Original Research Paper

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"CO_2 LASER ETCHING" -AN EFFICIENT ALTERNATIVE TO CONVENTIONAL ACID ETCHING TECHNIQUE?

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ABSTRACT **Aim:** to evaluate and compare the shear bond strength of the brackets bonded after CO2 laser etching, conventional acid etching technique and after combination of CO2 laser etching followed by conventional acid etching technique.

The combination of laser etching in different modes followed by chemical etching resulted in comparatively similar bond strength as samples of acid etching group therefore it can be used where maximum bond strength is required.

Continuous mode of carbon dioxide laser gives better results in terms of shear bond strength than ultra pulse laser etching. The combination of laser etching in different modes followed by chemical etching resulted in comparatively similar bond strength as samples of acid etching group

KEYWORDS : Co2 Laser,Shear bond strength,Pulsed Laser,.acid etching

INTRODUCTION:

Tremendous revolutionary changes have occurred during the last few decades in the ever changing scenario of Orthodontics. These have added to the precision, time efficiency, patient's convenience and biological acceptability over the years and have made Orthodontics an interesting domain to usher in. Owing to the continuous research for improvement in adhesives and techniques, Orthodontics has reached an era where direct bonding, its knowledge and application, have become an inherent part of treatment. However the constant re-evaluation of the method with therapeutic approach is inevitable and is an ongoing activity.

The surface changes of the enamel is dependent on the wavelength of Laser, emission mode of Laser (pulsed or continuous), energy density achieved at surface, duration of exposure and nature of substance absorbing the Laser energy. there is no study on CO_2 lasers with continuous pulse and ultra pulse mode and in combination with conventional, acid etching technique, hence in the present study Co_2 laser was used in continuous and ultra pulsed mode, as ultra pulse Co_2 lasers provide short duration pulses separated by sufficient time to allow the tissues to cool between the pulses and as a result it limit's thermal damage.

MATERIALS AND METHODS:

1. 130 freshly extracted young healthy non carious human maxillary and mandibular premolars extracted for orthodontic purpose. The criteria for tooth selection included intact enamel surface with no carious or hypoplastic lesions, no history of any pretreatment with chemical agent like hydrogen peroxide and no cracks due to use of extraction forceps.
2. 100 nos. aluminum blocks of size 10 x 10 mm dimension and 1 inch in length.
3. 100 nos. curved base beggs brackets(T.P Orthodontics)
4. Etchant, 37% orthophosphoric acid (3M SPE,Scotch Bond) USA
5. Dry air system free from oil and water
6. Carbon Dioxide laser system (Ultra CO_2 surgical VISCO Laser System USA)
7. Transbond XT light cure bonding adhesive paste(3M Unitek Monrovia, CA, USA)
8. Transbond XT light cure orthodontic adhesive primer (3M Unitek Monrovia, CA, USA)
9. Light cure unit (Light emitting diode)
10. Instron Machine (Universal testing machine 467 H, 1978. ENGLAND)

Scanning electron microscope (JEOL, JSM, 6380 A JAPAN)

FOR STUDYING SHEAR BOND STRENGTH

Group I consisted of extracted100 premolars. The roots of these teeth were embedded in cold cure resin encased in square aluminum blocks (10X10mm, 1 inch length) to which colour coded acrylic tail (10X5mm, 2½ inch length) were attached .The colour coding helped in identification and formation of various subgroups .All the specimen were polished with pumice and water on the buccal surface and then they were subjected to water rinsing and drying.

Group I was further divided into Sub group A, B and C

- **SUB GROUP A** consisted of 20 samples, the tails of which were colour coded in pink .These samples were subjected to acid etching. A 37% orthophosphoric acid gel was applied on the buccal surface of the premolars in the area of 4 X4 mm^2 for 15 seconds , then the specimen were washed in free running water for 30 seconds and dried for 15 seconds with compressed air without oil or moisture. A white frosty surface indicated etched enamel.
- **SUB GROUP B AND C** consisted of 80 samples, enamel of which were subjected to two modes of laser for etching i.e. continuous mode and ultra pulse mode after which they were acid etched with 37% of orthophosphoric acid for 15 seconds .

The breaking load obtained in KN was converted to Kg F(KN x 100= Kg F) The surface area of bracket was approximately $9mm^2$ Following formula was used to obtain shearing strength. Shearing strength = breaking load in Kg F/Cross section area in mm^2 = Kg F/ mm^2 Kg F / mm^2 x 9.81 give the bond strength in Mega Pascal.

GROUP III: (n=10)

FOR STUDY OF SURFACE MORPHOLOGY WITH SCANNING ELECTRON MICROSCOPE

- This study was performed on 10 premolars which comprised the group III
- Four premolars were subjected to laser etching, two samples each for continuous pulse & ultra pulse mode respectively. One sample was used in each pulsed mode i.e. 2 watt & 3 watt.
- Four premolars were subjected to laser etching, two samples with continuous pulse, (2watt and 3watt) and two with ultra pulse (2watt and 3 watt), which were then followed by conventional acid etching.
- One premolar was subjected to acid etching alone.
- One premolar was taken as control.
- The study surface (specimen 2mm thick) was mounted to aluminum stubs with silver paste .Each specimen was coated with gold palladium up to 10-20 nanometer thickness in a Palaron E-5000 sputter coating unit. The specimens were then examined under a scanning electron microscope (JEOL, JSM, 6380 A JAPAN) 10kvp to 20Kvp at working distance of 39mm with magnification of 1280x
- A total of 10 microphotographs were taken and surface characteristics were studied.

FOR STATISTICAL ANALYSIS

Student's independent "t" test was used to compare the difference among the samples in the same subgroup. The results of this comparison are reported as degree of freedom and p value. If the p value was less than point 0.05 it was considered that the difference is significant.

RESULTS:

Table III: Mean, median and ranges of all groups are summarized in this table

Group	Mean ± SD	Median	Range
B11	9.24±0.79	9.54	7.74-10.21
B12	11.29±1.20	11.13	9.65-13.1
B21	7.00±0.95	6.95	5.75-8.67
B22	7.65±0.83	7.68	6.39-8.74
C11	13.70±1.86	14.1	9.73-15.81
C12	14.80±1.18	14.58	13.11-16.51
C21	11.33±1.61	11.41	8.42-13.99
C22	12.16±1.98	12.07	9.31-15.13

The statistical analysis done to test the significance of difference for shear bond strength, temperature rise and enamel loss between acid etched,laser etched samples (continuous pulse and ultra pulse mode) and laser etching (continuous pulse and ultra pulse mode) followed by conventional acid etching revealed-

- There was a highly significant difference observed in shear bond strength between samples etched with continuous pulse 2 watt ($B1_1$) and continuous pulse 3 watt ($B1_2$) respectively. The mean value was highest in continuous pulse 3 watt laser group..
- Similarly there was highly significant difference in shear bond strength between control group and continuous pulse laser group ($B1_1$,$B1_2$) respectively. The highest mean shear bond strength was observed in control group.
- When shear bond strength between samples of acid etched group (control) were compared with samples etched with ultra pulse laser group ($B2_1$,$B2_2$), there was highly significant difference in shear bond strength between control group and ultra pulse laser group i.e. acid etch group resulted in more shear bond strength than the ultra pulse laser group.
- Highest shear bond strength was observed in samples of continuous pulse laser 3 watt followed by acid etching group and lowest shear bond strength was observed in samples of 2 watt ultra pulse laser group

DISCUSSION:

Etching tooth enamel with phosphoric acid creates surface irregularities and micro porosities that can be filled through adhesive penetration. Enamel etching with phosphoric acid creates an etch pattern characterized by a deep and uniform demineralization areas.

With the development of lasers and their applied use in orthodontics etching, new horizons have been opened in the field of orthodontic etching procedures.

Hence taking into account the background, the aims & objectives of the present study were to evaluate and compare the shear bond strength of the brackets bonded after CO_2 laser etching, conventional acid etching technique and after combination of CO_2 laser etching followed by conventional acid etching technique using different pulse modes of laser i.e. Continuous and Ultra.

The combination of laser etching in different modes followed by chemical etching resulted in comparatively similar bond strength as samples of acid etching group therefore it can be used where maximum bond strength is required.

Laser etching may save some amount of clinical time, but the savings are not great and may not justify the capital expenditure involved. Since this was an in vitro study, it had its limitations pertaining to in – vitro situations. The complex or environment with variations in temperature, stresses, humidity, acidity, and plaque is difficult to reproduce in laboratory, which may affect the bond strength.

CONCLUSION:

Highest mean shear bond strength was observed in Group $C1_2$ i.e. brackets bonded after etching with continuous pulse 3 watt followed by acid etching.

- Brackets bonded after 37% orthophosphoric acid etching, resulted in second highest mean shear bond strength values followed by brackets bonded after combination of continuous pulse 2 watt laser and 37% orthophosphoric acid.(Group $C1_1$)

- Ultra pulse 3watt laser followed by 37% orthophosphoric acid (Group $C2_2$) had more bond strength in comparison with ultra pulse 2watt followed by 37% orthophosphoric acid group.($C2_1$)

Thus from the findings of the study it can be concluded that etching of enamel surface with laser is more advantageous than etching of enamel surface with phosphoric acid as there is less enamel loss with laser during etching, debonding and clean up procedures, with less technique sensitivity, controlled depth, reduced time of etching and resistance against caries producing acids.

Further research is required to distinguish the most biocompatible type of laser which could be used for various other purposes, besides enamel pre – treatment procedures. Various aspects regarding the effective control of temperature during the lasing procedure requires extensive research.

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