A comparative evaluation of retention of pit and fissure sealants placed with conventional acid etching and Er,Cr:YSGG laser etching: A randomised controlled trial

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Aim: The aim of this study was to compare the retention rates of sealant placed either with conventional acid etching or Er,Cr:YSGG laser pretreatment of enamel surface.

Materials and methods: This is a prospective, single blind randomised controlled clinical trial enrolling 200 permanent first molars in 50 patients, aged 6-12 years for sealant placement. Study followed split mouth design where each side of the arch was randomly allocated to the two treatment group. Group A (Acid etch group): 37 % phosphoric acid (Scotchbond, 3M ESPE, Seefeld, Germany) was applied for 15 seconds, rinsed with water for 20 seconds and then air-dried using air spray. Group L (Laser etch group): Fissures were prepared with an Er,Cr:YSGG laser system (Waterlase, BIOLASE Technology, San Clemente, CA, USA) emitting photons at a wavelength of 2.78 μm . Laser irradiation at 1.5 W (60% air and 40% water), in a noncontact mode, with a repetition rate of 20 Hz for 10 seconds was used. Pit and fissure sealant (3M ESPE, Clinpro) was applied and cured for 20 seconds. One blinded, calibrated examiner, who was unaware of which preparation method has been used and who was not involved in the treatment procedures, evaluated the sealant at baseline and at 3, 6, 9 and 12 month follow-up visits.

Results: It was observed that overall retention rate in group A was slightly higher as compared to group L at all time periods, however, the difference was statistically non-significant ($p\text{-value} > 0.05$).
Conclusion: Er,Cr:YSGG laser etching is comparable to acid etching in terms of retention and patient acceptability.

Key words: Pit and fissure sealant • acid etching • Er,Cr:YSGG laser

Introduction

In this era of preventive dentistry, many techniques are available for prevention of dental caries. The main avenues include dietary modification, topical and systemic fluorides, sugar substitutes, pit and fissure sealants and caries vaccine.¹⁾ Pit and fissure sealants are one among the most highly recommended and widely accepted preventive procedures.^{1, 2)} The effectiveness of a sealant is related to its retention and retention is dependent on preparation of enamel sur-

face.³⁾ Currently, various enamel treatment procedures are under discussion for optimization of fissure sealant penetration. Acid etching is a well-accepted and standard method for pretreatment of enamel surfaces for adhesion of restorative materials.⁴⁾ However, in case of sealant placement, remaining debris and pellicle might not be removed from the base of fissures by the conventional prophylaxis and etching procedures.⁴⁾ Therefore, alternative methods have been proposed for preparing fissures other than acid etching for sealant retention like air abrasion and laser.⁵⁻⁷⁾

In recent years, lasers have been suggested as a pretreatment method to roughen enamel.⁶⁻⁸⁾ The main advantages that have been ascribed to laser technology are the lack of vibration and pain during the prepara-

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tion of the tooth and no need for local anaesthesia.^{8, 9)} Nd:YAG laser have been reported to produce major thermal effects on dentin, including cracks in the surrounding tissues, as well as increases in pulpal temperature.^{8, 9)}

With the development of Erbium family of lasers, this problem has been solved. The erbium 'family' of lasers has two distinct wavelengths, Er, Cr: YSGG (yttrium scandium gallium garnet) lasers and Er: YAG (yttrium aluminum garnet) lasers. The erbium wavelengths have a high affinity for hydroxyapatite and the highest absorption of water in any dental laser wavelengths. Consequently, it is the laser of choice for treatment of dental hard tissues. An Er,Cr:YSGG laser, with a 2.78 μm wavelength emission, can ablate dental hard tissue effectively because of its high absorbability in both water and hydroxyapatite. Moreover, no thermal effects on pulp tissue have been reported due to its water-cooled system, and this laser can be used in wet conditions.¹⁰⁾ The main advantage of the laser-etched surface is acid resistance. As the calcium/phosphorus ratio changes with the laser application, the enamel becomes more resistant to caries attack.^{11, 12)}

Considering these facts, the use of the Erbium lasers in fissure sealing is of increasing interest. Therefore, we conducted a study on children who are the ideal candidates for pit and fissure sealants with the primary objective of comparing the retention rates of pit and fissure sealant using acid etch and Er,Cr:YSGG laser etch over a period of 12 months. In addition, acceptance of both the enamel pretreatment procedures by the children was evaluated as the secondary objective.

Materials and methods

Study design

The present study was a prospective; single blind randomized control trial carried out after obtaining prior approval from the Ethical Committee of the Institution and registered with Central Trial Registry of India (Ref no. REF/2016/06/011618).

Sample size calculation

A sample size of 156 teeth was estimated to have at least an 80% chance of finding a significant difference using a two-sided test with $\alpha = 0.05$, if the true mean change in sealant retention after 1 year between the acid etch and laser techniques is 0.1 and with standard deviation of 0.3.¹³⁾ Keeping in mind the drop-out rate over a period of 12 months we included 200 teeth for

the study.

Sampling design

Study population comprised of 50 children aged 6-12 years, who visited the outpatient department of Pedodontics and Preventive Dentistry, Maulana Azad Institute of Dental Sciences, New Delhi, India. Recruitment was done through consecutive sampling according to specified eligibility criteria of the study during November 2014-December 2014.

Inclusion criteria

1. No restorations or prior sealants present on the teeth under study.
2. Absence of cavitated carious lesions.
3. Cooperative child patient.

Exclusion criteria

1. Any known history of medical disease, drug therapies or any other serious relevant problems.
2. Uncooperative patients.
3. Mentally and physically challenged patients.
4. Patients who were not willing to undergo pit and fissure sealants or refused to take part in the study.

The details of the study procedure and the purpose of the study were explained to the parents and written informed consent was obtained from them.

Randomization and allocation

A total of two hundred permanent first molars were selected for the study. Split mouth design was followed, where each side of the arch was randomly allocated to the two groups i.e. Group A and Group L according to block randomization technique.

Intervention

In Group A (the acid etch group): The teeth to be treated were isolated with rubber dam, pumice prophylaxis was done to clean the fissures. 37% phosphoric acid (Scotchbond, 3M ESPE, Seefeld, Germany) was applied for 15 seconds, rinsed with water for 20 seconds and then air-dried using air spray.

In Group L (the laser etch group): The teeth to be treated were isolated with rubber dam, pumice prophylaxis was done to clean the fissures as in Group A. Instead of acid etching, fissures were prepared with an Er,Cr:YSGG laser system (Waterlase, BIOLASE Technology, San Clemente, CA, USA) emitting photons at a wavelength of 2.78 μm . Laser irradiation at 1.5 W (60% air and 40% water), in a noncontact mode, with a repetition rate of 20 Hz was used. The treatment was performed with a 600- μm diameter tip aligned perpendicularly to the target area at a distance of 1-2 mm

from the surface for 10 secs. The maximum power density obtained was 530.5W/cm²

A light cured, resin-based, color changing, unfilled pit and fissure sealant (3M ESPE, Clinpro) was applied and cured with visible light curing system for 20 seconds. The sealant was pink when applied and on curing turned opaque white which facilitated in accurate assessment of its polymerization. Rubber dam was removed and occlusion was checked with articulating paper and adjusted as per the requirement. A single operator performed the procedures in all the patients.

Outcome assessment

One blinded, calibrated examiner, who was unaware of which preparation method had been used and who was not involved in the treatment procedures, evaluated the sealant at baseline and at 3, 6, 9 and 12 month follow-up visits. Follow up examinations were conducted in dental chair with the aid of mouth mirror and dental operating light. The criteria used for evaluation was according to Simonsen's criteria⁵⁾ which is depicted in **figure 1**:

- **Completely retained**- If some peripheral fissures were uncovered following sealant wear, but no ledges are present.
- **Partially retained**- If, following either wear or material loss, part of a previously sealed pit/fissure was exposed.
- **Completely lost**- No trace of sealant is detectable.

Acceptance of both the procedures by the same patient was recorded using Visual Analogue Scale.¹⁴⁾ Patients were asked to mark on a 100mm line with extreme ends denoting no discomfort to worst possible discomfort during the procedure. (**Figure 2**)

All the parameters were recorded on a pre prepared proforma for every patient.

Data analysis was performed using Statistical Package for the Social Sciences-21 (SPSS-21). The data was analyzed on the basis of categorical scores given to retention of sealants using chi- square analysis. P-values < 0.05 were considered statistically significant.

Results

Table 1 shows the retention rate of pit and fissure sealants in group A at various time intervals. A gradual decline in the number of teeth with completely retained sealant and an increase in number of teeth with partially retained and completely lost sealant was observed. Overall retention rate of sealants in group A

Figure 1: Diagrammatic representation of the evaluation criteria for maxillary and mandibular molars

Figure 2: Visual Analogue Scale

over a period of 12 months was observed to be 84.9%.

Table 2 shows the retention rate of pit and fissure sealants in group L at various time intervals. A gradual decline in the number of teeth with completely retained sealant and an increase in number of teeth with partially retained and completely lost sealant was observed. Overall retention rate of sealants in group L over a period of 12 months was observed to be 83.3%.

Table 3 shows the comparison of retention rates between the two groups at 3, 6, 9 and 12 months follow up evaluation. It was observed that overall retention rate in group A was slightly higher as compared to group L at all time periods, however, the difference was statistically non-significant (p -value>0.05).

Table 4 shows the mean VAS score of the patients, used for the evaluation of acceptance of both the procedure. It was observed that both the procedures were very well accepted by the patients with sta-

tistically no significant difference between the two groups.

CONSORT statement of the study is presented in **Figure 3**. Drop out of 22% was observed.

Discussion

The present *in vivo* study was conducted to evaluate the retention of pit and fissure sealant by two different techniques i.e. acid etching (Group A) and laser etching (Group L) technique in children. The most appropriate time for application of fissure sealants is soon after the eruption of permanent teeth as recently erupted teeth are immature and less mineralized which benefits from sealants.¹⁵⁾ However, Feigal reported that caries risk on surfaces with pits and fissures might continue into adulthood; therefore, post-eruptive age alone no longer should be used as a major criterion for mak-

Table 1: Retention rate in Group A over 12months follow up period

	3 months	6 months	9 months	12 months
	N (%)	N (%)	N (%)	N (%)
CR	87 (96.7)	54 (61.4)	40 (46.5)	32 (41.0)
PR	2 (2.2)	29 (33.0)	37 (43.0)	35 (44.9)
CL	1 (1.1)	5 (5.7)	9 (10.5)	11 (14.1)
Total	90 (100)	88 (100)	86 (100)	78 (100)

Abbreviations: CR-Completely retained, PR-Partially retained, CL-Completely lost

Table 2: Retention rate in Group L over 12months follow up period

	3 months	6 months	9 months	12 months
	N (%)	N (%)	N (%)	N (%)
CR	80 (88.9)	50 (56.8)	37 (43.0)	28 (35.9)
PR	8 (8.9)	31 (35.2)	38 (44.2)	37 (47.4)
CL	2 (2.2)	7 (8.0)	11 (12.8)	13 (16.7)
Total	90 (100)	88 (100)	86 (100)	78 (100)

Abbreviations: CR-Completely retained, PR-Partially retained, CL-Completely lost

Table 3: Intergroup comparison: Number and percent of sealants at each time interval

	3months		6months		9months		12months	
	Group A*	Group L+	Group A*	Group L+	Group A*	Group L+	Group A*	Group L+
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
CR	87(96.7)	80(88.9)	54(61.4)	50(56.8)	40(46.5)	37(43.0)	32(41.0)	28(35.9)
PR	2(2.2)	8(8.9)	29(33.0)	31(35.2)	37(43.0)	38(44.2)	35(44.9)	37(47.4)
CL	1(1.1)	2(2.2)	5(5.7)	7(8.0)	9(10.5)	11(12.8)	11(14.1)	13(16.7)
Total	90(100)	90(100)	88(100)	88(100)	86(100)	86(100)	78(100)	78(100)
p-value	0.121		0.758		0.848		0.783	

*Group A: Acid etch +Group L: Laser etch

Abbreviations: CR-Completely retained, PR-Partially retained, CL-Completely lost

Table 4: Intergroup comparison of acceptance of the procedure by the patients

Groups	VAS score (Mean $\pm$ SD)	p-value
Group A*	0.30 $\pm$ 2.22	1.000
Group L+	0.30 $\pm$ 2.22	

*Group A: Acid etch, +Group L: Laser etch

ing a decision about whether to place sealants or not.
¹⁶⁾ In view of this, we included a wider age range of 6-12 years for sealant placement in the present study for the benefit of the children.

The laser used in this study was a hydrokinetic

system. The main disadvantage of the Nd:YAG laser was the immediate increase in temperature, resulting in an inflammatory pulpal response.⁸⁾ Er,Cr:YSGG, which has a high absorption coefficient in water (6,500/cm) and enamel (400/cm), leading researchers to explore its use in enamel conditioning.¹⁷⁾ It operates at a wavelength of 2.78 μ m and a pulse duration of 140 microseconds, with a repetition rate of 20 Hz. The average output can be varied from 0 to 8 W, depending on the tissue to be cut. For cutting enamel, the clinician can use high irradiation outputs varying from 2.5 to 8 W. In this study, we used a lower output (1.5 W) to etch enamel as per Berks and colleagues¹⁸⁾ who observed that Er,Cr:YSGG laser irradiation using 1W, 1.5W or 2W produced etching patterns similar to those

Figure3: CONSORT statement

of acid etching by SEM study.

There are some contradictory findings concerning the use of lasers for enamel etching. The majority of previous studies demonstrated that the roughened surface produced by the laser alone lacks the seal obtained with acid etching.¹⁸⁻²⁰⁾ In contrast, some authors²¹⁻²³⁾ reported that laser irradiation may be used to etch enamel. Borsatto and coworkers found that microleakage of fissure sealant with the Er:YAG laser application was higher than that following acid etching or with the laser together with acid etching.²⁴⁾ Cehreli and coworkers reported that Er,Cr:YSGG laser pretreatment did not influence the resistance to microleakage of fissure sealants in primary teeth.²⁵⁾ In another microleakage study, it was reported that the laser irradiation alone or in combination with acid etching resulted in higher microleakage.²⁶⁾ In view of these results, it has been suggested that laser alone was inadequate for etching enamel prior to sealant application and conventional acid etching remains the most effective and simplest technique in sealants success. Furthermore, Manhart²⁷⁾ and Lupi²⁸⁾ reported that if Er:YAG laser conditioning was followed by acid etching, the retention of the sealants was equal to that achieved with acid etching alone. Similarly, Sungurtekin and Oztas²⁹⁾ reported that the micro-leakage values in their laser plus acid etching alone group were similar to those of their acid-etching group. In a recent study assessing the effect of laser surface treatment on the bond strength of a sealant, it was found that the laser prepared the enamel surfaces for sealing but did not eliminate the need for acid etching. As a result, it was concluded that acid etching following laser application enhances marginal seal and decreases microleakage of sealants.

In contrast, Moshonov and colleagues reported no difference in microleakage between lasing or acid etching.³⁰⁾ These contradictory findings may be due to the different outputs and experimental designs of the studies. As the studies mentioned above were *in vitro*, we cannot directly compare our results with them. *In vitro* studies could predict clinical success, but the real performance should be evaluated with clinical studies.

The result of our study are comparable to a clinical study done by Karaman and colleagues¹³⁾ in 2013, where fissure sealants were placed after pretreatment with acid etch and Er,Cr:YSGG laser etch in young

adults and evaluated for retention over a period of 24 months. No significant difference was observed between the two procedures. The authors supported their observation of good retention with laser etching by a recent study, where stereoscopic observation revealed that the laser was capable of cleaning debris in pits and fissures completely. Lased cavities also showed unevenness or irregularity of the enamel surfaces similar to acid etching.³¹⁾

The result of our study showed more number of partially retained sealants in both the groups as compared to fully retained as observed by Karaman and colleagues.¹³⁾ The reason for this finding can be attributed to non usage of adhesive system in our study whereas Karaman and colleagues¹³⁾ used adhesive system before sealant placement which might have enhanced the retention. In addition, we have used a clearly defined diagrammatic representation of sealant which might have led to more objective and non biased recording by the evaluator. Even though there were partial or total loss of sealant, it is hypothesized that laser-prepared enamel surface is less susceptible to acid attack and caries development.¹²⁾ Taking into consideration these features of the laser, it can be speculated that the laser could be a good choice for preparation of enamel prior to the application of a fissure sealant.

In terms of patient acceptability, both the procedures were very well accepted. Only one patient reported slight discomfort which may be attributed to dental anxiety. A finding worth mentioning was that the children found laser machine very attractive with its touch screen monitor displaying teeth and other parameters, which they were relating to games often played by them on their parent's phones and computers. This served positively in their behavior management by the operator. Long-term follow-up visits are also planned to determine if a difference in retention rates appears at later stage.

Conclusion

Er,Cr:YSGG laser etching is comparable to acid etching in terms of retention and patient acceptability. However, more research in this field is needed for it to substitute acid etching in clinical practice.

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