cutting-edge measurement technology, effective temperature control, and requires only a small volume of sample to analyze viscosity and hence was used in the current investigation.

While SEM can give very high-resolution images of a sample surface and can unmask nuanced details as little as 1 to 5 nm in size, it was employed in the current investigation to quantify the resin tag length(11,14). SEM images have a substantial field depth owing to the extremely narrow electron beam, giving them a prominent three-dimensional appearance that is useful for understanding the surface structure of a sample. It's crucial to lay the sealant at the right time. Because newly erupted teeth are most vulnerable to caries, they should be shielded from cracks and pits(14). Glass ionomers were the only moisture-tolerant sealants up until this point. One such more recent sealant produced is UltraSeal XT Hydro, a 53% highly filled resin with optimal viscosity features and cutting-edge adhesive technical properties that aids its flow into pits and cracks and adhere to the tooth effectively without the use of a drying agent(15).

The mean length of the resin tags used in the current investigation varied between 5.39 to 8.65 m in Group I and from 8.3 to 11.79 m for Group II. The mean value of resin tag length in the in vitro investigations by Prabhakar et al (16) was found to be between 5 and 10 m. It was discovered that Group I had a higher viscosity than Group II. Same phenomena was addressed by Irinoda et al. in their work, which revealed that higher sealant viscosity may result in worse adaptability and insufficient penetration to the base of pits and fissures, which would lower retention.

Low-viscosity sealants have a higher chance of flowing, spreading across the surface more quickly, and penetrating. The research done by Barnes et al (17) has demonstrated, on the other hand, that the viscous nature and flow characteristics of the fissure sealants had no bearing on their capacity to seal.

However, the results of this investigation showed that viscosity UltraSeal XT Hydro was determined to be lower than that of Group I (Clinpro), which led to improved penetration and a longer resin tag. There are three basic explanations that could be used to explain such behaviour. First, Group II (UltraSeal XT Hydrothixotropic)'s characteristic causes moisture penetration into pits and fissures at the microscopic level. Secondly, Group II's UltraSeal XTHydro adhesive technology produces stronger bonds. Hence, decreased microleakage and enhanced retention are produced by higher binding strengths. Finally, the usage of resin-based sealant (ClinproTM) was negatively impacted by wet or moisture contaminations.Majority of the porosities usually present are plugged with moisture when the enamel is wet. This results in poor resin penetration, which leads to tags of insufficient number and length to give good quality retention of the resin to enamel and ultimately had a high level of microleakage.

Limitations

Due to factors including type of fissure, enamel preparation, etching, and contaminating factors on the surface, sealants may behave differently depending on the environment.

CONCLUSION

According to the results of the current investigation, sealant belonging to Group II was established as less viscous, which led to improved sealant penetration and the formation of tags with an adequate quantity and length, which eventually helped with better sealant retention as compared to Group I. Moreover, teeth which are newly erupted and were previously left exposed due to moisture control issues can now be sealed thanks to the development of the hydrophilic sealant Ultraseal XT Hydro.

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Conflicts of interest

There are no conflicts of interest

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