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EVALUATION OF SHEAR BOND STRENGTH OF COMPOSITE USING SELF-ETCH ADHESIVE AND PRIOR ETCHING WITH ORTHO PHOSPHORIC AND OTHER WEAK ACIDS:AN EX VIVO STUDY

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ABSTRACT :

Objective: To evaluate and compare the shear bond strength of composite resin restoration on enamel using self-etch adhesive and after prior etching with Ortho phosphoric and other weak acids

Methodology : Self-etch adhesive was applied to the buccal surface of the teeth and composite resin was bonded using a customized mould in Group 1.In other groups, prior etching with orthophosphoric acid, citric acid, lactic acid, maleic acid and tartaric acid was done. Shear bond strength of all embedded samples were measured using a Universal Testing Machine and statistical analysis was done.

Results: The decreasing order of mean shear bond strength is as follows:
Pre-etching with Phosphoric acid > Pre-etching with Maleic acid>Pre-etching with Citric acid> Pre-etching with Lactic acid> Pre-etching with Tartaric acid >Self-Etch Bonding Technique

Conclusion: Prior etching with any acid improves the bond strength of self-etch adhesive and stronger the acid higher is the bond strength.

Keywords : Shear Bond Strength,Orthophosphoric Acids,Weak Acids

INTRODUCTION:

In dentistry, composites are widely used as restorative materials for the past six decades. Buonocore (1955) was the first to postulate acid etching before application of resins[1]. Later, Fusyama et al (1979) explored the possibility of acid etching dentin followed by Nakabayashi et al (1982) who introduced the concept of hybrid layer[2]. With changing technologies, dental adhesives have evolved from no-etch to total-etch to self-etch systems[4]. This study was undertaken to compare the effect of conditioning enamel with various weaker acids before the application of self-etch adhesive and evaluate for the improvement in bond strength.

METHODOLOGY:

Preparation of tooth samples:

Sixty human maxillary and mandibular premolars extracted for orthodontic therapeutic purpose stored in saline were collected.The buccal surfaces of the crown of selected teeth were cleaned with pumice slurry.The teeth were then stored in 10% thymol solution at room temperature.The teeth were randomly divided into 6 experimental groups (10 teeth per group)

Control Group

Group I(n=10)	Self-Etch bonding Technique

Test Groups :

Group II(n=10)	Prior etching with Orthophosphoric Acid
Group III(n=10)	Prior etching with Citric Acid
Group IV(n=10)	Prior etching with Lactic Acid
Group V(n=10)	Prior etching with Maleic Acid
Group VI(n=10)	Prior etching with Tartaric Acid

Each group was differentiated by colour coding of roots and marked numbers from 1 to 10 on the roots**[Fig 1]**.Drinking plastic straws of 3 mm internal diameter were cut into 3 mm height such that it adapts to the chosen convex buccal surface of each tooth.

GROUP I :

Self-etch adhesive was applied to the buccal surface of the tooth and rubbed for 20 seconds with a microbrush.Then, gently air dried for 5 seconds with chip blower.Light cured for 10 seconds.The precut plastic drinking straw was placed over the enamel perpendicular to the buccal surface of tooth and stabilized by dispensing hot melt glue at the outer circumferential contact area of the straw with the tooth.Composite resin material (3M ESPE Filtek Z350XT Nano Hybrid Universal Restorative) was filled inside the straw,cured for 30 seconds with the light cure unit from the top.After curing, the straws were cut and removed with scalpel blade no:11

Reagent Preparation:

The reagents of citric acid, lactic acid, maleic acid and tartaric acid were prepared to a concentration of 35% and stored in amber coloured bottles at room temperature and labelled **[Fig 2]**

GROUP II, III, IV, V and VI:

Etchants such as
GROUP II - 37% Ortho phosphoric acid,
GROUP III - 35%citric acid,
GROUP IV - 35%lactic acid,
GROUP V - 35%maleic acid,
GROUP VI - 35%tartaric acid were applied on the buccal surface of the tooth and waited for 20 seconds. Etchants were rinsed thoroughly for 20 seconds and air dried for 15 seconds.All the samples of these above groups were further prepared as explained in GROUP I **[Fig 3]**.

Preparation of bases for samples:

Acrylic resin bases were prepared by using preformed putty mould.The prepared sample teeth were embedded into them.The corresponding group and sample number was marked for each embedded tooth sample on the acrylic base immediately after removal from the mould

Evaluation of Shear Bond Strength:

Shear bond strength of all embedded samples were measured at room temperature using a Universal Testing Machine (Instron).Force was applied to the tooth/composite interface using the shearing blade at a crosshead speed of 1 mm/minute until debonding of the resin occur.

Values of shear bond strength of each sample were recorded and tabulated.The statistical analysis of the data was carried out using SPSS-VERSION 25.0

Figure 1

Figure 2

Figure 3

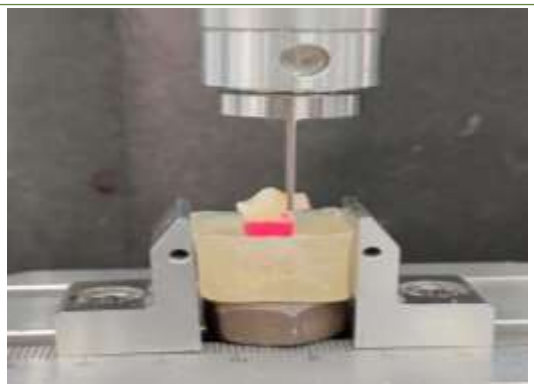

Figure 5

RESULTS

Table 1: Mean Shear Bond Strength Values of all Groups

Groups	N	Mean
I	10	11.5180
II	10	53.0410
III	10	33.2070
IV	10	32.0680
V	10	42.5440
VI	10	27.0180

Table 2: Comparison of the mean Shear Bond Strength values between Group I and all other groups (Post-hoc test)

Group	Groups	Mean Difference	p value*
I	II	-41.52300*	**.000(sig)**
	III	-21.68900	.134
	IV	-20.55000	.179
	V	-31.02600*	**.006(sig)**
	VI	-15.50000	.500

Table 3: Comparison of the mean Shear Bond Strength values between Group II and all other groups (Post-hoc test)

Group	Groups	Mean Difference	p value*
II	I	41.52300*	**.000(sig)**
	III	19.83400	.213
	IV	20.97300	.161
	V	10.49700	.861
	VI	26.02300*	**.037(sig)**

Table 4: Comparison of the mean Shear Bond Strength values between Group III and all other groups (Post-hoc test)

Group	Groups	Mean Difference	p value*
III	**I**	21.68900	.134
	II	-19.83400	.213
	IV	1.13900	1.000
	V	-9.33700	.915
	VI	6.18900	.989

Table 5: Comparison of the mean Shear Bond Strength values between Group IV and all other groups (Post-hoc test)

Group	Groups	Mean Difference	p value*
IV	**I**	20.55000	.179
	II	-20.97300	.161
	III	-1.13900	1.000
	V	-10.47600	.862
	VI	5.05000	.996

Table 6: Comparison of the mean Shear Bond Strength values between Group V and all other groups (Post-hoc test)

Group	Groups	Mean Difference	p value*
V	**I**	31.02600*	**.006(sig)**
	II	-10.49700	.861
	III	9.33700	.915
	IV	10.47600	.862
	VI	15.52600	.498

Table 8: Comparison of the mean Shear Bond Strength values between Group VI and all other groups (Post-hoc test)

Group	Groups	Mean Difference	p value*
VI	**I**	15.50000	.500
	II	-26.02300*	**.037(sig)**
	III	-6.18900	.989
	IV	-5.05000	.996
	V	-15.52600	.498

DISCUSSION

Freshly extracted teeth were chosen because they are the most suitable substrate for evaluation of adhesive systems[3]. The teeth were stored in saline immediately after extraction in order to prevent dehydration[3]. The buccal surface of selected teeth were cleaned with pumice slurry without additives to remove the surface debris as recommended by Gultz et al , 1999[4]. Samples were then stored in thymol which has antibacterial and antifungal properties[4].Other similar studies have used bonding clamp with teflon button mold for bonding[5,6],polyethylene mold[7] and plastic mold[8].However, the criteria for bonding is that the resin should be perpendicular to the surface being bonded and ISO 29022(2013) recommends a teflon mold of inner diameter

around 3 mm to be used[6]. Thus, considering these criteria, we used plastic straws as the mold. Then, shear bond strength was evaluated for all the samples. Universal Testing Machine[6,7,8,9,10] or Ultratester[5] can be used for this purpose.However,the standardised shear bond strength testing method according to ISO 29022 was UTM[6] and hence UTM was used in our study.

Table 1 shows the mean shear bond strength of all groups. The decreasing order of mean shear bond strength is as follows: Group II (Pre-etching with Phosphoric acid>Group V (Pre-etching with Maleic acid) > Group III (Pre-etching with Citric acid) >Group IV (Pre-etching with Lactic acid) > Group VI (Pre-etching with Tartaric acid)>Group I (Self-Etch Bonding Technique). It is well evident from our study that prior etching improves the bond strength of self-etch adhesive. This result is in accordance with the studies done by Rotta et al[11] and Soaresa et al[12]. The mean shear bond strength was the highest (53.04 MPa) in Group II in which pre-etching was done using orthophosphoric acid. This can be attributed to its highly acidic pH.

The least mean shear bond strength (11.51 Mpa) is noted in Group I in which the self-etch bonding technique was used. This could be due to: 1)the combination of acidic hydrophilic and hydrophobic monomers into a single step may compromise polymerization of the adhesive, 2) the inherent weak strength of the adhesive polymer and 3) the lower degree of polymerization of the resin monomer [13].

Table 2 shows the comparison of mean shear bond between Group I (self-etch bonding technique) and all other groups using Post-hoc test. Group II (Phosphoric acid) and Group IV (Maleic Acid) was found to be statistically significant with p-values (0.000) and (0.006) respectively while the values of other groups are not significant. The significant value of shear bond strength with pre-etching phosphoric acid group when compared to self-etch adhesive is because pre-etching increases the number of hydroxyl sites and hydrophilicity[14].The significant value of shear bond strength with pre-etching maleic acid group when compared to self-etch adhesive can be attributed to its high acidity(pH: 0.76).Based on the same concept, the shallow demineralization promoted by other weak acids in the enamel substrate supports lower resin bond efficiency .

Table 4 shows the comparison of shear bond strength of Group II (Pre-etching with Phosphoric acid) with all other groups . Mean Shear Bond Strengths of Group I (Self-etch bonding technique) and Group VI(Pre-etching with Tartaric Acid)was found to be statistically significant with p-values(0.000) and (0.037) respectively . The low shear bond strength exhibited by self-etch adhesive when compared to pre-etching groups was discussed earlier[15].

In Table 5 and 6, when Group III (Pre-etching with Citric Acid) and Group IV (Pre-etching with Lactic Acid) were compared with all other groups, there was no statistical significance. Table 7 shows that the mean shear bond strength of Group V (Pre-etching with Maleic acid) is significantly higher than that self-etch adhesive group, attributing to it's higher pH. Table 8 depicts that Group VI (Pre-etching with Tartaric Acid) shows statistically lower mean shear bond strength than the phosphoric acid group probably due to it's low dissociation constant [15]

A study was done by Trevalin et al[8] in which investigation of different acids for enamel etching was done. The mean bond strength to enamel was in the following order: Phosphoric Acid>Maleic Acid>Tartaric Acid>Citric Acid>Lactic Acid. Phosphoric and Maleic Acids scored the first two places similar to that our study whereas the order of decreasing bond strength of the other acids differed. Lactic Acid group was found to be the last one in Trevalin's study. The variation could be due to differences in the methodology such as sectioning of the crown and wet polishing of the buccal surface to obtain a flat enamel surface, the adhesive used was Adper Single bond and the microtensile bond strength was evaluated. However, in both the studies pre-etching with phosphoric acid showed the highest bond strength and the possible explanation stated was phosphoric acid demineralizes enamel with an average 4-fold greater demineralization depth than the other acids[16].

SUMMARY AND CONCLUSION

- Among the six groups, self-etch adhesive without pre-etching exhibited the least shear bond strength value. Thus, it is evident that prior etching with any acid improves the bond strength of self-etch adhesive
- Among the pre-etching groups, phosphoric acid group showed the highest shear bond strength followed by maleic acid. Thus, strong acid contributes to improved bond strength.
- Among the pre-etching groups, tartaric acid resulted in the least shear bond strength to enamel

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