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COMPARISON OF ENAMEL ACID ETCHING AND ER, CR: YSGG LASER ETCHING ON THE SHEAR BOND STRENGTH OF STAINLESS STEEL ORTHODONTIC BRACKETS (AN IN VITRO STUDY)

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ABSTRACT

Objective: This laboratory study examined the influence of laser irradiation of enamel etching at 3 different power settings with an erbium, chromium: yttrium, scandium, gallium, garnet (Er, Cr: YSGG) hydrokinetic laser system on the shear bond strength of orthodontic appliances and compared these with that of acid-etching.

Materials and methods: 64 maxillary premolars, extracted premolars for orthodontic purposes were used in this study, teeth were randomly divided into four groups. In Group 1, the buccal enamel surface was etched with 37% phosphoric acid (3M ESPE), In groups 2, 3, and 4, erbium, chromium-doped: Yttrium scandium-gallium-garnet (Er, Cr: YSGG) laser was used for etching, under the following specifications: Group 2 (1.0 Watt/20 Hz, 15 s), Group 3 (1.5 Watt/20 Hz, 15 s), and Group 4 (2.0 Watt/20 Hz, 15 s). After teeth surface preparation, standard edgewise stainless steel premolar brackets were bonded; 1 tooth in each group was not bonded and was examined under a scanning electron microscopic. Bonded teeth were then stored in normal saline at 37 c for 24 hours. Teeth were then debonded using the universal testing machine, SBS and ARI index scores were measured.

Result: Both the 1-Watt and 2-Watt laser irradiations showed fewer bond strengths compared with other irradiations. There was no significant difference in shear bond strength with 1.5-Watt lasing group compared to acid etching group, the evaluation of adhesive-remnant-index scores demonstrated a statistically significant difference in bond failure site among the groups. Generally, more adhesives left on the bracket surface with laser irradiation than with acid etching.

Conclusion: Etching obtained with an Er, Cr: YSGG laser (operated at 1.5- Watt for 15 seconds) is comparable to that obtained with acid etch and could be a feasible alternative to acid etching

KEYWORDS: shear bond strength, enamel acid etching, and enamel laser etching

INTRODUCTION

One of the most developing dental treatment nowadays is orthodontic treatment, where by applying different force on teeth making it possible to move them to the wanted direction. In order to achieve this, it needs a strong bonding between the tooth structure and the different material that are used in orthodontic, Since this bonding is being held in the mouth where the environment could be hot, cold, dry, wet, sour or/and sweet even a combination of all this plus a great biting force.

Orthodontic treatment requires the movement of teeth through the application of force, this force transferred to teeth through the bracket attachments (Proffit et al., 2014) . seventy years ago, this was achieved by banding the teeth through brackets that was soldered to the bands then they were cemented to the teeth, until enamel etching with phosphoric acid introduced by Buonocore (1955). However, it is a known fact that direct bonding saves chair time as it does not require prior band selection and fitting, has the ability to maintain good oral hygiene, improve esthetics and make easier attachment to crowded and partially erupted teeth, Thereafter

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bonding brackets directly onto tooth enamel became possible and Newman (1965) was first who used this technique for direct bonding of orthodontic brackets.

Surface conditioning is necessary to increase bond strength to enamel. The direct bonding of orthodontic brackets with composite resins has been considered as one of the most significant developments in orthodontics(Albaladejo et al., 2011).

For achieving successful bonding, the bonding agent must penetrate the enamel surface; have easy clinical use, dimensional stability and enough bond strength. Different etching techniques were introduced in literature to increase the bond strength some includes: conventional acid etching and laser etching techniques(Sezinando, 2014).

Acid etching has been the conventional method of enamel conditioning since its development in 1955 (Alavi et al., 2014, Ghaffari et al., 2017, Sfondrini et al., 2018b). The most widely accepted etching technique is the application of phosphoric acid at 37% for 30 seconds (Wang et al., 1994, Brauchli et al., 2010).

In the acid etching technique, an enamel surface is prepared for bonding by creating micro-porosities and changing the low-energy hydrophobic surface to a high energy hydrophilic surface(Reynolds, 1975b). However, the enamel surface consequently becomes prone to acid attack and caries around the orthodontic attachments due to demineralization of the surface if it is not completely filled with adhesive(Shannon, 1972).

Over the past years many studies have been conducted focusing on finding an alternative methods to conventional acid etching that are less damaging to the tooth structure and simultaneously yield optimum bond strength(de Jesus Tavarez et al., 2017, Hoshing et al., 2014a, Akhoundi et al., 2017, Heravi et al., 2015)

In recent years laser is proposed for pretreatment of the enamel surfaces for orthodontic bracket bonding (Sfondrini et al., 2018b, Latic Hodzic et al., 2018, Sallam and Arnout, 2018, Zarif Najafi et al., 2019, Ghaffari et al., 2017)Laser irradiation causes thermally induced changes on the enamel surface, such as roughening and micro-irregularities, similar to those caused by acid etching (Ozer et al., 2008). Laser etching treatment does not cause any pain (Usumez et al., 2002, Klein et al., 2005) and is able to inhibit enamel demineralization in vitro, (Klein et al., 2005). Moreover, the surface produced by laser etching is acid resistant since it modifies the calcium-to-phosphorus ratio and reduces the carbon-to phosphate ratio, thus reducing the susceptibility to acid attack and caries(Oho and Morioka, 1990) and it reduces chair time in the dental office (Ghaffari et al., 2017, Hoshing et al., 2014a, Akhoundi et al., 2017, Hoshing et al., 2014b).which could be important issues in orthodontic bonding.

The first laser introduced was the helium-neon laser followed by Nd; YAG and CO2 laser. Then the erbium family(Er; YAG and Er; Cr; YSSG) was introduced to dentistry. Since 1960, numerous types of laser have been used in dentistry (Raji et al., 2012). In dental practice, the first generation of lasers was used only for soft tissues(Berk et al., 2008b). The serious problem applying them on teeth was the immediate increase in temperature, resulting in inflammation of the dental pulp (Aoki et al., 2004). With the invention discovery of two types of lasers, Er: YAG and Er, Cr: YSGG, which were approved by US Food and FDA, Dental hard tissues can now be removed without causing damage (Lee et al., 2007).

There are contradictory findings concerning the use of lasers for enamel etching (Usumez and Aykent, 2003) and (von Fraunhofer et al., 1993a) found that laser irradiation was not able of etching the enamel, while (Ozer et al., 2008)and (Lee et al., 2003) stated that laser etching could be a successful alternative to conventional acid etching.

In addition, Tanji *et al.* (1997) reported that the Er: YAG laser interacts well with dental hard tissue and produced higher bond strength in comparison with acid etching. In contrast, Cardoso *et al.* (2008) and Hossain *et al.* (2003) showed that the mean shear bond strength of laser etching was lower than acid etching.

This posed a question whether Erbium laser etching could be an alternative to that of acid in addition another question regarding the optimum parameters that could achieve optimum bond strength and be comparable to acid etching was raised.

Therefore the purpose of the present study was designed with different parameters to evaluate and compare the SBS of Erbium laser etched enamel to acid etched. Moreover, to detect morphological changes on laser etched enamel surface using SEM.

Objectives of the study

1.To evaluate the effectiveness of the Er, Cr: YSGG dental laser system at 3 different power settings in etching enamel for direct bonding of orthodontic appliances.

2. Comparison of shear bond strengths (SBS), enamel surface characteristics, and adhesive remnant index (ARI) scores of bonding with laser irradiation and phosphoric-acid etching.

3. Assessing enamel surface characteristics using scanning electron microscope.

MATERIAL AND METHODS

This is an Ex vivo (in vitro) study between April 2017 and August 2017, 64 sounds extracted human maxillary premolar teeth for orthodontic purposes and collected, These teeth are extracted relatively frequently, making them easy to obtain. The teeth were stored in the specimen tubes containing distilled water and thymol crystals (0.1% weight/volume) to inhibit bacterial growth (Silverstone, 1967). , teeth were randomly selected based on the following criteria: Intact buccal surface that free of carious and restoration, unbroken buccal surface, buccal surface free from erosion, fluorosis and hypoplastic enamel deformities. Of the 64 teeth, 60 were randomly assigned to one of four treatment groups 15 teeth each, the remaining 4 teeth were not subjected to the shear test but were prepared for scanning electron microscopy (SEM) evaluation after different

Sample preparation

All teeth were mounted vertically in cubic plastic box 3x3x1.5 cm containing a self-cure acrylic resin that only buccal crown at a level slightly below the cervical line was exposed. A dental surveyor was used to align the buccal surface of teeth in the acrylic mold. Thereafter, labial enamel surfaces were polished with fluoride-free pumice slurry using a rubber prophylaxis cup attached to a slow headpiece for 10s, rinsed with air/water spray for 15 s and dried with a stream of oil-free compressed air for 10 s.

4. Test groups, each containing 15 teeth, the buccal surface were conditioned;

Group 1 – Phosphoric acid etch

A 37% orthophosphoric acid gel (Ivoclar-Vivadent; Schann, Liechtenstein) was used to etch 15 premolars for 30 seconds (group A). The teeth were then rinsed with water from a 3-in-1 syringe for 30 seconds and dried with air source from triple syringe for 20 seconds. For all teeth that were etched, the frosty white appearance of etched enamel was noticed.

Group 2, 3 and 4 – Laser etching group

The Er, Cr: YSGG (waterlase, biolase MD USA) laser is a hydrokinetic system. This device allows precise hard tissue treatments by laser energy interaction with water above and at the tissue interface. It operates at a wavelength of 2.78 μm. The average output can be varied from 0.1 to 8 W and a frequency range from 10-50 Hz, it has both hard tissue (H mode) and soft tissue (S mode). The laser energy is delivered through a fiber optic system to a tip and is bathed in an adjustable air/water spray. For cutting enamel, high irradiation outputs from 2.5 to 6 W can be used.

In this study the wavelength remains unchanged (2.78 μm), For all laser etching groups 2,3 and 4 a frequency of 20Hz, air pressure setting 80%, water pressure setting of 90 %... pulse duration of 140 ms and tip MGG6 were same, the only changed parameter was power output of (1W, 1.5W and 2 W) respectively for Group 2,3, and 4 The irradiation was performed in the noncontact and focused mode, with a cylinder fiber tip positioned perpendicular to the enamel surface at a distance of 1– 3 mm from the target tissue. Laser irradiation of enamel surfaces was accomplished by hand, using a sweeping motion. Consequently, irradiation distance ranges from 1 to 1.5 mm All laser irradiations were performed for 15 seconds like it has been done in (Berk et al., 2008a). After Er, Cr: YSGG laser irradiation, the samples were dried with compressed air.

A total of four teeth from each group were separated for SEM analysis without any bonding procedure. Thus the effects on teeth were examined separately. For SEM analysis, the four teeth were evaluated separately. One tooth was acid-etched with orthophosphoric acid, and three were laser-irradiated at different power outputs.

The brackets and bonding procedure

After all the etchings had been performed, stainless-steel standard Stainless steel orthodontic brackets 0.22inch for maxillary premolars were used (Gemini, 3M Unitek, Monrovia, CA),), which easily fitted onto the curvature of the buccal surface of the premolar, are used in this study. The prescribed angulations and torque degree for these brackets are 0 and -7 degree. The bracket base is formed of mesh-shaped arc and the average surface area of the bracket base is determined to be 9.61 mm^2. The bracket base size for bracket was determined by contacting the manufacturer.

The brackets were bonded to the teeth with an orthodontic adhesive (Transbond XT; 3M Unitek), Before curing the bracket was placed onto the tooth surface, adjusted to its final position, and pressed firmly into place, each bracket was subjected to a 300- g compressive force for 10s as described by (Bishara et al., 2003).the 300gm force was applied by using digital tension orthodontic force gauge(ATL_10Y, China). The composite remnants around the brackets were removed with a probe, the curing is then performed with Light Emitting Diode (Denjoy, DY400-4(7W), 2000-2400 mW/cm2 for 40 seconds placed at the mesial, distal, occlusal and gingival aspects for 10s each. The power output was checked with a radiometer constantly after curing of every group (every 15 samples).

All the specimens were allowed to bench cure for 10 min before being placed in a container filled with distilled water and maintained at 37° +/- 1°C for 24 hours in darkness. Leaving the specimens for 24 hours before debonding does not reflect clinical practice. However, it does allow adhesive cement to mature to optimal bond strength (Chamda and Stein, 1996).

Shear bond strength measurements were carried out at Salahadin University, College of Engineering, Department of Mechanics, and Material Strength Lab. The specimens were fixed inside a holding apparatus which in turn secured at lower jaw of the testing machine so that the bracket base paralleled to shearing force. After that, shearing blade (10 mm width and the tapered edge of 0.5 mm thickness) coupled to a movable upper part (crosshead) of testing machine. An occlusal-gingival load was applied in such way that shearing blade struck against the edge of bracket base at a crosshead speed of 0.5 mm/min, producing a shear force at bracket-tooth interface until bracket detached. A computer, electronically connected to the testing machine, recorded the force to debond the bracket in Newton. The bond strength was calculated in Mega Pascal (MPa) by dividing the force (Newton) to the surface area of brackets in (mm2), yielding the result at MPa.

Adhesive remnant index

Once the brackets were debonded, the enamel surface of each tooth was examined under 35 time's magnification under a stereomicroscope (Leica EZ4 HD) to determine the amount of residual adhesive on each tooth. The ARI scores were recorded as described by Årtun and Bergland (1984) with the following scale: 0, no adhesive left on the tooth; 1, less than half of the adhesive left on the tooth; 2, more than half of the adhesive left on the tooth; and 3, all adhesive left on the tooth, with a distinct impression made by the bracket mesh. Table 2.

SEM observation

After the enamel surfaces were conditioned in each group, two samples from each group before bonding procedure were inspected by SEM (Leo 1455 VPGermany) to study the surface topography of enamel following different conditioning techniques. Samples were dehydrated in increasing concentrations of ethanol and water up to 100% ethanol and then coated with gold (approximately 10 to 15 nm) using gold coating apparatus (Nanostructured coating, Hitachi, S-4160). The enamel surface of each tooth was observed under SEM at one chamber pressure (low vacuum), 30 kV accelerating voltage and 110-mA beam current, and photographs were taken at X1000, X5000 and X10000 magnifications. The procedure of mounting, coating, and imaging of samples carried out at the in Karlstad University (Sweden)/ The Faculty of Health, Science and Technology/ Department of Engineering and Physics/ Mechanical and materials engineering

Statistical analysis

Descriptive statistics, including the mean, the standard deviation (SD) and the range, were calculated for each of the four groups of teeth tested. Comparisons of means were made with Kruskal-Wallis and Mann-Whitney tests. Fisher's exact test was used to determine significant association between the experimental method used and the ARI scores. Spearman's rho correlation coefficient was calculated between SBS and the ARI score in each experimental group. Significance level was set at

$p \leq 0.05$. SPSS version 24 was used for data analysis.

RESULTS

Table (1): Descriptive statistics for acid etching and different laser irradiations with different distance. Overall Kruskal-Wallis $P < 0.001$. * Mann-Whitney test was used.

Group	SBS (MPa)							
	No.	Range	Mean	SD	SE	Acid etch*	1-W laser*	1.5-W laser*
Acid etch	15	9.3 - 14.5	11.6	1.8	0.46			
1-W laser	15	2.0 - 5.2	3.8	1.1	0.28	<0.001		
1.5-W laser	15	8.3 - 13.5	10.7	1.7	0.44	0.083	<0.001	
2-W laser	15	2.0 - 6.2	4.5	1.3	0.34	<0.001	0.095	<0.001

SD: standard deviation; SE: standard error

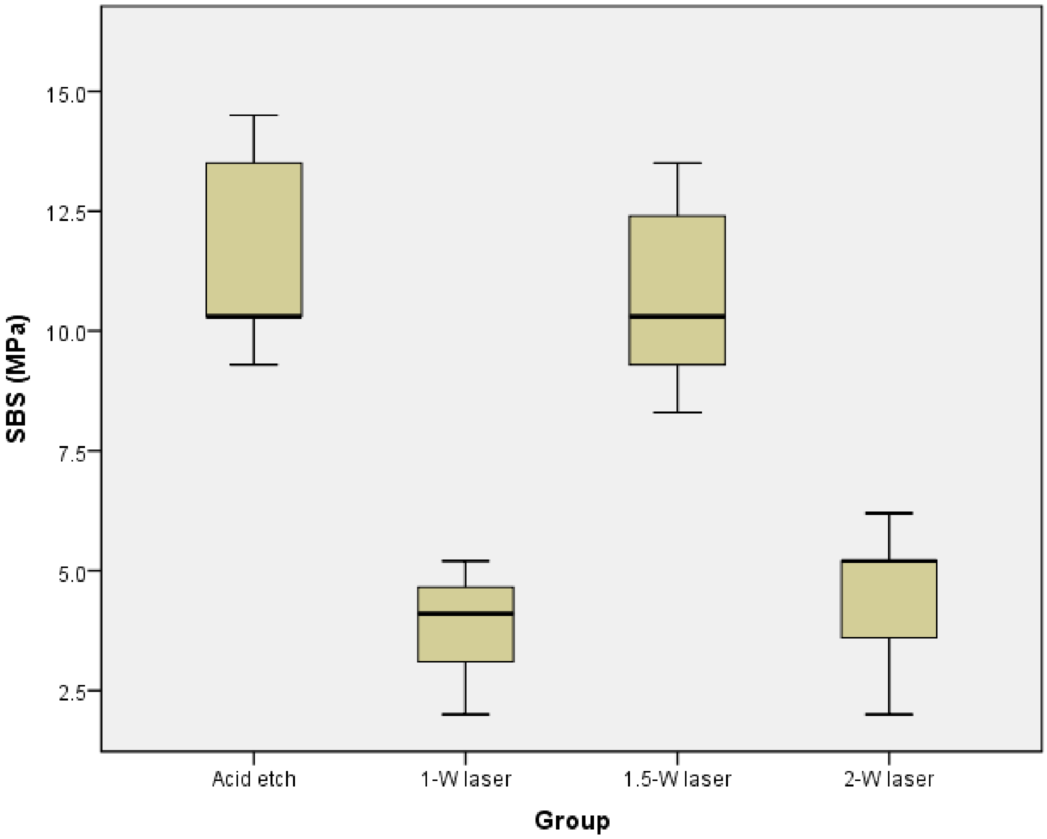

FIG. (1): Mean values and standard errors of shear bond strength (SBS in MPa) for four different pretreatment methods

Shear bond strengths

Descriptive statistics and results of multiple comparisons are shown in Table I and Figure 1. The acid-etched group (group A) yielded the highest mean debonding force (11.6±1.8 MPa). This was followed by the 1.5W laser-irradiated (group c) (10.7±1.7 MPa) and the 2-W(D) (4.5±1.3 MPa) and 1-W(B) laser-irradiated (3.8±.1.1 MPa), respectively.

A Kruskall-Wallis test showed that there were statistically significant differences among the 4 surface treatment methods with respect to bond strength ($P < 0.001$). A Mann-Whitney U test of couples revealed a non-significant difference between the acid-etched group and 1.5-W couple, and between 1-W and 2-W laser etched couples, whereas acid-etched and 1-W laser-etched couple and acid-etched and 2-W laser couple, 1-W and 1.5-W laser-etched couple, 1.5-W and 2-W laser-etched couple showed a statistically significant difference table 1.

Table. (2): Residual adhesive ratings according to ARI for 4 different etching procedures

Group	ARI 0	ARI 1	ARI 2	ARI 3	Fisher's exact test	Fisher's exact test excluding Acid etch
Acid etch	0	10	2	3	*P* <0.001	
1-W laser	12	3	0	0		0.045
1.5-W laser	9	4	2	0		
2-W laser	11	4	0	0		

Adhesive Remnant Index after debonding

The ARI marks for the four groups are listed in Table 2. The ARI scores indicate the site of bond failure for the acid-etched and laser-etched groups.

The Fisher's exact test revealed statistically significant differences among the four groups ($P < 0.001$). When the acid-etched group was dropped from the comparison, the remaining groups still showed statistically significant differences (0.0045).

Scanning electron microscope observation of enamel surface (SEM)

In this study, SEM evaluation showed some different surface characteristics, one macroscopically representative specimen from each of groups A and C was being examined by SEM. However, SEM examination of groups B&D were canceled after the SBS procedure, because the bond values achieved at this setting were below clinically acceptable levels. An untouched enamel specimen was also examined under SEM to allow us to make a visual comparison of the restored acid-etched and the 1.5-W laser-irradiated.

Surface characteristics of the acid-etched enamel seen in (Fig 4) were related to the type I etching pattern described by Silverstone et al. (1975). The prism core material was removed, leaving the prism periphery relatively unaffected.

SEM of 1.5W laser irradiation (Fig 2) showed the type III etching pattern described by Silverstone et al. (1975) characterized by a random etching pattern in which adjacent areas of the tooth surface corresponding to types II and I were present. There were also regions in which the pattern could not be related to prism morphology. Cracks in the surface area were also visible on both directions.

The restored debonded surfaces of both the acid etched (Fig 5) and the laser-etched sample (Fig 3) demonstrated surface structures rougher than the SEM-examined part of the intact enamel. However, the restored surface of the laser-etched sample showed a more irregular pattern than that of the restored acid-etched sample with tiny crater and a lot of resin cover.

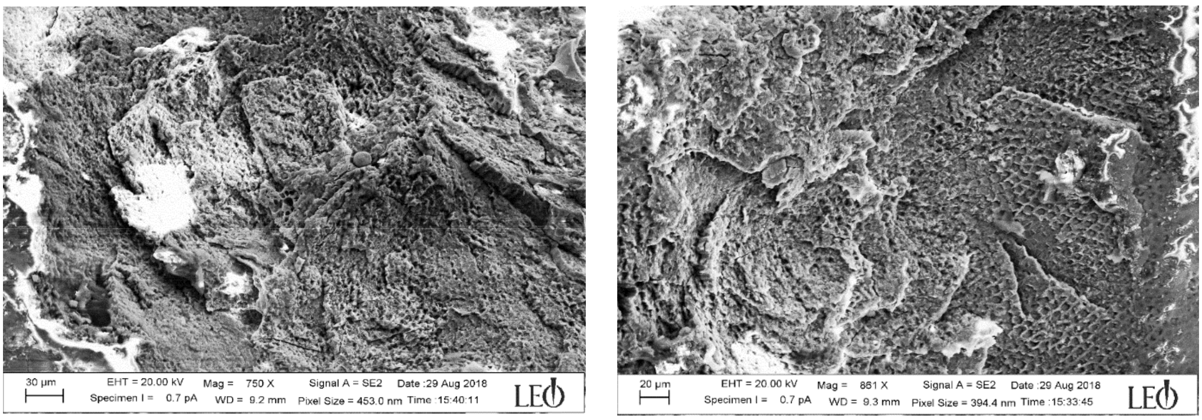

Fig. (2): SEM of 1.5W laser etching enamel surface at 2 different magnificatios.

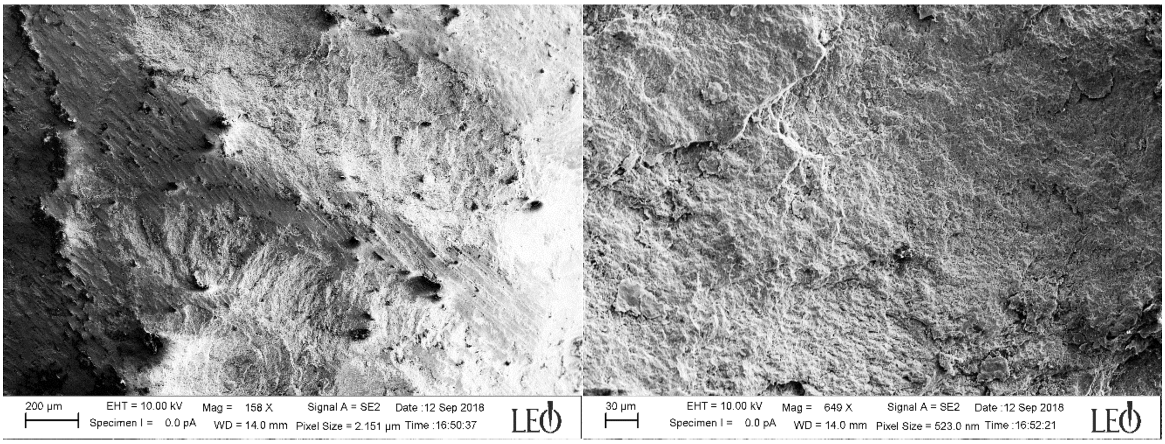

Fig. (3): SEM of restored enamel surface after 1.5 laser etching at 2 different magnifications

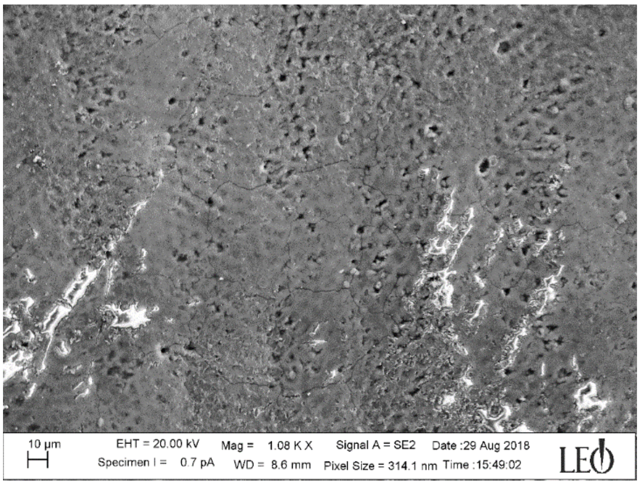

Fig. (4): SEM of enamel surface etched by 37% phosphoric acid for 30 seconds

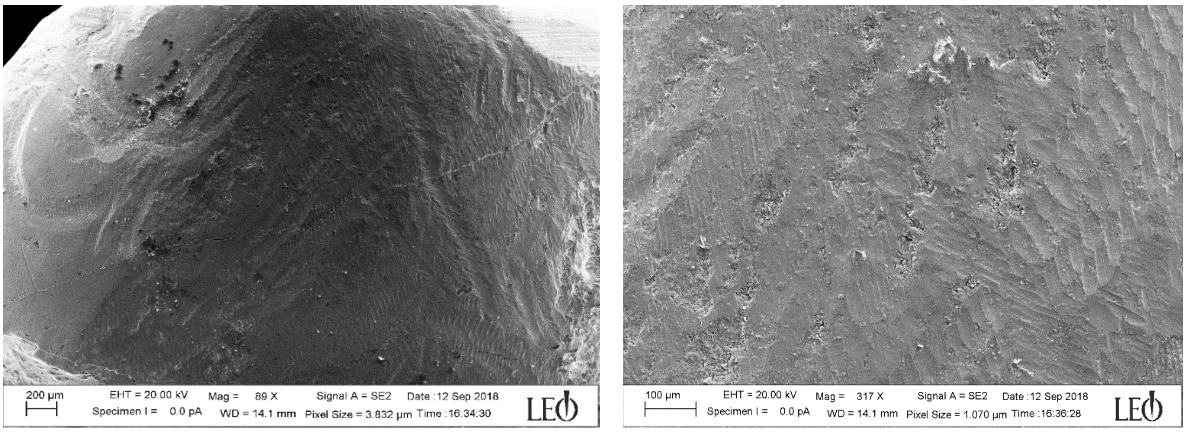

Fig. (5): SEM of restored enamel surface after phosphoric acid etching at different magnifications.

DISCUSSION

In literatures, several studies (Berk et al., 2008b, Özer et al., 2008, Sağır et al., 2013) stated the bond strengths of enamel surfaces irradiated with Erbium laser, most of these studies have irradiated enamel within range of 1.0 to 2.0 W Er:YAG laser and resulted in acceptable SBS .According to that, in our study manual, in this study we used 1W, 1.5W, and 2W and pulse frequency were 20Hz which is the most efficient watts and frequency used for etching enamel surface. The laser wavelength was constant (2780 nm), since it was used for comparison with conventional etching, and the use of different wavelengths would cause a different effect.

Although the average power output of the laser system we used can be varied from 0 to 8 W. For cutting the enamel, high irradiation outputs from 2.5 to 8 W could be used (Bishara et al., 2001). But, to etch the enamel, lower outputs (0.75 to 2.0 W) that would probably etch the enamel,

The result of this study indicate that SBS; achieved with the Er, Cr: YSGG hydrokinetic laser system at 1.5W laser-irradiated group yielded statistically similar bond strength values to those of acid etching. During treatment, orthodontic attachments are subjected to tensile, shear, and torsion forces. Maijer and Smith (1979)found a bond strength of 8MPa to be adequate for orthodontic brackets. On the other hand, Reynolds (1975a) suggested that adequate bond forces range from 6 to 8 MPa. Laser etching with 1.5 W produced clinically acceptable minimum, mean, and maximum shear bond strength. No results were less than acceptable limits. Laser etching with 1.5 W produced comparable levels of shear bond strengths to phosphoric-acid etching. This finding was in accordance to that of (Özer et al., 2008, Başaran et al., 2011b, Hosseini et al., 2012, A Sallam and A Arnout, 2018) whom used the same power output 1.5W. On the contrary, the results presented here conflict with previous studies that showed a significant difference in SBS between acid-etched and Er: YAG laser-etched groups (Contreras-Bulnes et al., 2013, Sfondrini et al., 2018a), This may be caused by the different samples used (human/bovine teeth), different laser machines, different laser irradiation settings (power output, pulse repetition rate, pulse duration settings, energy output, and irradiation time), or different operation modes (contact or non-contact mode, external water cooling, and irradiation distance). Further studies are required to determine standard and optimal parameters for laser etching. Being an Ex-vivo study, as an In-vivo study is inapplicable because of ethical consideration. On the other hand, because in 1W and 2W laser etching groups the average SBS mean were 3.8MPa and 4.5MPa respectively, which are considered below average SBS, thus laser etching at these settings seems unacceptable for clinical use. These results were agreed with(von Fraunhofer et al., 1993b, Başaran et al., 2011a),and were opposite to (Usumez et al., 2002, Jamenis et al., 2011) whom found that laser at 2W power output can etch the enamel, this difference is probably the result of different parameters I.E pulse frequencies or maybe the hand-controlled sweeping motion of the laser beam during the conditioning; the motion might cause a weakly standardized etching pattern throughout the irradiated area.

Regarding the adhesive remnant index ARI; in the current study, the ARI scores were compared between the two groups. According to Fisher's exact test, a significant difference in the mean rank of the ARI score was found between the two groups and a lower value was observed in the laser-etched group. Phosphoric acid showed the statistically significantly highest mean value for ARI which indicated bracket/adhesive interface failure or a great amount of adhesive remained on the enamel surface. On the other hand, laser groups showed significantly lower mean value of ARI revealed less amount of adhesive remained on the enamel surface. In other words, the enamel/adhesive interface failure was the predominant in most of the orthodontic specimens etched with a laser where the majority of the adhesive material remained on the bracket bases, this result was is in line with the results by Hosseini et al. (2012) and Usumez et al. (2002), but opposite to the study by Gokcelik et al. (2007), since the latter showed higher ARI scores in the laser-etched samples compared to that in the acid-etched group. The difference between the results is probably due to the different types of the applied lasers. This could be an advantage or a disadvantage. Less chair time is needed with less adhesive left on the enamel after debonding with lower risk of damaging the enamel surface, but it might cause enamel fracture while debonding, especially with ceramic brackets. It should be noted that failure at the resin-enamel interface has a higher incidence in the clinical setting compared to the in-vitro circumstances because the factors in the oral environment for instance thermal changes, humidity, temperature and microbial plaque compromise the enamel-etching and decrease its efficacy (Fernandez and Canut, 1999).

Concerning time needed for etching of both laser and acid etchings; the 15-second laser etching time used in this study. The minimum time required for acid etching is 15 seconds according to Wang and Lu (1991) and Gardner and Hobson (2001), followed by 15 to 30 seconds of washing and 5 to 10 seconds of drying the etched surface (i.e., a total time of 30 to 45 seconds). If laser etching and drying could be performed in 20 to 25 seconds, allowing immediate placement of a bracket, there would be a savings of 10 to 20 seconds per tooth and a savings of 3.5 to 7 minutes for a full-mouth bonding. Still, more time could be saved if etching and fast resin curing could be combined in the same laser unit.

Finally, 1.5 W laser etching appears to be a possible alternative to acid etching. Though, this is an in vitro evaluation under controlled conditions and, it may not reflect the actual oral environment and real-life loading patterns. Hence, the results may not be directly extrapolated to in vivo conditions. Clinical success is the final test, and prospective clinical trials should be conducted to confirm the in vitro results

CONCLUSION AND SUMMARY

Taking the restrictions of this study into concern, the following can be concluded:

1. The study results showed that etching of enamel surface with an Er, Cr: YSGG hydrokinetic laser system gave statistically similar bond strengths to that of acid etching with 37% orthophosphoric acid for 30seconds.

2.Metallic orthodontic brackets bonded to laser-etched surfaces always fail at the resin–enamel interface, while those bonded to acid-etched surfaces tend to fail at the bracket–resin interface,

3.Laser enamel etching produce surface topography as described by silvestrsone, and it seems possible to restore enamel to its original gloss after debonding and polishing.

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الأهداف : بحثت هذه الدراسة المخبرية تأثير اشعاع الليزر في تخديش مينا السن في 3 طاقات مختلفة مع الإربيوم والكروم: الإيتريوم ، سكانديوم ، الغاليوم ، العقيق (Er، Cr: YSGG) نظام الليزر الهيدروكينيتكي على قوة القص الترابطية لحتصرات تقويم الأسنان ومقارنتها مع تلك التي عمل لها تخديش بواسطة حامض الفسفوريك.

المواد والطرق: تم استخدام 64 من اسنان الضواحك المستخرجة لأغراض تقويم الأسنان في هذه الدراسة ، وتم تقسيم الأسنان بشكل عشوائي إلى أربع مجموعات. في المجموعة رقم 1 ، تم حفر سطح المينا بحمض الفسفوريك بنسبة 37٪ (M ESPE3) ، في المجموعات 2 و 3 و 4 ، تم استخدام: Er) Yttrium scandium-Gallium-garnet، Cr: YSGG) لتخديش المينا ، وفقًا للمواصفات التالية: المجموعة 2 (1.0 واط / 20 هرتز ، 15 ثانية) ، المجموعة 3 (1.5 واط / 20 هرتز ، 15 ثانية) ، والمجموعة 4 (2.0 واط / 20 هرتز ، 15 ثانية). بعد تحضير السطح ، تم لصقاقواس من نوع (Edgewise) غير القابل للصدأ ومن كل مجموعه تم عزل سن واحدلم يتم لصقه عاى المينا لغرض فحصه تحت المجهر الضوئي. ثم تم تخزين الأسنان المستخدمة فى اللصق في محلول ملحي طبيعي عند 37 درجة مئوية لمدة 24 ساعة. بعد ذلك تم نزع الأسنان باستخدام آلة الاختبار العالمية، وتم قياس درجات مؤشر SBS و ARI.

النتيجة: أظهر كل من الاسنان المعرضة لاشعاع الليزر W-1 و W-2 قوة أقل من الروابط مقارنة مع الإشعاعات الأخرى. لم يكن هناك اختلاف كبير في قوة رابطة القص مع مجموعة الليزر 1.5 واط مقارنة مع مجموعة التخديش الحامضي ، وأظهر تقييم درجات مؤشر بقايا لاصقة وجود فرق كبير إحصائيا في موقع فشل الرابطة بين المجموعات. بشكل عام ، هناك مواد لاصقة متبقية على سطح القوس مع تشعيع بالليزر مقارنة بتخديش الأحماض.

الخلاصة: التخديش الذي تم الحصول عليها باستخدام ليزر Er، Cr: YSGG (التي يتم تشغيلها عند W -1.5 لمدة 15 ثانية) قابلة للمقارنة مع تلك التي تم الحصول عليها باستخدام التخديش الحمضي ويمكن أن تكون بديلاً ممكنًا عن التخديش الحمضي

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