Evaluation of Chlorhexidine Application on Shear Bond Strength in Different Brackets and Different Etching Techniques in Vitro Study

Bayan Ghdhban[1], Nidhal H. Ghaib[2]

[1]Post graduate; [2]Professor/College of Dentistry, University of Baghdad, Iraq

Abstract

Purpose of this study was to assess the etch enamel surface of teeth, affect "shear bond strength" in application chlorhexidine and the "adhesive remnant index" scores.

Material and Method: Eighty premolar teeth half of the samples (Groups A,B/metal bracket.C,D/ceramic bracket) were conditioned with using 37% orthophosphoric acid gel (SDI, California,USA)for 30s washed/ dried. The other half of the samples (Groups E,F/metal bracket.G,H/ceramic bracket) were conditioned with Er:CrYSGG laser system, Power: 2W, Wave length: 2,780,energy: 250 mJ , Pulse duration: 140 µs Frequency: 20 Hz. ,Cooling system: 90%:%80air-water spray , Mode of application: swiping motion (Waterlase,1 plus from Biolase USA) and then washed and dried. The groups(B,D,F,H) sealant was applied with CHX varnish**.**

Results: statistical analyses presented that SBSs of laser radiation were significantly difference than that of acid etching.

Conclusions: laser etched resulted the bond Strength accepted clinically in the metal , ceramic and could be an substitute to the acid etching .CHX sealant not significant affect in orthophosphoric acid etching but more weaker in laser etching.

Keywords: *chlorhexidine application; shear bond strength; etching techniques; vitro study*

Introduction

key to therapeutic success is get highly bond strength and less damage to the tooth surface. The bond strength between the bracket base and tooth surface should be sufficient to withstand the thermal and mechanical effect of the oral environment and have to provide sufficient resistance against stresses from arch wires and force of mastication**(1,2),**it is consider acid etching has been standard procedure for bonding orthodontic brackets .But the decalcified enamel surface after acid etching has the prospective disadvantage of making the enamel more liable to a caries attack . There is an urgent to found simpler clinical techniques with decrease enamel loss and provide clinically better bond strength. Lately, It has attracted significant attention to using laser radiation are Er:YAG, and Er,Cr:YSGG because it results in an irregular surface pattern which is similar to that of an acid etching pattern**(3)** ,and can remove the smear layer and it does not involve heat or vibration, It can be modifies crystalline and chemical structure of the tooth surface and more resistant to caries. **(4).** Fixed appliances difficulties maintaining proper oral hygiene, and easily dental plaque can accumulate therefore increase prevalence of plaque-induced diseases lead to a higher risk of rising gingivitis and decalcification (5) Prevention of dental caries plays a vital role in orthodontic treatment, strategies chemotherapeutic treatment regimens have received much attention and have presented satisfactory result.Chlorhexidin (CHX) as chemical antimicrobial substances are proficient of inhibiting bacterial adhesion, metabolic activity, and colonization by reducing the bacterial growth·CHX collective with thymol in a varnish have excellent adsorption to the tooth surface for long period, prevent its immediate loss, thus acting

as slow-releasing reservoirs[6]. these study has been established to evaluate and comparable the laser etching with acid-etching and to decide the suitability of these with chlorhexidine varnish .

Materials and Methods

Sample organization and preparation: The selected (82) upper premolar teeth intact enamel, no caries and cracks . The teeth were pumiced/ washed-dried for (10) s. The teeth embedded in acrylic resin and align the buccal surface of the tooth with mounting jig was used to be parallel to the force applied through shear test [7]. The power of laser output can be various from 0-6W determined the tissue to be cut. The power settings for laser groups had been selected on the basis dentinal studies and pilot study, the using 2 W power, the rate repetition pulse 20 pulses / second (20 Hz), a duration of the pulse 140microseconds,[8,9,10]. The Er,Cr:YSGG laser (Waterlase, I plus from Biolase USA), is produces accurate cuts for hard tissue via interaction with water at the enamel surface. The air levels were 90% and water 80%, respectively. To standardized the distance, The beam of laser was a vertical to the tooth surface at a distance of 1 m[11], a sweeping manner was moved by hand over an about 4*4 an acrylic resin with a gap, was retained on the enamel surface during an exposure time of 15 seconds[1] (Fig:1-1). All specimens were randomly divided into:

Group A (10teeth): Enamel etched with 37% orthophosphoric acid for 30 second, then rinsed/dried for 15 second then bonding metal bracket as control group.

• Group B (10teeth): Enamel etched with 37% orthophosphoric acid for 30 second then rinsed/dried for 15 second then bonding metal bracket with chlorhexldine sealant.

• Group C (10teeth): Enamel etched with 37% orthophosphoric acid for 30 second then rinsed/dried for 15 second then bonding ceramic bracket without chlorhexldine sealant.

• Group D (10teeth): Enamel etched with 37% orthophosphoric acid for 30 second then rinsd/dried for 15 second then bonding ceramic bracket with chlorhexldine sealant.

• Group E (10teeth): Enamel irradiated with the Er,Cr:YSGG laser at 2 W for 15 seconds then washed/ dried for 15 second then bonding metal bracket without chlorhexdine sealant

• Group F (10teeth): Enamel irradiated with the Er,Cr:YSGG laser at 2 W for 15 seconds then washed/ dried for 15 second then bonding metal with chlorhexdine sealant

• Group G (10teeth): Enamel irradiated with the Er,Cr:YSGG laser at 2 W for 15 seconds then washed/ dried for 15 second then bonding ceramic bracket without CHX sealant.

• Group H (10teeth): Enamel irradiated with the Er,Cr:YSGG laser at 2 W for 15 seconds and bonding ceramic bracket with chlorhexldine sealant.

The two teeth were utilized for observation by "scanning electron microscopy" (SEM) to decide the morphology/topography of the etching enamel .

Adhesive preparation: The group B,D, F,H were incorporated, with CHX varnish has equivalent, thymol+CHX (1 mg of each/gm) ,two drops of CHX were added to every one drop of primer 2:1 and then mixed,[12].Thin uniform coat was applied to etched enamel surface from mixture Transbond XT primer and curing for 15 second all groups [13].

Bonding Procedure: each group of the brackets were bonded to premolars utilizing primer / resin (3M Unitek,Monrovia, U.S.A),in the center of the facial surface of the tooth. Sufficient pressure " 200 gm. load on the upper part of the vertical arm of the surveyor" to promote excess adhesive, which was removed by probe, and then brackets light cured for 10s;5s for each side. the intensity of light was 1200 m W/cm .later exposed to thermocycling 500 times in distilled water between 5uC and 55uC, with a dwell time in each bath of 30s and a transfer time of 15s. All specimens accomplished by using "Tinius `Olsen universal testing machine with 5 KN load cell and a crosshead speed of 1 mm/ minute" [13],as a result that the readings in newtons

Then, values were altered into megapascals (MP) via dividing the force on the base of bracket area(metal 10.50mm^2/ceramic10.75 mm^2).The facial surface of every tooth were inspected under a stereomicroscope (10X magnification) later debonded bracket for conclude the ARI score to define quantity of resin residual on the enamel surfaces was predominant site of bond failure [Artun and Bergland, 1984][14].ARI ranges between 0 - 3 (0:no residual resin covering on tooth; 1:less than 50% resin covering on tooth; 2: more than 50% residual resin on tooth; 3: 100%residual resin covering on tooth).Data were collected and analyzed using SPSS program version 25. The descriptive statistics included means, standard deviations, frequency distribution and percentage, while the inferential statistics included Shapiro-Wilk test, independent sample t-test and Chi-square test.

Results

SBS in descriptive statistics was expressed in (MPa) for 8 groups tested are existing in(Table:1/Fig:1). Anova revealed the existence of significant differences (P<0.0001)between laser etching/acid etching and Tukey test informed that with conventional acid etching , the highest SBS values were recorded than laser etching .Adding CHX as the sealant lowers SBS in laser groups,but no more effect in acid etching special in metal bracket(Table:2/Fig:1).Chi-square comparison of the ARI scores between entirely groups(Table:3/ Fig:2) shown that the groups were significantly different .The minimum quantity of residual adhesive was found in laser groups. SEM analysis revealed the different etching patterns gained for every group .

Table 1 : Descriptive statistics and comparison the effect of etching type with CHX on the shear bond strength of different brackets

Etching types	Presence or absence of CHX	Descriptive statistics				Comparison (d.f.=18)		
		MB		CB				
		Mean	S.D.	Mean	S.D.	Mean difference	t-test	p-value
Phosphoric acid	Without CHX	13.963	2.576	19.542	3.994	-5.579	-3.712	0.002 (HS)
	With CHX	12.396	2.069	12.551	3.297	0.155	0.588	0.563 (NS)
LASER	Without CHX	11.053	2.227	9.462	1.160	1.591	2.004	0.060 (NS)
	With CHX	5.923	1.152	2.943	1.026	2.980	6.109	0.000 (HS)

Table 2: Descriptive statistics and comparison the effect of chlorhexidine on the shear bond strength of different brackets

Etching types	Brackets' types	Descriptive statistics				Comparison (d.f.=18)		
		Without CHX		With CHX				
		Mean	S.D.	Mean	S.D.	Mean difference	t-test	p-value
Phosphoric acid	MB	13.963	2.576	12.396	2.069	1.597	2.059	0.0543 (NS)
	CB	19.542	3.994	12.551	3.297	6.992	4.676	0.000 (HS)
LASER	MB	11.053	2.227	5.923	1.152	5.130	6.469	0.000 (HS)
	CB	9.462	1.160	2.943	1.026	6.519	13.315	0.000 (HS)

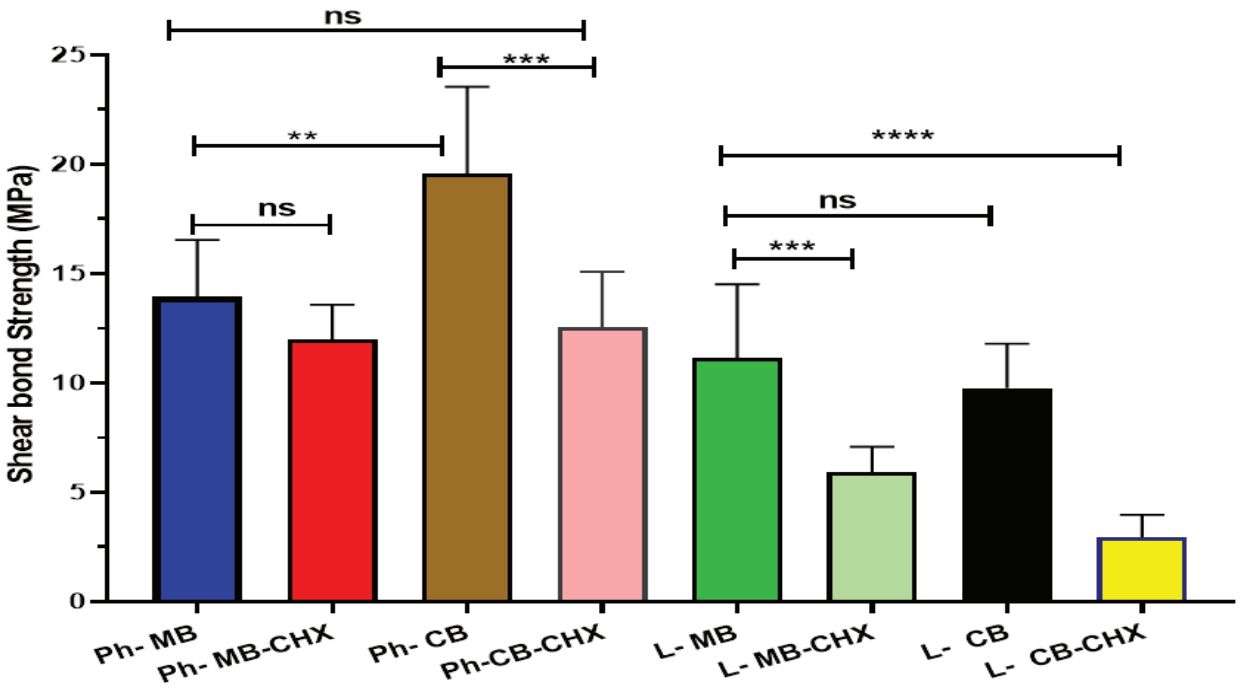

FIG. 1 Box plot of shear bond strengths (MPa) of the different groups tested.

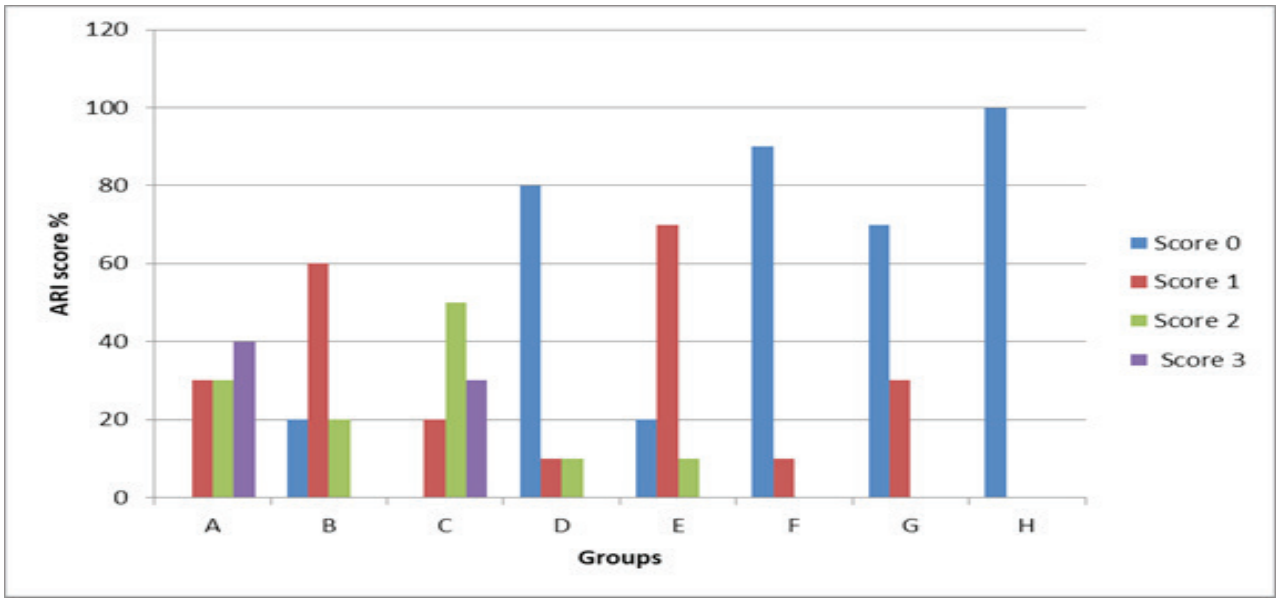

Fig.2: Frequency distribution of adhesive remnant index

Table 3: Frequency distribution and percentage of ARI of different groups

Groups	Score 0	Score 1	Score 2	Score 3	Total
A	0 (0%)	3 (30%)	3 (30%)	4 (40%)	10 (100%)
B	2 (20%)	6 (60%)	2 (20%)	0 (0%)	10 (100%)
C	0 (0%)	2 (20%)	5 (50%)	3 (30%)	10 (100%)
D	8 (80%)	1 (10%)	1 (10%)	0 (0%)	10 (100%)
E	2 (20%)	7 (70%)	1 (10%)	0 (0%)	10 (100%)
F	9 (90%)	1 (10%)	0 (0%)	0 (0%)	10 (100%)
G	7 (70%)	3 (30%)	0 (0%)	0 (0%)	10 (100%)
H	10 (100%)	0 (0%)	0 (0%)	0 (0%)	10 (100%)

Discussion

Acid etching is consider the well technique of attachment resins to tooth surface[15] .But is more susceptible to acid attack as result to plaque accumulation nearby to the brackets especially when saliva contamination and air bubbles disturb the resin penetrance. Recently introduced laser etching as alternative to the acid etching ,because decrease the caries risk, by Alteration of calcium to phosphorus ratio. But the lased surface is fissured and less homogenous[1]. We aimed to find the most suitable enamel preparing techniques for bracket attachment in terms of SBS,ARI, and SEM observations ,with minimums caries risk by CHX application .

In present study, the laser parameters determine based on a previous studies and pilot study[8][9][10] The results of present study revealed that SBS values of brackets bonded with laser etching were significantly lesser than that of acid etching in both(LM,LC brackets). Reynolds[29] recommended the SBS ranged from 6 to 8 MPa clinically acceptable bonding. So, the SBSvalues for LM and LC groups in present study are still acceptable clinically strengths for bracket bonding. These results agree with the findings to[8,10,16]. But is different from Findings[17,9].

Probably this Contradictory the findings relating they utilized more various power outputs of laser technique and varies nature curvature enamel structures or formed micro pores, craters in enamel and melted bubbles formed during laser etching or may be as result of the using sweeping motion by hand controlled of the laser beam during the etching may be reason a inadequately standardized etching pattern during the irradiated area. Further might standrazition be aid to solve this problem, Our results also agree with the findings of Nakamura *et al* [18].Chlorhexidine such as in Cervitec plus (1% Chlorhexidine +1%thymol) has proved to be better antimicrobial agent, therefor using as the sealant with primer agent,to reduce minimal time application and does not rely on patient compliance. Also retained on to the oral surfaces by attaches to the glycoproteins by reversal electrostatic binding thus gets CHX releases slowly into the oral environment permitting for a prolonged antimicrobial effect[19].Laser in CHX sealant commonly weaker this is probably causing a existence of micro cracks under close enamel particles ,this may formed a weakened substrate, this is more susceptible to the happening of fractures during measured bond strength testing[20].But is more acceptable in acid etching this agreement with Karaman [21].

In acid etching more ARI score was found on facial surface resultant in decreased enamel fracture risk and final more "bracket bond strength". These results were in agreement with Samruajbenjakul et al,[22] . reduce ARI score was found in laser etching and sealant with CHX . This means a smaller quantity of adhesive remaining on tooth surface resulting in relatively reduced SBS . These results were comparable with studies showed via Sibi et al, [23].

Different etching patterns achieved in SEM analysis , according to Silverstone et al[24]. the acid etched enamel shows cracks in some regions ,and produced enamel surface resembled type 1 pattern of etching (Fig: 4).

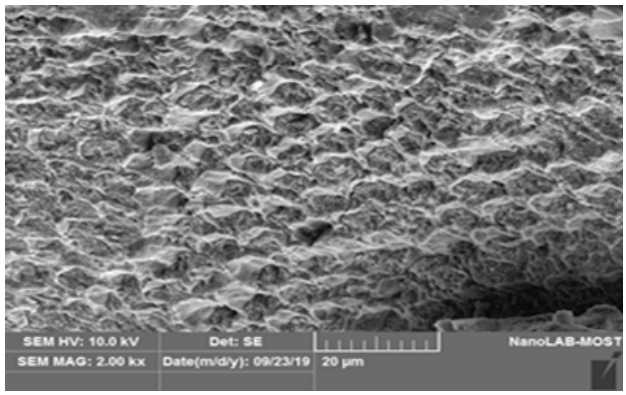

Fig.4: Scaning electron microscope image of an enamel surface etched with acid

Conclusions

The results of the study point to that etching of tooth surface with an" acid etching with 37% orthophosphoric acid for 30s" is more predictable bond strengths than did "Er,Cr:YSGG hydrokinetic laser system". But laser can be consider acceptable bond strength more practical and quicker than acid etching. CHX sealant did not influence bond strength in acid etching but not significant in laser etching.

Ethical Clearance: The Research Ethical Committee at scientific research by ethical approval of both MOH and MOHSER in Iraq

Conflict of Interest: None

Funding: Self-funding

References

1. Sağır, S., Usumez, A., Ademci, E. and Usumez, S., Effect of enamel laser irradiation at different pulse settings on shear bond strength of orthodontic brackets. The Angle Orthodontist, 2013. 83(6),:.973-980.
2. Zhu JJ, Tang AT, Matinlinna JP, Hägg U. Acid etching of human enamel in clinical applications:

a systematic review. J Prosthet Dent 2014;112:122-35.

3. Shafiei F, Jowkar Z, Fekrazad R, Khalafi-Nezhad A. Micromorphology analysis and bond strength of two adhesives to Er,Cr:YSGG laser-prepared vs. bur-prepared fluorosed enamel. Microsc Res Tech 2014; 77: 779-784.
4. Ghaffari H, Mirhashemi A, Baherimoghadam T, Azmi A,Rasooli R. Effect of Surface Treatment on Enamel Cracks After Orthodontic Bracket Debonding: Er,Cr:YSGG Laser-Etching Versus Acid-Etching. *J Dent (Tehran)* 2017; 14: 259-266
5. Ren Y, Jongsma MA, Mei L, van der Mei HC,Busscher HJ: Orthodontic treatment with fixed appliances and biofilm formation – a potential public health threat? Clin Oral Invest 2014; 18: 1711–1718.
6. Patel, P.M., Hugar, S.M., Halikerimath, S., Badakar, C.M., GokhAle, N.S., Thakkar, P.J., Kohli, D. and Shah, S., Comparison of the effect of fluoride varnish, chlorhexidine varnish and casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) varnish on salivary Streptococcus mutans level: A six month clinical study. Journal of clinical and diagnostic research: JCDR, 2017. 11(8), p.ZC53.
7. Scribante A, Sfondrini MF, Fraticelli D, Daina P, Tamagnone A, Gandini P. The influence of no-primer adhesives and anchor pylons bracket bases on shear bond strength of orthodontic brackets. Biomed Res Int 2013;2013:315023.
8. Vijayan, V., Rajasigamani, K., Karthik, K., Maroli, S., Chakkarayan, J. and Haris, M., 2015. Influence of erbium, chromium-doped: Yttrium scandium-gallium-garnet laser etching and traditional etching systems on depth of resin penetration in enamel: A confocal laser scanning electron microscope study. Journal of pharmacy & bioallied sciences, 7(Suppl 2), S616.
9. Hoshing UA, Patil S, Medha A, Bandekar SD. Comparison of shear bond strength of composite resin to enamel surface with laser etching versus acid etching: An in vitro evaluation. J Conserv Dent 2014; 17: 320-324.
10. Gulec, L., Koshi, F., Karakaya, İ., Yanardag, E.C. and Ulusoy, N., Micro-shear bond strength of resin cements to Er, Cr: YSGG laser and/or acid etched enamel. Laser Physics, 2018. 28(10), 10560
11. Yilanci, H., Usumez, S. and Usumez, A., Can We Improve the Laser Etching with the Digitally Controlled Laser Handpiece—Xrunner?. Photomedicine and laser surgery, 2017. 35(6), 324-331
12. Frey-Hugentobler, C.L.M., 2013. Effects of different chlorhexidine pretreatments on adhesion of metal brackets in vitro (Doctoral dissertation, University of Zurich).
13. Årtun J, Bergland S. Clinical trials with crystal growth conditioning as an alternative to etch enamel pretreatment. Am J Orthod 1984; 85: 333-40.
14. Blöcher S., Frankenberger R., Hellak A., Schauseil M., Roggendorf M.J., Korbmacher-Steiner H.M. Effect on enamel shear bond strength of adding microsilver and nanosilver particles to the primer of an orthodontic adhesive. BMC Oral Health, (2015). 15: 42.
15. Buonocore MC. A simple method of increasing the adhesion of acrylic filling material to enamel surface. *J Dent Res* 1995;34:849-53.
16. Verma, M., Kumari, P., Gupta, R., Gill, S. and Gupta, A., Comparative evaluation of surface topography of tooth prepared using erbium, chromium: Yttrium, scandium,gallium, garnet laser and bur and its clinical implications. *The Journal of the Indian Prosthodontic Society*, 2015. *15*(1), 23.
17. Martínez-Insua A, Da Silva Dominguez L, Rivera FG, Santana-Penín UA. Differences in bonding to acid-etched or Er:YAG-laser-treated enamel and dentin surfaces. J Prosthet Dent 2000;84:280-8.
18. Nakamura T, Wakabayashi K, Kinuta S, Nishida H,Miyamae M and Yatani H Mechanical properties of new self-adhesive resin-based cement J. Prosthodont. Res. (2010) 54 59–64
19. DePaola LG, Spolarich AE. Safety and efficacy

of antimicrobial mouthrinses in clinical practice. J Dent Hyg Fall Suppl 2007; 81: 13–25.

20. Cardoso MV, De Munck J, Coutinho E, Ermis RB, Van Landuyt K,de Carvalho RC, Van Meerbeek B . Influence of Er, Cr:YSGG laser treatment on microtensile bond strength of adhesives to enamel. Oper Dent (2008) 33:448–455

21. Karaman AI, Uysal T: Effectiveness of a hydrophilic primer when different antimicrobial agents are mixed. Angle Orthod 2004, 74:414–419.

22. Samruajbenjakul B, Kukiattrakoon B. Shear bond strength of ceramic brackets with different base designs to feldspathic porcelains. Angle Orthod. 2009;79: 571–76.

23. Sibi AS, Kumar S, Sundareswaran S, Philip K, Pillai B. An in vitro evaluation of shear bond strength of adhesive precoated brackets. J Ind Orthod Soc. 2014; 48(2):97-103.

24. Silverstone LM, Saxton CA, Dogan IL, Fjerskov D . Variation in the pattern of acid etching on human dental enamel examined by scanning electron microscope. Caries Res (1975)9:373–387.