DOI: 10.7860/JCDR/2023/62942.18551

Original Article

Dentistry Section

Comparison of the Retention Rates of Pit and Fissure Sealants Placed on First Permanent Molars Treated with Air Abrasion and Acid Etching: A Split-mouth Randomised Clinical Trial

BODIKE DEEPIKA[1], C VINAY[2], KS ULOOPI[3], KAKARLA SRI ROJARAMYA[4], PENMATSA CHAITANYA[5], MV RAMESH[6]

ABSTRACT

Introduction: Pit and fissure sealants are a reliable and safe method of occlusal caries prevention. Accurate preconditioning of the enamel surface is essential for long-term sealant retention.

Aim: To assess the retention rate of pit and fissure sealants applied to first permanent molars treated with air abrasion and acid etching in children aged 6 to 9 years.

Materials and Methods: This split-mouth randomised study was conducted in the Department of Paediatric Dentistry, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India from March 2019 to March 2020. The study included 45 children aged 6-9 years with 180 completely erupted maxillary and mandibular first permanent molars. The children were randomly divided into two groups: Group-I (Air Abrasion) and Group-II (Conventional Acid Etch). After pretreatment of the enamel surface with either air abrasion or acid etching, sealant was applied. Sealant retention was evaluated at 6- and 12-month intervals using Tonn and Ryge's scoring criteria under a dental operating microscope. Statistical analysis was performed using the Wilcoxon Signed-rank Test and the Mann-Whitney U Test.

Results: The mean age of the study participants was 7.6±0.5 years. At the 12-month interval, complete sealant retention was observed in 23% of teeth in the air abrasion group and 21% in the acid etch group. The p-value of 0.657 indicates that the difference was not statistically significant. The comparison of sealant retention rates in maxillary and mandibular molars treated with both air abrasion (p=0.191, p=0.881) and acid etching (p=1.000, p=0.574) showed no statistically significant differences at both the 6- and 12-month intervals.

Conclusion: The retention rate of fissure sealants on enamel surfaces treated with air abrasion was comparable to acid etching. There was no difference in sealant retention rates between maxillary and mandibular molars in both the air abrasion and acid etch groups.

Keywords: Aluminium oxide, Conventional acid etch, Dental caries

INTRODUCTION

Dental caries is the most prevalent microbial infection affecting the oral cavity. Approximately 90% of caries lesions in permanent posterior teeth are pit and fissure lesions [1]. Despite the occlusal surfaces constituting only 12.5% of the total tooth surface area, it has been reported that occlusal pit and fissures account for almost 50% of caries in children [2]. The rough and irregular nature of occlusal surfaces makes them challenging to clean effectively, leading to the accumulation of biofilm and bacterial proliferation [3]. Sealants are a valuable addition to oral health preventive efforts as they can inhibit the development and spread of occlusal caries. By forming a micromechanical bond with the tooth's occlusal surface, sealants create a protective barrier that disrupts metabolic exchange [4]. The integrity and retention rate of fissure sealants are crucial factors for clinical success. The longevity of sealants depends on the retentive state of the surface and the removal of any debris before placement [5].

The traditional method of enamel surface preparation for sealant application involves acid etching. Etching increases the surface area of irregular enamel and promotes the formation of resin tags, which provide micro-mechanical interlocking at the enamel-sealant interface [6]. However, etching alone may not completely remove debris and pellicle from deep pits and fissures [5]. Literature suggests that enamel surface treatment with air abrasion and laser application improves sealant retention [5,7]. With the advancement of minimally invasive dentistry, the use of air abrasion has increased. During air abrasion, a stream of aluminum oxide particles is directed at the tooth structure using compressed air, bottled carbon dioxide, or nitrogen gas. This process not only mechanically roughens the enamel but also clears questionable fissures [5].

Treating the enamel surface with air abrasion has shown improved sealant retention by effectively removing biofilm from deep fissures and grooves [8]. Additionally, air abrasion eliminates the need for the extra step of acid etching [9,10]. However, there is a lack of well-defined clinical trials that evaluate the use of air abrasion for enamel surface pretreatment. Therefore, the present study was designed and conducted to assess whether air abrasion could achieve comparable results to the conventional acid etching protocol in enhancing the retention rate of sealants placed on the occlusal surfaces of first permanent molars.

MATERIALS AND METHODS

The study was a split-mouth randomised controlled trial conducted in the Department of Paediatric Dentistry, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India from March 2019 to March 2020. The institutional review board approved the study (VDC/IEC/2018/30), and the trial was registered with the Clinical Trials Registry of India (CTRI/2020/20/031361). The protocol adhered to the ethical guidelines for human experimentation outlined in the Declaration of Helsinki. A total of 45 children were brought to the Department of Paediatric Dentistry for sealant application after obtaining written informed consent from parents and school officials.

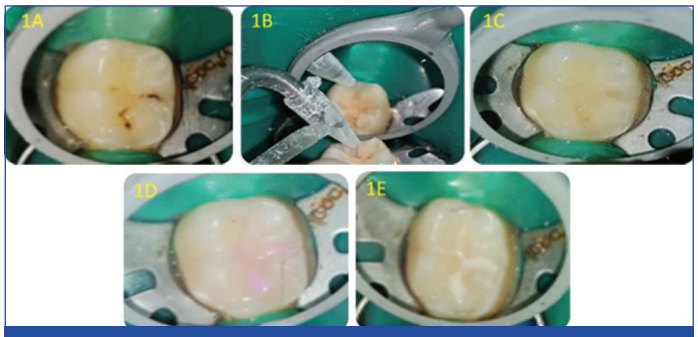
Inclusion and Exclusion criteria: Healthy and cooperative children aged 6-9 years with fully erupted, caries-free permanent first molars in the maxilla and mandible, exhibiting deep retentive pits and fissures, and available for follow-up visits up to 12 months were included. Teeth with previous restorations or sealants and medically compromised children with a history of respiratory diseases were excluded from the study.

Sample size calculation and allocation: The sample size was estimated using the N Power formula [11] based on the results of a previous investigation. It was determined that 59 samples per group were required at a significance level of 5%, a study power of 80%, and a difference of 8.5. Ultimately, 90 teeth were included in each group, accounting for a follow-up loss rate of 35%.

Study Procedure

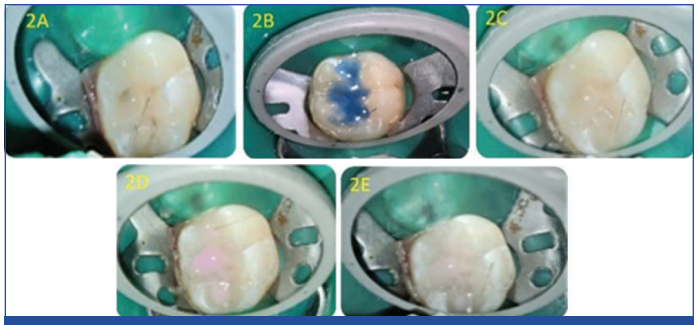
A total of 80 children were initially screened, and 35 of them were excluded due to not meeting the inclusion criteria. The remaining 45 children's 180 teeth, i.e., four teeth per child were randomly divided into two groups, with two teeth allocated to each group: the test group (air abrasion, n=90 teeth) and the control group (conventional acid etching, n=90 teeth). Block randomisation with a block size of 4 was used for the allocation process. In accordance with the split-mouth design, air abrasion was performed on one side, while conventional acid etching was done on the other side. The allocation information was sealed in numbered envelopes, and the outcome assessor and data analyst were blinded to the allocation. However, the operator could not be blinded as the procedures for enamel surface treatment were different.

The clinical procedure was carried out by a single operator in a dental office setting. Rubber dam and high-volume suction were used for proper isolation. In the air abrasion group, the enamel surface was abraded using an air abrasion system (AQUA care unit, VELOPEX, London, UK) with 29 µ aluminum oxide particles (VELOPEX, London, UK) for a duration of 5 seconds at a distance of 2 mm [Table/Fig-1a-e]. In the conventional acid etch group, etching was performed using 37% phosphoric acid gel (D-Tech, Pune, India) for 15 seconds. Subsequently, the teeth were rinsed, dried, and sealant (Clinpro, 3M ESPE, USA) was applied, followed by light curing for 20 seconds using an LED curing light with a wavelength of 420-480 nm [Table/Fig-2a-e].

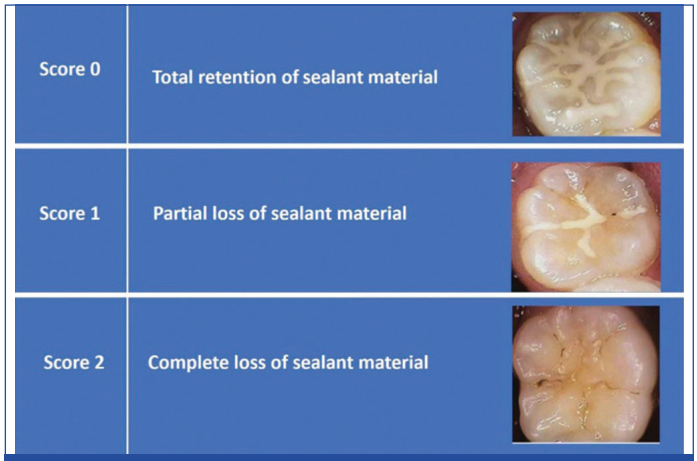


[Table/Fig-1]: Enamel surface pretreatment with air abrasion. a) Preoperative image; b) Treatment with air abrasion; c) Abraded tooth; d) Sealant application; e) Postoperative image.

Occlusion evaluation was conducted using articulating paper, and if any premature occlusal contacts were present, a finishing bur was used to correct them. Sealant retention was assessed at 6- and 12-month intervals using Tonn and Ryge's criteria [12] under a dental operating microscope (Labomed, Los Angeles, CA, USA) at 6X magnification [Table/Fig-3]. Two examiners were trained to score the sealant retention, and a sample size of 10% was allotted to them for standardisation. Intra and inter-examiner reliability was assessed using Cohen's kappa statistics, which showed values of 0.87 and 0.84, respectively, indicating almost perfect consistent agreement. The study's outcome measure was the retention rate of sealants placed on the occlusal surfaces of permanent first molars treated with air abrasion and acid etching at 6- and 12-month intervals.



[Table/Fig-2]: Enamel surface treatment with acid etching. a) Preoperative image; b) Etching the tooth; c) Etched tooth surface; d) Sealant application; e) Postoperative image.



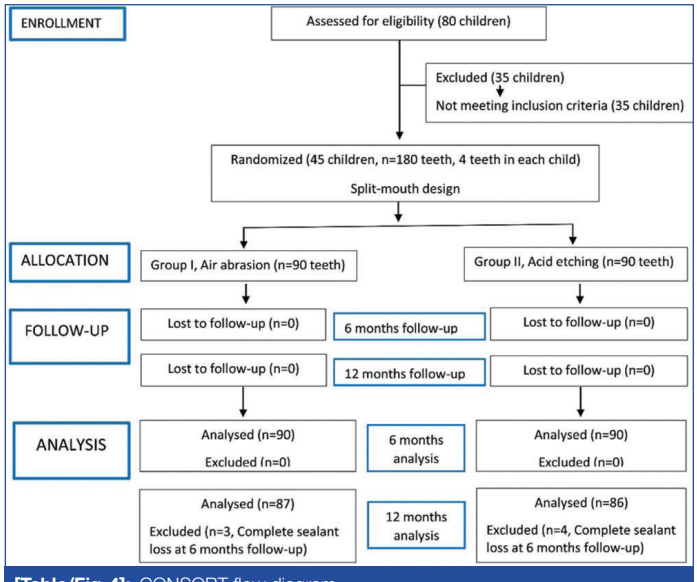
[Table/Fig-3]: Tonn and Ryge's criteria [12].

STATISTICAL ANALYSIS

The obtained data was statistically analysed using non parametric tests. Categorical data were analysed using the Mann-Whitney "U" test, while the comparison of data between the two groups was performed with the Wilcoxon sign rank test. A probability value of $p \leq 0.05$ and $p \leq 0.001$ was considered for statistical significance and high significance, respectively.

RESULTS

The Consolidated Standards of Reporting Trials (CONSORT) flow diagram [Table/Fig-4] shows the participants' participation in the study. The average age of the participants was 7.6±0.5 years. The study sample consisted of 24 girls and 21 boys, with no dropouts; all of the children were present for the follow-up.



[Table/Fig-4]: CONSORT flow diagram.

In the intragroup comparison, the air abrasion group showed a complete retention rate (Score-0) of 46.7% and 23.3% at 6 and

12-month intervals, respectively. A Score-1, indicating partial sealant loss, was observed in 50% and 56.7% of the teeth at 6 and 12-month intervals, respectively. Meanwhile, a Score-2, representing complete sealant loss, was observed in 3.3% and 20% of the teeth at 6 and 12-month intervals, respectively. The difference between the scores at 6 and 12 months was found to be statistically highly significant [Table/Fig-5].

Retention scores	6 months	12 months	p-value
Score-0	42 (46.7%)	21 (23.3%)	0.001, HS
Score-1	45 (50%)	51 (56.7%)	
Score-2	3 (3.3%)	18 (20%)	
Total	100%	100%	

[Table/Fig-5]: Intragroup comparison of sealant retention rates in air abrasion group at different time intervals.
Wilcoxon sign rank test, HS: Highly significant

In the intragroup comparison of the acid etch group, the complete retention rate (Score-0) was found to be 40% and 21.1% at 6 and 12-month intervals, respectively. Score-1 was observed in 55.6% and 65.6% of the teeth at 6 and 12-month intervals, respectively. A Score-2 was observed in 4.4% and 13.3% of the teeth at 6 and 12-month intervals, respectively. The difference between the scores at 6 and 12 months was found to be statistically highly significant [Table/Fig-6].

Retention scores	6 months	12 months	p-value
Score-0	36 (40%)	19 (21.1%)	0.001, HS
Score-1	50 (55.6%)	59 (65.6%)	
Score-2	4 (4.4%)	12 (13.3%)	
Total	100%	100%	

[Table/Fig-6]: Intragroup comparison of sealant retention rates in acid etch group at different time intervals.
Wilcoxon sign rank test, HS: Highly significant

In the intergroup comparison of the air abrasion and acid etch groups, the differences in complete sealant retention (Score-0), partial sealant retention (Score-1), and complete sealant loss (Score-2) were found to be statistically not significant. Both groups exhibited similar retention rates at 6 and 12-month intervals. Retention rates were significantly reduced from 6 to 12-month intervals. Finally, at the 12-month interval, 23.3% of teeth in the air abrasion group and 21.1% in the acid etch group showed complete retention, and the difference was not statistically significant [Table/Fig-7].

Evaluation period	Retention scores	Group-1 (Air abrasion)	Group-2 (Acid etch)	p-value
6 months	Score-0	42 (46.7%)	36 (40%)	0.353, NS
	Score-1	45 (50%)	50 (55.6%)	
	Score-2	3 (3.3%)	4 (4.4%)	
12 months	Score-0	21 (23.3%)	19 (21.1%)	0.657, NS
	Score-1	51 (56.7%)	59 (65.6%)	
	Score-2	18 (20%)	12 (13.3%)	

[Table/Fig-7]: Inter-group comparison of sealant retention rates in air abrasion and acid etch groups at different time intervals.
Mann-Whitney U test, NS: Not significant

The comparison of sealant retention rates in maxillary and mandibular molars treated with both air abrasion and acid etching was also found to be statistically not significant at both time intervals [Table/Fig-8,9].

Evaluation period	Scores	Group-1 (Air abrasion)		p-value
		Maxillary molars	Mandibular molars	
6 months	Score-0	24 (53.3%)	18 (40%)	0.191, NS
	Score-1	20 (44.4%)	25 (55.6%)	
	Score-2	1 (2.2%)	2 (4.4%)	
12 months	Score-0	11 (24.4%)	10 (22.2%)	0.881, NS
	Score-1	24 (53.3%)	27 (60%)	
	Score-2	10 (22.2%)	8 (17.8%)	

[Table/Fig-8]: Comparison of sealant retention rates in maxillary and mandibular molars treated with air abrasion at different time intervals.
Mann-Whitney U test, NS: Not significant

Evaluation period	Scores	Group-2 (Acid etch)		p-value
		Maxillary molars	Mandibular molars	
6 months	Score-0	18 (40%)	18 (40%)	1.000, NS
	Score-1	25 (55.6%)	25 (55.6%)	
	Score-2	2 (4.4%)	2 (4.4%)	
12 months	Score-0	11 (24.4%)	8 (17.8%)	0.574, NS
	Score-1	28 (62.2%)	31 (68.9%)	
	Score-2	6 (13.3%)	6 (13.3%)	

[Table/Fig-9]: Comparison of sealant retention rates in maxillary and mandibular molars treated with acid etch at different time intervals.
Mann-Whitney U test, NS: Not significant

DISCUSSION

The observations of the current study showed that complete sealant retention in teeth treated with air abrasion was comparable to acid etching at both 6 and 12-month intervals. Optimal adaptation of dental sealants depends on adequate enamel treatment and sealant penetration to the bottom of the fissures. Accurate preconditioning of the enamel surface is critical for the retention of the sealant for a longer duration. Pre-conditioning of pits and fissures increases the surface area, sealant penetration, and provides a bulk of sealant, which in turn improves wear resistance [13].

Air abrasion is a mechanical method of enamel surface pretreatment that removes debris remaining in the pits and fissures. Air abrasion creates a roughened surface, allowing the sealant material to adhere effectively to the surfaces [14]. Other benefits of air abrasion include no heat, noiselessness, and vibration-free operation. Its ability to conserve tooth structure and improve bonding of restorations to enamel has made it popular nowadays [15,16]. Literature evidence suggests that air abrasion enhances enamel bonding [15,16]. Air abrasive technology is less technique-sensitive compared to the conventional acid etch technique [11].

The sealant used in the present study is an unfilled, fluoride-releasing, and colour-changing sealant. Unfilled light-cured resin-based sealants have shown greater retention than filled ones, according to the literature [17,18]. Due to its decreased viscosity, an unfilled resin can penetrate the fissure system more deeply and be retained more effectively [18]. The unique property of colour change from the original pink colour to opaque upon light-curing has advantages: the pink colour allows for better visualisation during sealant placement, and the opaque colour after curing is convenient for evaluating retention during follow-up visits.

Children in the 6-9 years age group were chosen for the study as they have recently erupted permanent first molars with deep retentive pits and fissures that require sealant placement. In the present study, a dental operating microscope with 6X magnification was used to check the sealant retention during follow-up visits, as it provides better vision to appreciate the finest details. Tonn and Ryge's criteria was used to evaluate sealant retention, as it is simple, easy to record, and communicate [12].

In the present study, air abrasion has shown comparable results to acid etching at both 6 and 12-month intervals. This may be due to the wider and deeper pits and fissures, as well as the removal of organic matter, plaque, and a thin layer of prismless enamel, which enhances the ability of the sealant material to penetrate the prepared tooth surface. Similarly, Bendinskaite R et al., have also reported comparable performance of air abrasion and acid etching over five

years [19]. In contrast, a few studies have demonstrated that air abrasion produces a rough surface but lacks the seal obtained with acid etching [6,20].

When Knobloch LA et al., evaluated the effects of air abrasion, acid etching, and the combination of both techniques on primary enamel, they found that the combination demonstrated the strongest shear bond strength. They hypothesised that the improved bond strength was due to an increase in surface area and the contours produced at the macroscopic level by air abrasion, as well as the micropores produced by acid etching [21]. Fumes AC et al., in their systematic review, reported that pretreatment with phosphoric acid leads to lower microleakage in occlusal sealants compared to air abrasion [22].

In the present study, maxillary molars treated with both air abrasion and acid etching showed similar complete sealant retention rates compared to mandibular molars at both intervals. Similarly, McCune RJ et al., observed no difference in the sealant retention rate between maxillary and mandibular teeth at three years of follow-up [23]. In contrast, a few studies have shown that maxillary teeth retain sealants better than mandibular teeth. They proposed that occlusal forces are better dissipated in maxillary molars compared to mandibular molars due to greater number of roots and the fine trabecular bone, which has a larger surface area to disperse stresses [8,24].

In summary, surface pretreatment of enamel with air abrasion showed similar sealant retention rates compared to the acid etch group. This study confirms that the use of air abrasion does not have any added advantages over acid etching and, in fact, requires an extensive armamentarium.

Limitation(s)

The air abrasion system is expensive and requires a stringent isolation protocol to avoid damage to adjacent soft tissues. The splattering of powder particles within the oral cavity and accidental ingestion are additional concerns, for which the use of rubber dam isolation is necessary.

Future recommendations: A future recommendation of the study is to evaluate air abrasion pretreatment along with subsequent acid etching, to determine whether their combined use provides better retention than when used alone. Further research evaluating the marginal leakage of sealants placed on enamel surfaces pre-treated with air abrasion and acid etching is essential to determine the best method for improving sealant retention.

CONCLUSION(S)

The retention rate of fissure sealants on enamel surfaces treated with air abrasion is comparable to acid etching. There is no difference in the sealant retention rates between maxillary and mandibular molars in both the air abrasion and acid etch groups.

REFERENCES

[1] Beauchamp J, Caufield PW, Crall JJ, Donly K, Feigal R, Gooch B, et al. Evidence-based clinical recommendations for the use of pit-and-fissure sealants: A report of the American Dental Association Council on Scientific Affairs. J Am Dent Assoc. 2008;139(3):257-68.
[2] Ripa LW. Occlusal sealing: Rationale of the technique and historical review. J Am Soc Prev Dent. 1973;3(1):32-39.
[3] de Paiva MA, Leite DF, Farias IA, Costa AD, Sampaio FC. Dental anatomical features and caries: A relationship to be investigated. Dental Anatomy. 2017. Intechopen. Doi: 10.5772/intechopen.71337.
[4] Simonsen RJ. Pit and fissure sealant: Review of the literature. Pediatr Dent. 2002;24(5):393-94.
[5] Yazici AR, Kiremitçi A, Dayangaç B. A two-year clinical evaluation of pit and fissure sealants placed with and without air abrasion pretreatment in teenagers. J Am Dent Assoc. 2006;137(10):1401-05.
[6] Blackwood JA, Dilley DC, Roberts MW, Swift EJ. Evaluation of pumice, fissure enameloplasty and air abrasion on sealant microleakage. Pediatr Dent. 2002;24(3):199-203.
[7] Baygin O, Korkmaz FM, Tüzüner T, Tanriver M. The effect of different enamel surface treatments on the microleakage of fissure sealants. Lasers Med Sci. 2012;27(1):153-60.
[8] Bhushan U, Goswami M. Evaluation of retention of pit and fissure sealants placed with and without air abrasion pretreatment in 6-8 year old children- An in vivo study. J Clin Exp Dent. 2017;9(2):e211-17.
[9] Wright GZ, Hatibovic-Kofman S, Millenaar DW, Braverman I. The safety and efficacy of treatment with air abrasion technology. Int J of Paediatr Dent. 1999;9(2):133-40.
[10] Kanellis MJ, Warren JJ, Levy SM. Comparison of air abrasion versus acid etch sealant techniques: Six-month retention. Pediatr Dent. 1997;19(4):258-61.
[11] Kanellis MJ, Warren JJ, Levy SM. A comparison of sealant placement techniques and 12-month retention rates. J Public Health Dent. 2000;60(1):53-56.
[12] Vyas D, Garla BK, Dagli RJ, Solanki J, Parakh D, Vyas A. Retention of a flowable unfilled composite resin in comparison to a dual staged conventional posterior restorative and flowable unfilled resin-based sealant. Int J Oral Health Dent. 2016;2(3):177-82.
[13] Geiger SB, Gulayev S, Weiss EI. Improving fissure sealant quality: Mechanical preparation and filling level. J Dent. 2000;28(6):407-12.
[14] Huang CT, Kim J, Arce C, Lawson NC. Intraoral air abrasion: A review of devices, materials, evidence, and clinical applications in restorative dentistry. Compend Contin Educ Dent. 2019;40(8):508-13.
[15] Sancakli HS, Erdemir U, Yildiz E. Effects of Er: YAG laser and air abrasion on the microleakage of a resin-based fissure sealant material. Photomed Laser Surg. 2011;29(7):485-92.
[16] White JM, Eakle WS. Rationale and treatment approach in minimally invasive dentistry. J Am Dent Assoc. 2000;131 Suppl:13S-19S.
[17] Kumaran P. Clinical evaluation of the retention of different pit and fissure sealants: A 1-year study. Int J Clin Pediatr Dent. 2013;6(3):183-87.
[18] Rock WP, Weatherill S, Anderson RJ. Retention of three fissure sealant resins. The effects of etching agent and curing method. Results over 3 years. Br Dent J. 1990;168(8):323-25.
[19] Bendinskaite R, Peciuliene V, Brukiene V. A five years clinical evaluation of sealed occlusal surfaces of molars. Stomatologija. 2010;12(3):87-92.
[20] Hatibovic-Kofman S, Wright GZ, Braverman I. Microleakage of sealants after conventional, bur, and air-abrasion preparation of pits and fissures. Pediatr Dent. 1998;20(3):173-76.
[21] Knobloch LA, Meyer T, Kerby RE, Johnston W. Microleakage and bond strength of sealant to primary enamel comparing air abrasion and acid etch techniques. Pediatr Dent. 2005;27(6):463-69.
[22] Fumes AC, Longo DL, De Rossi A, Fidalgo TKDS, de Paula E Silva FWG, Borsatto MC, et al. Microleakage of sealants after phosphoric acid, Er: YAG laser and air abrasion enamel conditioning: Systematic review and meta-analysis. J Clin Pediatr Dent. 2017;41(3):167-72.
[23] McCune RJ, Bojanini J, Abodeely RA. Effectiveness of a pit and fissure sealant in the prevention of caries: Three-year clinical results. J Am Dent Assoc. 1979;99(4):619-23.
[24] Whitehurst V, Soni NN. Adhesive sealant clinical trial: Results eighteen months after one application. J Prev Dent. 1976;3(3 Pt 2):20-22.

PARTICULARS OF CONTRIBUTORS:
1. Former Resident, Department of Pedodontics and Preventive Dentistry, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India.
2. Professor, Department of Pedodontics and Preventive Dentistry, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India.
3. Professor, Department of Pedodontics and Preventive Dentistry, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India.
4. Reader, Department of Pedodontics and Preventive Dentistry, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India.
5. Reader, Department of Pedodontics and Preventive Dentistry, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India.
6. Reader, Department of Public Health Dentistry, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Kakarla Sri Rojaramya,
Flat 301, Sivika Heights, Sanjana Estates, Gollalakoderu,
West Godavari District-534202, Andhra Pradesh, India.
E-mail: roja.ramya86@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Jan 18, 2023
- Manual Googling: Jul 24, 2023
- iThenticate Software: Jul 26, 2023 (16%)

ETYMOLOGY: Author Origin

EMENDATIONS: 7

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: **Jan 17, 2023**
Date of Peer Review: **Mar 15, 2023**
Date of Acceptance: **Jul 27, 2023**
Date of Publishing: **Oct 01, 2023**