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Comparison of Acid Versus Laser Etching on the Clinical Performance of a Fissure Sealant: 24-Month Results

E Karaman • AR Yazici • M Baseren
J Gorucu

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Clinical Relevance

Etching of enamel with either acid or laser provides similar clinical performance of fissure sealants.

SUMMARY

Objective: **To compare the clinical performance of a pit and fissure sealant placed with the use of different enamel preparation methods, i.e. acid or Er,Cr:YSGG laser etching, over 24 months.**

Methods: **Sixteen subjects (15 female, 1 male) with no restorations or sealant present on their fissures and no detectable caries participated. Using a table of random numbers, a total of 112 sealants (56 with acid-etching, 56 with laser etching) were placed on the permanent premolar and molar teeth. All restorative procedures except for application of the laser were performed by the same dentist. After completion of the fissure preparation either with acid or laser, the adhesive was applied; then a pit and fissure sealant, Clinpro Sealant, was placed and polymerized. Clinical evaluations were done at baseline and at 6-, 12-, 18-, and 24-month follow-up visits by two calibrated examiners, who were unaware of which etching method had been used. The retention of sealants and caries were evaluated with the aid of a dental explorer and an intra-oral mirror. Each sealant was evaluated using the following criteria: 1=completely retained; 2= partial loss; 3= total loss. The Pearson chi-square test was used to evaluate differences in**

*Emel Karaman, DDS, PhD, Faculty of Dentistry, Department of Conservative Dentistry, Ondokuz Mayıs University, Kurupelit, Samsun, Turkey

A. Rüya Yazici, DDS, PhD, Department of Conservative Dentistry, Hacettepe University, School of Dentistry, Sihhiye, Ankara, Turkey

Meserret Baseren, DDS, PhD, Department of Conservative Dentistry, Hacettepe University, Faculty of Dentistry, Sihhiye, Ankara, Turkey

Jale Gorucu, DDS, PhD, Hacettepe University, Sihhiye, Ankara, Turkey

*Corresponding author: Ondokuz Mayıs University, Faculty of Dentistry, Department of Conservative Dentistry, Kurupelit, Samsun, 55139, Turkey; e-mail: dtemelc@yahoo.com

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the retention rates among the sealants used with different etching methods.

Results: **All patients attended the 24-month follow-up visit and all sealants were evaluated (total recall rate 100%). At the end of 24 months, 83.9% of the sealants from laser group and 85.7% of those from acid-etch group were recorded as "completely retained". There were no statistically significant differences in retention rates among the preparation methods after all evaluation periods ($p>0.05$). No statistically significant differences were found between the retention rates of premolar and molars at each evaluation period. No secondary caries was detected in association with any sealants. Conclusion: The clinical performance of fissure sealants placed after acid or Er,Cr:YSGG laser etching was similar.**

INTRODUCTION

Pit and fissure sealants are one of the most highly recommended and widely accepted preventive procedures; they were first reported by Cueto and Buonocore[1] in 1967.[2] It has been shown that fissure sealants are highly effective in preventing dental caries, reducing caries in the pits and fissures.[3] By late adolescence, almost 70% of youths have experienced dental caries. Most of these carious lesions are found in the pits and fissures of permanent posterior teeth, with molars being the most susceptible to caries.[4]

The effectiveness of a sealant is related to its retention, and a retained sealant has been shown to be 100% effective.[5] Retention rates differ according to the proper isolation of the working field, viscosity of the sealant material, preparation of enamel surfaces, and use of adhesive system.[6] Etch-and-rinse adhesives are the commonly used adhesives prior to the application of fissure sealants. Many studies have confirmed the benefits of adhesive systems used under sealants. Hitt and Feigal[7] first reported the benefit of adding an adhesive between the etched enamel and the sealant as a way of optimizing bond strength. Other studies also have shown that application of an adhesive under sealants increases bond strength,[8,9] reduces microleakage,[10] enhances flow of resin into fissures,[11] and improves short-term clinical success.[12]

The acid-etch technique is a well-accepted and standard method for roughening enamel surfaces. However, remaining debris and pellicle might not be removed from the base of fissures by the conventional prophylaxis and the etching procedures.[13,14] Therefore, alternative methods have been proposed for preparing fissures other than acid etching for sealant retention.[15–17] The use of a laser has been suggested as a pretreatment method to roughen enamel. Laser application in dentistry has been a research interest for the past 30 years and recently has risen in popularity. The main advantages that have been described with the use of laser technology are the lack of vibration and pain during the preparation of the tooth and no need for local anesthesia.[18,19] Previous lasers have been reported to produce major thermal effects on dentin, including cracks in the surrounding tissues, as well as increases in pulpal temperature.

With the development of the erbium, chromium: yttrium-scandium-gallium-garnet (Er,Cr:YSGG) laser, this problem has been solved. 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.[20] 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.[21,22] Considering these facts, the use of the Er,Cr:YSGG laser in fissure sealing is of increasing interest.[23] There are conflicting results about the effectiveness of laser etching during fissure preparation. While some authors[24–26] have reported that acid and laser etching cause similar results in terms of marginal adaptation and microleakage, some of them recommended the use of acid after laser application and also stated that the laser etching did not eliminate the need for acid etching.[27–29] Therefore, the search continues for the most effective enamel surface preparation to enhance sealant integrity and retention.

To the best of the authors' knowledge, only one clinical study has compared the retention rates of sealants placed after acid or Er,Cr:YSGG laser etching, and this clinical study was only over 14.5 months.[30] The aim of our 24-month clinical study was to evaluate the clinical performance of a fissure sealant, Clinpro, using two different enamel preparation methods, acid and laser etching. The null hypothesis tested was that no differences would be found between the two preparation methods.

MATERIALS AND METHODS

Subjects were recruited from among patients seeking routine dental care at the conservative dentistry

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clinics at Hacettepe University, Faculty of Dentistry. A total of 112 sealants, distributed in 63 molars and 49 premolars, were placed in 16 patients comprising 15 women and 1 man with a mean age of 21 years (range 20 to 23 years). The patients had good general and oral health and hygiene and no caries, bruxism, malocclusion, previously placed restorations, or allergy to resins. The protocol and consent form for this study were reviewed and approved by the University Human Ethics Committee, and written informed consent was obtained from all patients.

After taking bitewing radiographs of molar and premolars, the fissures of the teeth were cleaned with a slurry of pumice applied with a bristle brush in a slow-speed handpiece to remove salivary pellicle and any remaining plaque. A table of random numbers was used to assign the teeth for etching with either acid or laser. The teeth were isolated with cotton rolls and suction. For the acid-etch group, the fissures were etched with 35% phosphoric acid (Scotchbond, 3M ESPE, Seefeld, Germany) for 30 seconds, rinsed for 15 seconds, and dried for a few seconds until the surface was chalky white. For the laser 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 1.25 W (65% air and 75% water), in a noncontact mode, with a repetition rate of 10 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. The duration of exposure depended on the time needed to guide the laser beam evenly across the pits and fissures to be irradiated. After preparation of the fissures, an etch-and-rinse adhesive, Adper Single Bond 2 (3M ESPE), was used according to the manufacturer's instructions. The Clinpro Sealant (3M ESPE) was then applied to the fissures of teeth. To prevent voids and air entrapment, the sealant was gently teased through the fissure with the tip of a periodontal probe and was then polymerized using a quartz-tungsten-halogen light (Hilux, Benlioglu, Ankara, Turkey) for 40 seconds. Light output of the curing unit was found to exceed 550 mW/cm^2 prior to and after the study, as verified with a radiometer (Curing Radiometer Model 100; Demetron Research Corp, Danbury, CT,USA). The occlusion was checked with articulation paper. Finishing and polishing were performed using fine-grit diamond burs (Diatech, Swiss Dental, Heerbrugg, Switzerland) and rubber cups (Edenta AG, Au, Switzerland). The same dentist performed all operative procedures, except for the laser application.

All patients were available for all evaluations. Two calibrated examiners, who were unaware of which preparation method had been used and who were not involved in the treatment procedures, evaluated the restorations at baseline, and at 6-, 12-, 18-, and 24-month follow-up visits. The retention of sealants and caries occurrence was evaluated with the aid of a dental explorer and an intraoral mirror and visual inspection. The sealants were evaluated in terms of caries formation as present or absent and retention as:

1 = completely retained (CR)

2 = partial loss (PL)

3 = total loss (TL)

The Pearson chi-square test was used to evaluate the differences in retention rates between the two different etching methods at a 5% level of significance. Future follow-up visits at 36 months and 48 months are also planned.

RESULTS

Sixteen patients participated in this clinical study and all of them were available for all evaluations (total recall rate was 100%). Table 1 shows the distribution of preparation methods with regard to premolar and molar teeth.

The distribution of sealant retention rates is displayed in Table 2. A total of 112 restorations (56 for acid, 56 for laser) for 16 patients were evaluated at the 6-monthfollow-up visit. Only one fissure sealant placed after acid etching was totally lost, and two fissure sealants placed after laser application were partially lost after 6 months.

After 12 months, 111 fissure sealants of 16 patients were available for evaluation. No statistically significant differences were found between the retention rates of the acid group (91.1%) and the laser group (91.1%).

At the 18-monthfollow-up visit, 101 teeth were fully sealed with fissure sealant. The retention rate in the acid-etch group was 89.2%, while it was 91.1% in the laser group. Four sealants from each group were evaluated as partially lost. Two sealants from the acid-etch group were completely lost, while no sealants from the laser group were lost.

At the end of 24 months, 47 sealants from the acid group and 48 sealants from the laser group were

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Table 1: *Distribution of Preparation Methods With Regard to Premolar and Molar Teeth*

	Acid	Laser	Total
Premolar	24	25	49
Molar	32	31	63
Total	56	56	112

evaluated as completely retained; the retention rates were 83.9% and 87.5%, respectively. Only two sealants from the acid group were totally lost during the study, while none of them were "totally lost" in the laser group. Seven sealants from the acid-etch group and eight sealants from the laser group were partially lost. There were no significant differences in retention rates between these two preparation methods after 6, 12, 18, or 24 months.

The distributions of retention rates of premolars and molars are shown in Tables 3 and 4. No statistically significant differences were found between the retention rates of premolars and molars at each evaluation period. There was no caries development during the evaluation periods.

DISCUSSION

This clinical study examined the retention of a fissure sealant used with an adhesive system after acid or Er,Cr:YSGG laser etching in young adults. It is known that early placement of sealants protects teeth from caries development. Since recently erupted teeth are immature and less mineralized, the most appropriate time for application of fissure sealants is soon after the eruption of the permanent teeth.[31] Because clinical studies with children have some difficulties like isolation of the teeth, cooperation of the children, and bringing the children to scheduled appointments, this study evaluated sealant loss in patients with a mean age of 21 years. In 2002, Feigal[32] reported that caries risk on surfaces with pits and fissures might continue into adulthood; therefore, posteruptive age alone no longer should be used as a major criterion for making a decision about whether to place sealants. He also pointed out that any tooth at any age could benefit from sealants.

In the current study, there was no significant difference between the two enamel preparation methods. Therefore, the null hypothesis should be accepted. It has been reported that 5% to 10% of all sealants can be expected to fail annually.[33] In the present study, the percentage of the total loss of sealants was 3.5% for the acid-etch group and 0% for the laser group at the end of 24 months.

The laser used in this study was a hydrokinetic system. The main disadvantage of the previous lasers was the immediate increase in temperature, resulting in an inflammatory pulpal response. With the Er,Cr:YSGG laser system, not only could the temperature be suppressed but also cutting efficiency could be increased. Using a pulsed-beam system and fiber delivery, it has proved to be a valuable tool for ablating enamel and dentin. Since the handpiece of the Er,Cr:YSGG laser is light, its manipulation is easy. Unnecessary etching of the enamel is also prevented with the Er,Cr:YSGG laser.[34] There are some contradictory findings concerning the use of

Table 2: *Sealant Retention Rates: Number and percent of sealants at each time interval*

	6-Month		12-Month		18-Month		24-Month	
	Acid	Laser	Acid	Laser	Acid	Laser	Acid	Laser
CR	55 (98.2%)	54 (96.4%)	51 (91.1%)	51 (91.1%)	50 (89.2%)	51 (91%)	47 (83.9%)	48 (85.7%)
PL	0 (0%)	2 (3.5%)	3 (5.3%)	5 (8.9%)	4 (7.1%)	5 (8.9%)	7 (12.5%)	8 (14.2%)
TL	1 (1.7%)	0 (0%)	2 (3.5%)	0 (0%)	2 (3.5%)	0 (0%)	2 (3.5%)	0 (0%)
Total	56	56	56	56	56	56	56	56
p Value	>0.05		>0.05		>0.05		>0.05	

Abbreviations: CR, completely retained; PL, partial loss; TL, total loss.

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Table 3: *Distribution of Sealant Retention Rates (Number (percent)) of Acid-Etch Group for Premolars and Molars*

	ACID-ETCH							
	6-Month		12-Month		18-Month		24-Month	
	Premolar	Molar	Premolar	Molar	Premolar	Molar	Premolar	Molar
CR	23 (95.8%)	32 (100%)	22 (91.6%)	29 (90.6%)	22 (91.6%)	29 (90.6%)	21 (87.5%)	26 (81.2%)
PL	0 (0%)	0 (0%)	1 (4.1%)	2 (6.2%)	1 (4.1%)	2 (6.2%)	2 (8.3%)	5 (15.6%)
TL	1 (4.1%)	0 (0%)	1 (4.1%)	1 (3.1%)	1 (4.1%)	1 (3.1%)	1 (4.1%)	1 (3.1%)
Total	24	32	24	32	24	32	24	32
p Value	>0.05		>0.05		>0.05		>0.05	

Abbreviations: CR, completely retained; PL, partial loss; TL, total loss.

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.[35,36] In contrast, some authors[37–39] reported that laser irradiation may be used to etch enamel. Borsatto and others[40] 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. In another microleakage study, it was reported that the laser irradiation alone or in combination with acid etching resulted in higher microleakage.[41] In concurrence with these results, it has been suggested that the laser alone was not adequate for etching enamel prior to sealant application. Cehreli and others[26] reported that Er,Cr:YSGG laser pretreatment did not influence the resistance to microleakage of fissure sealants in primary teeth. In all these studies, it was concluded that conventional acid etching remains the most effective and simplest technique in sealants' success. Furthermore, Manhart and others[28] and Lepri and others[27] 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 Oztas[29] reported that the micro-

Table 4: *Distribution of Sealant Retention Rates (Number (percent)) of Laser Group for Premolars and Molars*

	LASER							
	6-Month		12-Month		18-Month		24-Month	
	Premolar	Molar	Premolar	Molar	Premolar	Molar	Premolar	Molar
CR	25 (100%)	29 (93.5%)	25 (100%)	25 (80.6%)	25 (100%)	25 (80.6%)	25 (100%)	23 (74.1%)
PL	0 (0%)	2 (6.4%)	0 (0%)	6 (19.3%)	0 (0%)	6 (19.3%)	0 (0%)	8 (25.8%)
TL	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total	25	31	25	31	25	31	25	31
p Value	>0.05		>0.05		>0.05		>0.05	

Abbreviations: CR, completely retained; PL, partial loss; TL, total loss.

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leakage values in their laser plus acid etching 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.[42] As a result, it was concluded that acid etching following laser application enhances marginal seal and decreases microleakage of sealants. 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 theirs. *In vitro* studies could predict clinical success, but the real performance should be evaluated with clinical studies. In a recent clinical study, the two-year clinical performance of two minimally invasive cavity preparation techniques, bur and laser, in Class I occlusal resin composite restorations was compared. In that study, no significant differences were observed between the two techniques and both cavity preparation techniques performed equally, with excellent outcomes after 24 months. However, in that study, laser was used for cavity preparation and flowable resin composite was used.[43]

A split-mouth clinical trial was undertaken to compare the retention of fissure sealants placed using CO_2 laser or acid etching. After a mean follow-up period of 14.5 months, the retention rates were found to be statistically similar.[30] As there is a lack of studies evaluating the laser etching effect on sealant's retention, it is difficult to discuss our findings. In a recent study, 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. They also showed the advantage of the laser in reaching the narrow and deepest parts of the fissures.[44] The removal of debris that accumulates in fissures could increase sealant retention.[14] Laser irradiation also reduces the carbonate to phosphate ratio, leading to the formation of more stable and less acid soluble compounds.[21,22,45,46] Even if there were partial or total loss of a sealant, the laser-prepared enamel surface would be less susceptible to acid attack and caries development. 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. Long-term follow-up visits are also planned to determine if a difference in retention rates or caries development among the two preparation methods will occur at later sealant ages.

CONCLUSION

As preparation of enamel either with acid or laser did not affect the clinical performance of fissure sealants it might be advantageous to prefer laser with its benefits in caries prevention.

Conflict of Interest

The authors of this manuscript certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service and/or company that is presented in this article.

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