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Research Article

Comparative Evaluation of Air Abrasion and Acid Etching on Sealant Integrity by Color Coverage Caries Evaluation System

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Abstract

Aim: To determine the effect of air abrasion over acid etching on sealant integrity evaluated by CCC sealant evaluation system.

Materials and Methods: A split-mouth, one and a half year follow-up clinical trial was conducted among 60 children aged 6 - 8 years. Group 1 children received acid etching Vococid (VoCo) for enamel preparation whereas Group 2 received air abrasion (KCP 2000 PLUS (ADT Inc.)) after which both the groups were sealed with a resin based sealant (Clinpro TM 3M ESPE, USA). All the cases were clinically evaluated after application by a trained and calibrated examiner at an interval of 6 months for one and a half years in the department. Descriptive statistics included the computation of percentages. The statistical tests applied for the analysis were Pearson's chi-square test (χ^2) and the Fisher exact test.

Results: Sealant coverage was more in acid etching group as compared to the air abrasion group. Statistically, insignificant difference was found when both the groups were compared at all the time intervals ($p > 0.05$). Caries was more in air abrasion group as compared to acid etching group although the results were statistically insignificant among all the groups compared ($p = 0.67$).

Conclusion: Caries was found little more in air abrasion group but, statistically, the difference was insignificant, when acid etching and air abrasion groups were compared with caries at all the intervals. It is suggested that to derive the full potential of caries prevention, sealants should be of optimal coverage. To achieve this, sealed surfaces require regular monitoring and appropriate maintenance.

Keywords: *Air Abrasion; Color; Coverage; Caries; Sealants*

Introduction

Dental caries is a significant general health issue and it is the most predominant oral ailment among youngsters. It is also the causative factor for several morbid conditions in the oral cavity as well as other systems of the body [1]. The distribution of caries worldwide has shown many variations [2].

Prevention of caries has received less importance when compared to the treatment of caries. Studies have proved that application of sealants is an effective method of caries prevention by micro mechanical bonding to the tooth surface preventing access to the micro-organisms and their byproducts [3]. Buonocore's great investigation of 1955 denoted the beginning of a noteworthy transformation in the clinical routine with regards to dentistry [4]. The principal advantage in the clinical field of his work was the invention of the primary dental pit and fissure sealant, Nuva-Seal (L.D. Caulk) in February 1971 [5]. Based on a systematic review, 2016 guidelines were gathered

by the American Dental Association Council on Scientific Affairs and the American Academy of Pediatric Dentistry for the application of pit and fissure sealants on the occlusal surfaces of deciduous and permanent molars in kids and young people [6].

The ability of sealants depends on their capacity to separate pits and crevices from the mix of microbes and their supplements and the acidic metabolic items [7]. Retention and integrity of the sealant are prime factors involved to derive benefit from the application of sealant [8]. Maximum sealant integrity depends on the morphology of the pits and fissures and efficient enamel pretreatment before the sealant application. Enamel pretreatment is also mandatory to enable access to the deeper zones of the pit and fissures so as to remove stains and organic debris and also increase the surface roughness [9]. Failure to do so may result in significant microleakage [10].

Acid etching of the enamel has been a traditional method for the preparation of enamel before the application of sealants but several studies have shown that acid etching alone is not sufficient in removing all the debris and pellicle from the base of the fissures. In addition, acid etching is a time consuming procedure requiring several steps and previous studies have shown that only acid etching enamel preparation led to 5-10% sealant loss every year [11,12]. Therefore, a few elective techniques have been utilized trying to improve the life span of the sealants however with questionable outcomes [13,14].

Although Dr. Robert Black introduced air abrasion in 1940s and improved later by Dr. J. Tim Rainey, it re-emerged and in 1990s was used very scarcely with minimal invasive dentistry [15,16]. Air abrasion system is for all intents and purposes effortless, which by and large dispenses with the requirement for a painless arrangement, and delivers no vibration and heat, making it a decent choice for youngsters who are scared of anaesthesia and commotion and vibration of an ordinary dental bur [17].

Sealant applicant needs to be assessed for the clinician planning individual patient health care at subsequent recall visits to check sealant integrity and development of any caries. A legitimate, reproducible, useful, and attainable and proper assessment system called CCC (Color, Coverage, Caries) was presented by Deery., *et al* [18]. The CCC Sealant Evaluation System has all the earmarks of being a fitting technique for use to survey fixed surfaces and gives an adaptable device to the clinician, analyst, and instructor.

Several investigations have detailed confronting outcomes when air abrasion treatment was utilized before fissure application. The vast majority of them were done *in vitro* [19,20]. Unfortunately, we couldn't retrieve any information in the literature to compare air-abrasion and acid-etching methods to prepare enamel before application of sealant using color, coverage and caries (CCC) together.

Materials and Methods

Study design and population

A split-mouth, one and a half year follow-up clinical trial was conducted among 60 children aged 6 - 8 years. This study was reviewed by the Ethical Committee of the institution and was granted ethical clearance for the same. The purpose and details of the study were explained to the parents of the participating children and an informed consent was taken. It was made sure that strict confidentiality would be maintained at all times and that the parents or guardians were free to withdraw without being penalised.

Inclusion criteria

Subjects fulfilling the eligibility criteria of

1. Voluntary participation.
2. Children with all erupted permanent first molars that were free of any previous fissure sealants or dentinal caries or any restoration.
3. Those who are currently not under any medications.

Exclusion criteria

1. Those with any debilitating systemic disease.
2. Those finding difficulty in opening their mouth.

Training and calibration

Before starting the procedure, a senior faculty member standardised and calibrated the examiner in the Department of Public Health Dentistry to see that uniform interpretations, understanding, and application of the codes and criteria were maintained during consistent examination. Intra-examiner reliability was calculated by examining a group of 5 children and the re-examination was carried out at least 30 min after the initial examination. The kappa value was 0.88, which denoted substantial level of agreement between the examinations.

Group 1: Acid etching group

Kids were told to dry brush their teeth while waiting for the sealant arrangement. The surfaces were then cleaned with prophylaxis glass utilizing pumice and water for 15 seconds and dried daintily with packed oil-free air. The confined surfaces were then covered with 37% phosphoric acid gel (Vococid (VoCo)) for 15 seconds pursued by flushing with water for 15 seconds and air-dried.

Group 2: Air abrasion group

Every member was given comparative guidelines as in the acid etching group. After dry brushing, teeth were altogether cleaned with pumice and water utilizing prophylaxis container and dried softly with oil-free compacted air. The administrator air-rubbed pits and fissures utilizing 50µ alumina oxide particles KCP 2000 PLUS (ADT Inc.) for 15 seconds at 160 psi. The spout tip was held oppositely at the separation of 1 to 2 millimeters. The tooth was flushed with water for 30 seconds and completely dried.

Sealant application

A light restored pit and crevice sealant (Clinpro TM 3M ESPE, USA) was bonded to occlusal pit and fissures of both the categories after pretreatment with acid etching and air abrasion utilizing a syringe provided by the producer. The sealant changed shading from pink to cloudy white on curing. Abundant sealant was cleared with an explorer and light restored for 20 seconds. The high points were checked with an articulating paper and balanced in like wise manner. If there should be an occurrence of high focuses, they were decreased utilizing composite finishing ribbons. Patients were released and planned for review visits at a half year, one year and 1 and half years interim.

Outcome assessment

All the cases were clinically evaluated after application by a trained and calibrated examiner at an interval of 6 months for one and half years in the department. All follow up examinations were performed. Children were made to sit comfortably in a dental chair. Sealants were checked under visual examination. If desired CPI probe was used to assess the retention in a dental chair under the operatory light. The primary outcome was sealant retention and the secondary outcomes were discoloration and cariostatic effect. The retention rate was assessed based on Color, Coverage and Caries (CCC) sealant evaluation system described by Deery., *et al* [18].

Statistical analysis

The recorded data was compiled and entered in a spreadsheet computer program (Microsoft Excel 2010) and then exported to data editor page of SPSS version 19 (SPSS Inc., Chicago, Illinois, USA). Descriptive statistics included computation of percentages. The statistical tests applied for the analysis were Pearson's chi-square test (χ^2) and fisher exact test. For both the tests, confidence interval and p-value were set at 95% and ≤ 0.05 respectively.

Results

The present study comprised of 60 subjects. The design of the study was split mouth randomised clinical trial i.e. 60 teeth in each group. One group undergoing application of pit and fissure sealant with acid etching procedure while the other one with air abrasion. Subjects lost to follow up were two and three at one and 1.6 years of follow up i.e. subjects remained in the study were 58 and 57 at one and 1.6 year of follow up respectively.

When coverage of sealants were compared, it was found that at all the different time interval i.e. 6 months, one year and 1.6 years, sealant coverage was more in acid etching group as compared to air abrasion group. Statistically insignificant difference was found when both the groups were compared at all the time intervals ($p > 0.05$). When caries was compared at different intervals it was found that after one year and 1.6 years of follow up, caries was more in air abrasion group as compared to acid etching group. Statistically, the insignificant difference was found between the groups at all the time intervals ($p = 0.67$).

Coverage Categories	Time interval					
	6 month		1 year		1.6 year	
	Acid etching	Air abrasion	Acid etching	Air abrasion	Acid etching	Air abrasion
Sealant covering all of the fissure systems	52	50	47	45	41	38
Sealant present on > 50% of the fissure system	6	7	4	5	5	7
Sealant present on < 50% of the fissure system	2	1	6	6	7	6
No sealant present	0	0	1	2	4	6
Chi-square	0.42		0.49		0.92	
p-value	0.94		0.92		0.82	

Table 1: *Comparison of sealant coverage at different intervals among acid etching and air abrasion group.*

Caries Categories	Time Interval					
	6 months		One year		1.6 years	
	Acid etching	Air abrasion	Acid etching	Air abrasion	Acid etching	Air abrasion
Sound/No caries	60	60	56	54	52	49
Enamel caries	0	0	2	4	5	8
Dentinal caries	0	0	0	0	0	0
Pulp caries	0	0	0	0	0	0
Fisher exact test	0.29					
p value	0.67					

Table 2: *Comparison of the caries at different intervals among acid etching and air abrasion group.*

Discussion

The essential proportion of sealant viability is maintenance. The clinical viability of fissure sealants is legitimately identified with their retention [21,22]. If the sealant material stays attached to the tooth and gives a decent seal, at that point it is sensible to expect that caries rate can be diminished [23]. The outcome measured in the present investigation was retention (coverage), caries incidence, and discoloration.

There is no institutionalized strategy for surveying and revealing the sufficiency of fixed surfaces and this makes it hard for similar examination and assessment at review visits. Most investigations have defined their criteria or have used Simonsen criteria for the assessment of sealants [24,25].

But the disadvantage of using Simonsen criteria is that it does not calculate partially retained sealants and does not score for the presence of dental caries. For sealant evaluation prime factors to be considered are sealant identification, differentiation between preventive and restorative sealants, colour of sealants, its coverage the status of caries. The CCC sealant evaluation system introduced by Deery., *et al.* [18] is user friendly, scores the presence of caries, and also scores the level of surface coverage.

The examination technique for caries was visual-material, with an accentuation on visual, and a blunt probe was utilized to affirm the nearness of the sealant. This clarifies the utilization of CCC sealant assessment criteria in the present investigation.

Greater part of the investigations on sealants have used the half-mouth plans in which only half side of the mouth are dealt with but teeth on the opposite side are not treated [26,27]. However, untreated teeth cannot be used as controls for ethical reasons. A split-mouth configuration is ideal for comparing two systems and it was guaranteed that each child gets sealants application on both sides of mandibular permanent molars. The examination technique to determine caries was visual-material, with focus on visual, and a blunt probe was utilized to affirm nearness of the sealant. This clarifies the utilisation of CCC sealant assessment criteria in the present investigation.

Ideal adjustment of dental sealants depends basically on a satisfactory enamel treatment and sealant entrance to the base of the fissures is influenced by fissure profundity and morphology [28]. Proper penetration is critical in profound crevices which are increasingly defenseless for caries progression. An exact pre-moulding of enamel surface in profound crevices might be undermined by the powerlessness to expel trash, to drive the etching gel into the most profound regions, and to appropriately dry the surface [29].

Phosphoric acid etching is the most utilized enamel etching system in cement dentistry, additionally for sealants application. Although etching removes irregularities on enamel surface and improves the surface roughness required for sealant retention it does not guarantee total cleaning of the most profound occlusal pits and crevices before sealant placement [30]. For efficient sealant bonding it is necessary that all the debris from the enamel is mechanically removed [10]. Previous studies have reported that mechanical fissure preparation opens up the fissures leading to increased bulk of sealants thereby providing lower microleakage scores [9].

Complete sealant coverage was seen slightly more in acid etching group when compared with air abrasion although the results were statistically insignificant. This could be attributed to the fact that both inorganic and organic components of enamel were removed with air abrasion leading to a smoother and hence a less retentive surface which was also seen in study by Laurell and Hess [31]. Whereas when enamel is treated with acid etching, selective dissolution of only the inorganic component of the enamel matrix occurs, leading to more retention. This finding was similar to Eakle., *et al.* [32] who revealed that in spite of roughened surface produced by air abrasion it lacked the seal obtained by acid etching and with the findings of Davis., *et al.* [33] and Mentes and Gescoglu [34] who showed that air abrasion alone was not sufficient in conditioning the teeth prior to sealing, resulting in significant marginal leakage. This finding is also in accordance with the results of Brown and Barkmeier [35], Ferdianakis [36], Ellis., *et al.* [37] and Guirguis., *et al.* [38] who all found that air abrasion alone was not sufficient in sealing the teeth prior to application of the sealants. However, findings of Keen., *et al.* [39] and Wright., *et al.* [40] showed no statistically significant difference in micro leakage between acid etched and air abraded teeth prior to sealant or composite placement. Various differences in parameters such as the pressure used, size and type of the particles, distance and angulation of the nozzle tip can be attributed for such disagreement.

In this study it tends to be unmistakably valued that at all the distinctive time intervals i.e. half year, one year and 1.6 years, clear color was more in air abrasion group whereas opaque was more in acid etching group. Statistically, insignificant difference was found, when

acid etching and air abrasion were compared in relation to different color categories of pit and fissure sealant at all the intervals ($p > 0.05$). The importance of color helps the clinician to check for the presence of the sealants in the recall visits. The sealant used here was fluoride releasing unfilled sealant. The color of the sealant on application is pink which helps the clinician to apply uniformly covering all the fissures as compared to clear sealants. After curing the sealant changes color to opaque white. In a study by Rock where use of clear sealants were assessed against coloured (opaque) sealants, combined identification error rate for opaque resin was only 1%, whilst for clear resin it was 23%. Highly significant difference was observed ($p < 0.0001$). Significant differences were also found in the accuracy with which the three dentists identified each type of resin. There was also significant difference in the accuracy with which the different dentists identified the sealants. To identify the presence of resin on an untreated tooth was the most common error [41].

After 6 months caries was not reported in any of the subjects in both the acid etching and air abrasion groups. But after one and 1.6 years caries was found in 6.90% and 14.04% of the subjects respectively with statistically insignificant difference. This means that the fissure sealant application had slow progression of caries. This could be attributed to the fluoride releasing property of the sealants we used in the study.

Fluoride is known to inhibit the metabolism of microbial flora thus exhibiting antimicrobial property. Fluoride helps in reducing caries activity by reducing the demineralisation, inducing remineralisation, inhibiting plaque attachment and inhibiting microbial metabolism. These findings were also reported by Florio., *et al.* where progression of caries was arrested after the application of sealants on active non cavitated lesions [41]. As a greater part of the studies referenced in comparison with our study results above were *in vitro*, we cannot directly compare our results with them, as ours is an *in-vivo* clinical trial. *In-vitro* studies could foresee clinical achievement; however, the genuine presentation ought to be assessed with *in-vivo* clinical examinations. Henceforth, this could be considered as one of the limitations of the present study.

Conclusion

Our study concluded that when acid etching and air abrasion were compared to different sealant coverage categories of pit and fissure sealant at all the intervals statistically insignificant difference was found. Caries was found little more in air abrasion group but, statistically insignificant difference was found, when acid etching and air abrasion groups were compared to caries at all the intervals. It is suggested that to derive the full potential of caries prevention, sealants should be of optimal coverage. To achieve this, sealed surfaces require regular monitoring and appropriate maintenance. More efforts need to be taken by conducting *in-vivo* studies with longer follow-ups and a larger sample size to assess the significant difference in caries incidence and discoloration.

Conflict of Interest

There are no conflicts of interest.

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