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RESEARCH ARTICLE

COMPARATIVE EVALUATION OF TWO STEP BONDING SYSTEM AND CONVENTIONAL BONDING SYSTEM ON SHEAR BOND STRENGTH OF ORTHODONTIC BRACKETS - AN INVITRO STUDY

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ABSTRACT

Background: Technological and material advancements in Orthodontics has made possible a constant improvement in the quality of orthodontic treatment. Recently, more advanced self-etching adhesive materials have been used by minimizing the requirement for priming and etching lowering the chance of contamination and shortens bonding times. The current study involves the use of new self-priming adhesive resin AQUALINE LC, reducing the chair side time. **Aims & Objectives:** To evaluate light cure adhesive resins' shear bond strength both with and without primer. to evaluate three distinct light-cure adhesive resins' shear bond strengths both with and without primer. **Material & Methods:** 75 non-carious, non-fluorosed premolars that had been therapeutically removed were used in the investigation. Teeth were separated into 5 groups. Aqualine LC in Group A; Transbond XT with Primer is in Group B; Transbond XT without Primer is in Group C; Enlight with primer is in Group D; and Enlight without primer is in Group E. **Results:**Aqualine LC (Group A), Transbond XT with primer (Group B), Transbond XT without (Group C), Enlight with primer (Group D), and Enlight without primer (Group E) have mean values of 5.8713, 6.0840, 5.174, 5.573, and 4, respectively. This shows that, compared to all other groups with and without primer, the overall mean of Enlight without primer has the lowest bond strength, followed by Transbond XT without primer, Enlight with primer, Aqualine LC, and Transbond XT with primer. **Conclusion:** All of the primers utilized in the study (Aqualine LC, Transbond XT, and Enlight) had bond strengths that were clinically acceptable.

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INTRODUCTION

Technological and material advancements in Orthodontics has made possible a constant improvement in the quality of orthodontic treatment. Researchers and clinicians have been trying to make bonding agents better ever since bonding brackets were invented. After Buonocore[1] introduced acid etch procedures in 1955 and Kanca introduced all etch techniques, the field of adhesive dentistry has been growing ever since. Buonocore[1] showed that the use of an acid-etching procedure prior to the application of acrylic restorative materials on enamel surfaces greatly improved their adhesion. The enamel crystals in the prism structure are differently dissolved by acid-etching, producing a roughened surface that can be retained by micromechanical means. A 5 to 50μm depth porous enamel surface layer is produced by acid-etching.[2] First bonding in orthodontics was reported by Newman[3] in 1965. His attempt to bond orthodontic attachment to teeth using epoxy resin opened a new horizon in orthodontics and an era of bandless treatment was born. This procedure improves the overall treatment results by eliminating band occupying interdental spaces, decreasing gingival irritation and easier removal of plaque and decreased risk of decalcification. Since then, there has been a major research drive to increase bond strength between dental materials and dental hard tissues. Orthodontic bonding is a technique-sensitive procedure.[4]The use of light-cured polymers for orthodontic bonding was initially reported in vitro by Tavas and Watts.[5] Recently, more advanced self-etching adhesive materials have been used in orthodontics to streamline the bonding procedure by cutting down on bonding processes and doing away with the requirement for priming and etching, which lowers the chance of contamination and shortens bonding times. These self-etching primers have demonstrated benefits like less enamel loss, avoided saliva contamination, and shortened chair time by combining the conditioning and priming chemicals into a single acidic solution. Trans-illumination, a property of tooth structure and direct illumination help in curing the adhesive under the metal bracket from various angles in the direct bonding approach Since the bond strength of orthodontic brackets is a critical component of orthodontics, shear bond strength (SBS) should be the first consideration when developing bonding materials. One noteworthy finding is that, in contrast to the current standard unit of Mega Pascal (MPa), the unit of bond strength is pounds per square inch. One MPa, or 145.038 pounds of force per square inch, would be the typical conversion. The Bond strength of the Brackets must support the forces exerted during the Orthodontic treatment. According to Reynolds,[6] resistances between 5.9 and 7.8 MPa were enough to tolerate masticatory forces.

The mean bond strengths of an acidic primer and composite resin were 10.4 MPa and 11.8 MPa, respectively, when Bishara et al.[7] used a traditional adhesive procedure to assess the bond strengths. The SBSs of self-etching primers can vary widely, ranging from 2.8 MPa to 16.6 MPa. Among the factors influencing shear bond strength are the adhesive properties of the bonding materials, the attachment at the different interphases, such as the composite to bracket and tooth to composite, and the polymerization of the composite bonding material. The current study involves the use of new self-priming adhesive resin AQUALINE LC, reducing the chair side time. It was thought necessary to assess the bonding ability of AQUALINE LC, a self priming adhesive resin, because there were no research on the subject. Therefore, comparing the shear bond strength of three distinct light cure adhesive resins with and without primer, as well as evaluating the shear bond strength of light cure adhesive resins with and without primer, were the study's objectives.

MATERIALS AND METHODS

Materials used

- 75 Non-carious, Non-Floroused Extracted Premolars.
- Metal Brackets - 0.022 x 0.028 slot (3M). (Fig 1)
- 37% Phosphoric Acid Gel (Prime Etch). (Fig 2)
- Primer – Orthosolo (ORMCO) (Fig 3)
- Aqualine LC adhesive resin (Tomy International Inc) (Fig 4)
- Transbond XT light cure adhesive (3M, Unitek, Monrovia, California). (Fig 5)
- Enlight Light Cure adhesive (Ormco). (Fig 6)

Equipment used

- Instron universal testing machine (MCS TNE-2.5T, India) (Fig 17)
- Light cure unit (Dentsply Spectrum).

The study utilized 75 therapeutically extracted non-carious non-fluorosed premolars which were collected from the department of Oral and Maxillo-facial surgery for orthodontic purpose and were kept in a solution of 0.1% thymol. When choosing the teeth, care was taken to make sure the buccal enamel was intact, the teeth were free of cavities and/or repair, hypoplasia, attrition, abrasion, erosion, or fracture, and they hadn't received any prior chemical treatment.

Preparation of the teeth: All teeth were handled carefully such that there was no physical or chemical damage to their enamel prior to testing. They were preserved in 0.1% thymol saline after being cleaned with an ultrasonic cleaner and polished with pumice for ten seconds using rubber prophylactic cups. Only the crown section of the teeth was visible since they were positioned vertically on blocks of color-coded acrylic (methyl methacrylate self-cure resin foundation).

Brackets used in the study: In the study, 3M metal premolar brackets with an MBT 0.022" slot were utilized. According to the manufacturers' information, the bracket base's surface area was 9.806 mm².

Primers used in the study were

- Orthosolo –ORMCO

Adhesive used in the study

- Aqualine LC adhesive resin (Tomy International Inc) (Fig 4)
- Transbond XT light cure adhesive (3M, Unitek, Monrovia, California) (Fig 5)
- Enlight Light Cure adhesive (Ormco) (Fig 6)

Bonding procedure: Based on the type of adhesive used with and without primer, all the teeth were divided into 5 groups of 15 each.

Group A – Aqualine LC (Fig 7)
Group B – Transbond XT with Primer (Fig 8)
Group C – Transbond XT without Primer (Fig 9)
Group D – Enlight with Primer (Fig 10)
Group E – Enlight without Primer (Fig 11)

All the teeth were etched for 30 seconds with 37% phosphoric acid gel, thoroughly cleaned and allowed to dry until the enamel shows a frosty white appearance. After etching, a small layer of primer is applied to the etched enamel, and it is light-cured for 10 seconds using a light-curing unit (Dentsply) for Group B and Group D teeth only.

Next, the bracket base is covered with their respective adhesives based on the group divided, which is applied with sufficient pressure to express surplus adhesive flash around the tooth's center of the facial surface. The bracket positioner is used to remove excess adhesive flash from the bracket base's margins, and a Light Cure unit (Dentsply) is used to light cure the adhesive for 20 seconds. (Fig 12 – Fig 16)

Bond strength testing: At Virtue Metasol Pvt. Ltd. in Hyderabad, the shear bond strength was assessed using an Instron universal testing apparatus (MCS TNE-2.5T, India) (Fig 17). Until the bracket sheared, the testing machine's crosshead moved at a rate of 1 mm per minute. In newtons, the highest force required to cause bracket fracture or debond was noted. The shear bond strength per unit area was calculated by dividing the figures by the unit area of the bracket base.

Statistical analysis: For five groups, descriptive statistics such as mean, standard deviation, median, and minimum and maximum values were computed. The study employed a two-way analysis of variance (ANOVA) to ascertain whether there were noteworthy variations in debond values between various

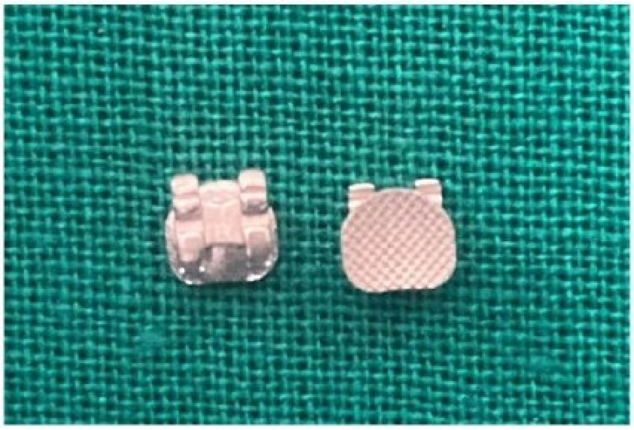

Figure 1: Metal Brackets

Figure 2: Etchant

Figure 3: Bonding agent

Figure 4: Aqualine LC

Figure 5:Enlight (Ormco)

Figure 6: Transbond XT

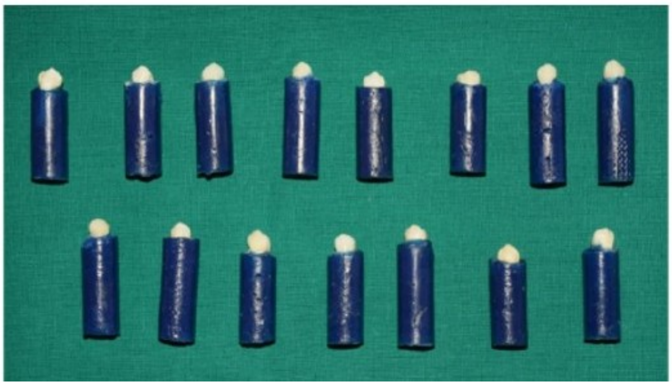

Figure 7: Group A - Aqualine LC

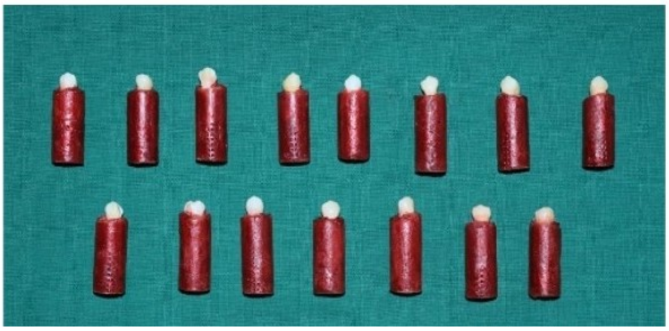

Figure 8: Group B - Transbond XT with Primer

Figure 9: Group C - Transbond XT without Primer

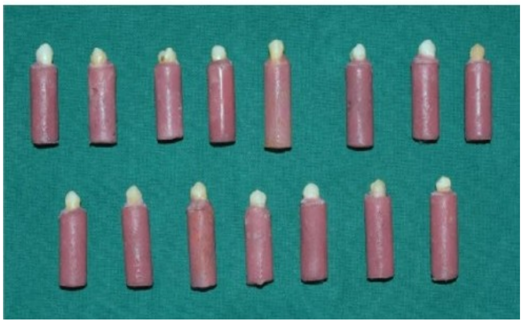

Figure 10: Group D - Enlight with Primer

Figure 11: Group E - Enlight without Primer

Figure 12: Group A Bonding Procedure (Application of Etchant, Bonding bracket with Aqualine LC)

RESULTS

The goal of the current study was to compare the shear bond strengths of three distinct light cure adhesive resins with and without primer, as well as to assess the shear bond strength of such resins with and without primer. 75 therapeutically extracted non-carious non-fluorosed premolars were collected and divided in to 5 groups, Group A (Aqualine LC), Group B (Transbond XT with primer), Group C (Transbond XT without primer, Group D (Enlight with primer),Group E (Enlight without primer).The results show that:

Table 1 shows the descriptive statistics for shear bond strengths in all the five study groups.

- The mean value of Aqualine LC (Group A) is 5.8713 with a standard deviation of 2.236, with a minimum value of 2.33 and maximum value of 11.06.
- The mean value of Transbond XT with primer (Group B) is 6.0840 with a standard deviation of 1.772, minimum value of 2.90 and maximum value of 8.42.
- The mean value of Transbond XT without primer (Group C) is 5.174 with a standard deviation of 1.658, minimum value of 3.14 and maximum value of 9.43.
- The mean value of Enlight with primer (Group D) is 5.573 with a standard deviation of 1.970, mimimum value of 2.64 and maximum value of9.50.
- The mean value of Enlight without primer (Group E) is 4.691 with a standard deviation of 1.403, mimimum value of 2.33 and maximum value of 6.97.

This indicates that the overall mean of Enlight without primer has the least bond strength. Among all the groups with and without primer, Transbond XT with primer had the highest shear bond strength, followed by Enlight with primer, Aqualine LC, and Transbond XT without primer. Table 2 shows With a p value of 0.224 (p=0.0224), the change in shear bond strength between the study groups is not statistically significant; yet, there are mean differences between the groups when compared to one another.

Table 3 shows multiple pairwise comparison between study groups:

- Aqualine LC's comparison with other research groups Enlight with primer (0.11), Transbond XT with primer (0.69), and Enlight without primer (1.18) had the highest mean differences, which are not statistically significant.

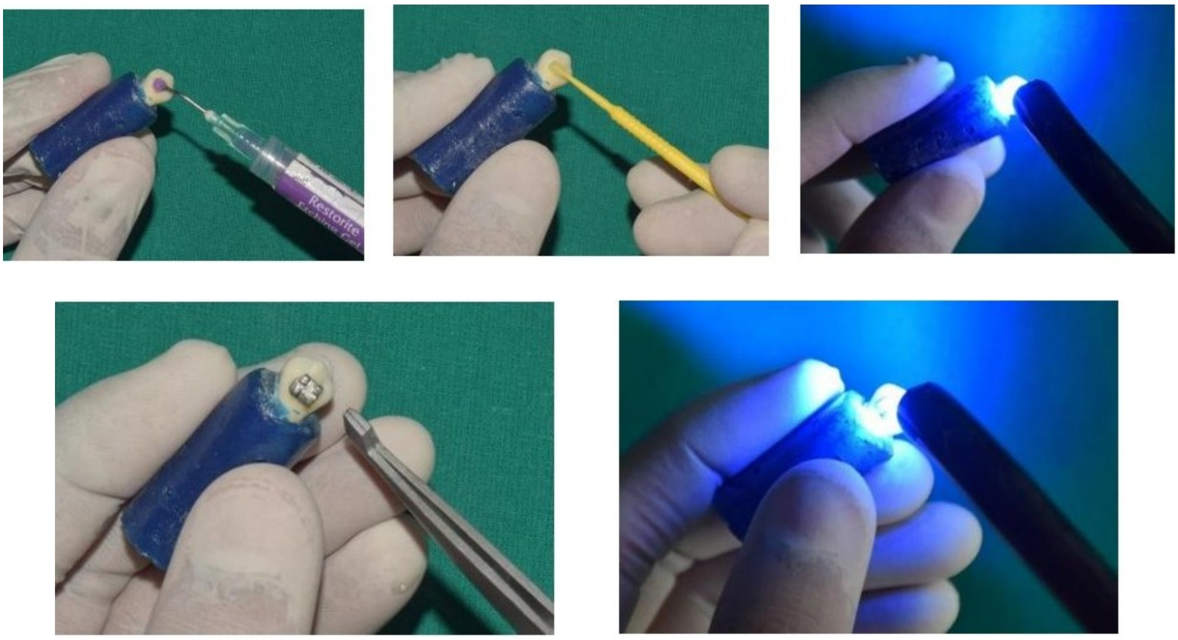

Figure 13. Group B Bonding procedure (Application of Etchant, Primer and bonding of Bracket with Transbond XT)

Figure 14. Group C Bonding Procedure (Application of Etchant, bonding bracket with Transbond XT)

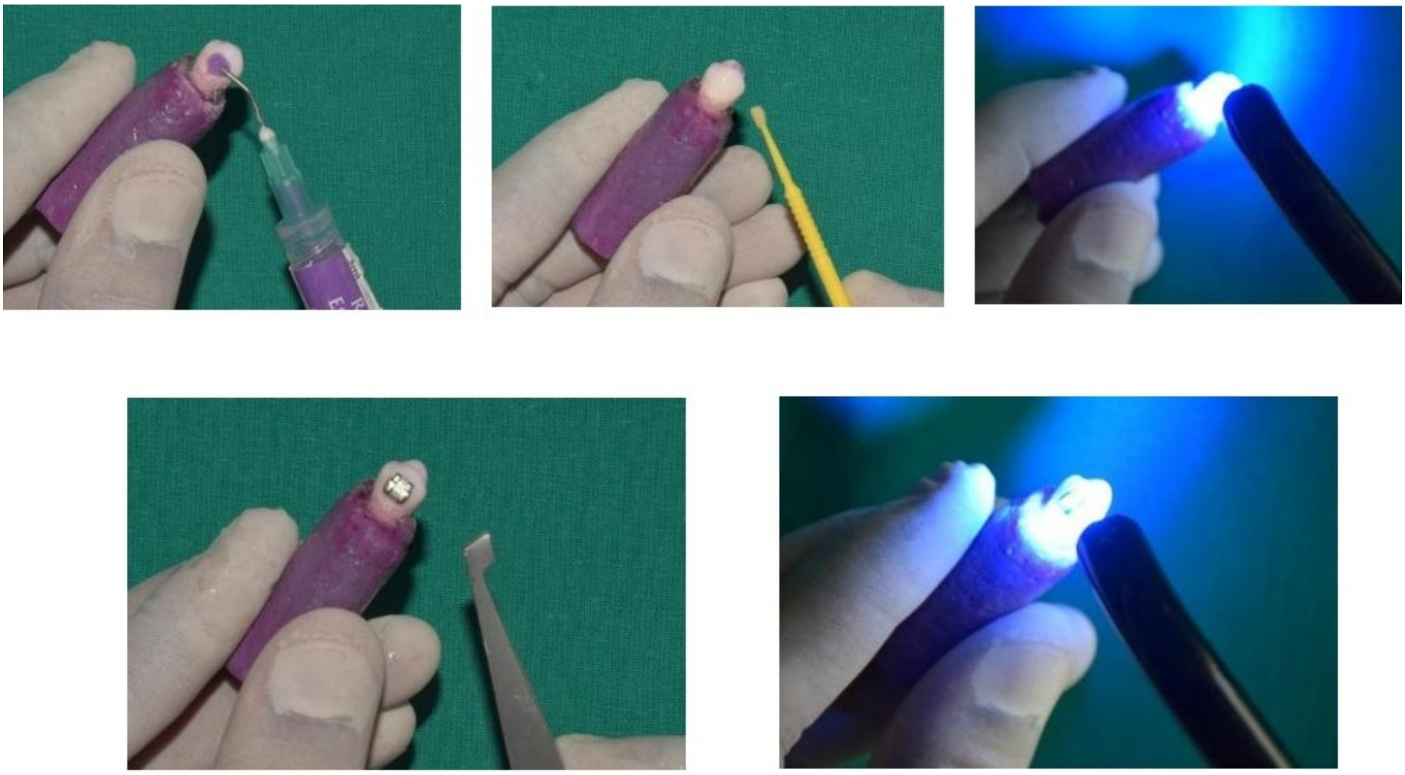

Figure 15. Group D Bonding procedure (Application of Etchant, primer & bonding bracket withEnlight)

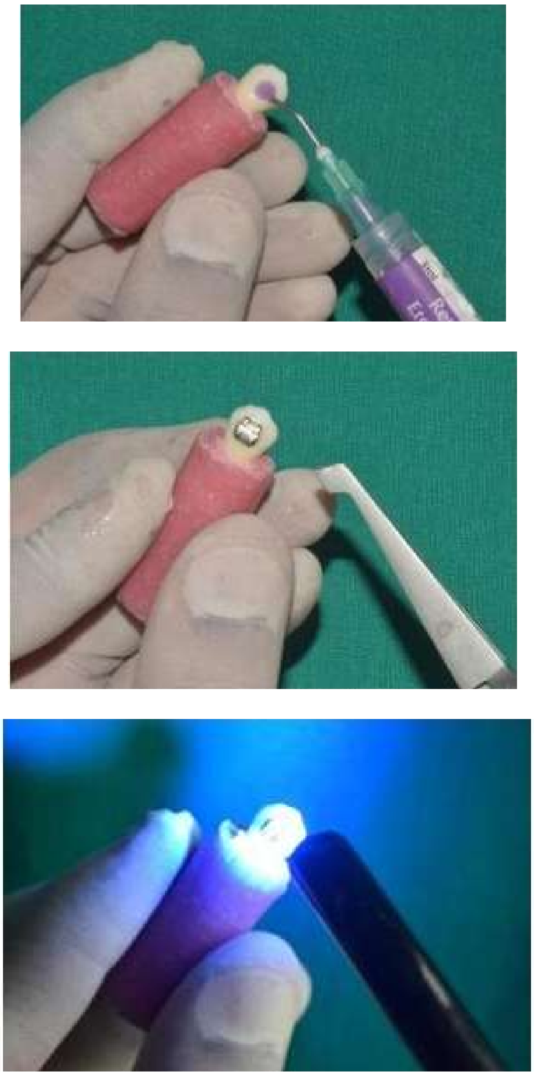

Figure 16. Group E Bonding Procedure (Application of Etchant & Bonding bracket with Enlight)

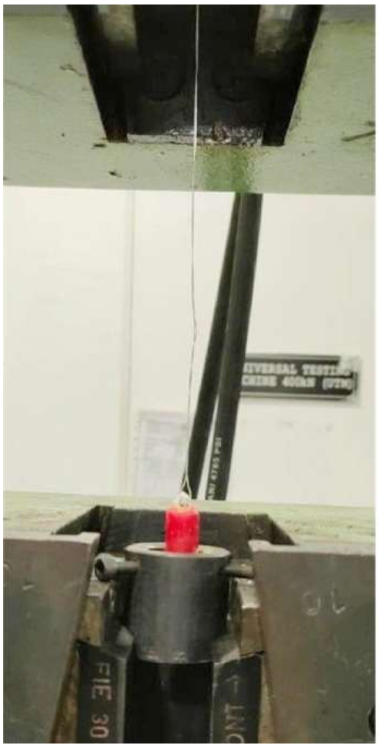

Figure 17. Universal Testing Machine

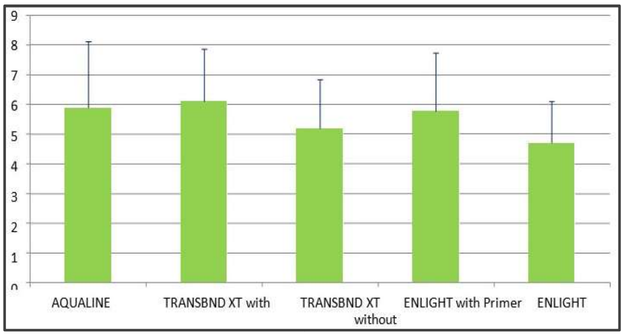

Figure 18. Comparison of shear bond strength between the study groups

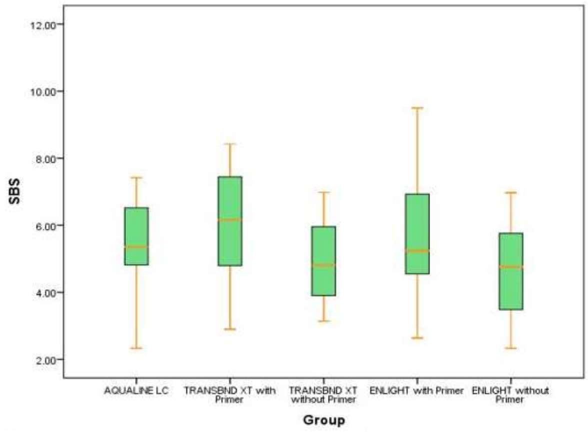

Figure 19. Box plot showing the comparison of shear bond strength between the study groups

- Enlight without primer (1.39) has a higher mean difference than Transbond XT with primer when compared to other study groups, followed by Transbond XT without primer (0.91), Enlight with primer (0.32), and Aqualine LC (0.21), all of which are not statistically significant.
- Enlight without primer (0.48), Enlight with primer (-0.58), Aqualine LC (-0.69), and Transbond XT with primer (-0.91) have the highest mean difference when compared to Transbond XT without primer.
- When Enlight with primer is compared to other study groups, there is a higher mean difference in Enlight without primer (1.06) followed by Transbond XT without primer (0.58), Aqualine LC (-0.11) and Transbond XT with primer (-0.32).
- 4.When Enlight without primer is compared to other study groups, there is a high mean difference in Transbond XT with primer (1.39) followed by Aqualine LC (1.18), Enlight with primer (1.06) and Transbond XT without primer(0.48)

The bar graph (Fig 18) denotes comparison of shear bond strength within study groups from high to low:

- The shear bond strength is highest in Transbond XT with primer (6.084)
- The shear bond strength for Aqualine LC(5.873)
- The shear bond strength for Enlight with primer(5.575)
- The shear bond strength for Transbond XT without primer(5.174)
- The shear bond strength is lowest for Enlight without primer(4.691)

Table 1. Descriptive statistics for shear bond strength in the study groups

Group	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
AQUALINE LC	15	5.8713	2.23678	.57753	4.6326	7.1100	2.33	11.06
TRANSBOND XT with Primer	15	6.0840	1.77291	.45776	5.1022	7.0658	2.90	8.42
TRANSBOND XT without Primer	15	5.1740	1.65828	.42817	4.2557	6.0923	3.14	9.43
ENLIGHT with Primer	15	5.7553	1.97079	.50886	4.6639	6.8467	2.64	9.50
ENLIGHT without Primer	15	4.6913	1.40367	.36243	3.9140	5.4687	2.33	6.97

Table 2. comparision of shear bond strength between the study groups

Group	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		F value	P value
					Lower Bound	Upper Bound		
AQUALINE LC	15	5.8713	2.23678	.57753	4.6326	7.1100	1.459	0.224
TRANSBOND XT with Primer	15	6.0840	1.77291	.45776	5.1022	7.0658		
TRANSBOND XT without Primer	15	5.1740	1.65828	.42817	4.2557	6.0923		
ENLIGHT with Primer	15	5.7553	1.97079	.50886	4.6639	6.8467		
ENLIGHT without Primer	15	4.6913	1.40367	.36243	3.9140	5.4687		

Table 3. Multiple pairwise comparisons of shear bond strength between the study groups

Reference Group	Comparison Group	Mean Difference	P value	95% Confidence Interval	
				Lower Bound	Upper Bound
AQUALINE LC	TRANSBOND XT with Primer	-.21267	.998	-2.0841	1.6588
	TRANSBOND XT without Primer	.69733	.834	-1.1741	2.5688
	ENLIGHT with Primer	.11600	1.000	-1.7555	1.9875
	ENLIGHT without Primer	1.18000	.402	-.6915	3.0515
TRANSBOND XT with Primer	AQUALINE LC	.21267	.998	-1.6588	2.0841
	TRANSBOND XT without Primer	.91000	.654	-.9615	2.7815
	ENLIGHT with Primer	.32867	.988	-1.5428	2.2001
	ENLIGHT without Primer	1.39267	.239	-.4788	3.2641
TRANSBOND XT without Primer	AQUALINE LC	-.69733	.834	-2.5688	1.1741
	TRANSBOND XT with Primer	-.91000	.654	-2.7815	.9615
	ENLIGHT with Primer	-.58133	.907	-2.4528	1.2901
	ENLIGHT without Primer	.48267	.951	-1.3888	2.3541
ENLIGHT with Primer	AQUALINE LC	-.11600	1.000	-1.9875	1.7555
	TRANSBOND XT with Primer	-.32867	.988	-2.2001	1.5428
	TRANSBOND XT without Primer	.58133	.907	-1.2901	2.4528
	ENLIGHT without Primer	1.06400	.507	-.8075	2.9355
ENLIGHT without Primer	AQUALINE LC	-1.18000	.402	-3.0515	.6915
	TRANSBOND XT with Primer	-1.39267	.239	-3.2641	.4788
	TRANSBOND XT without Primer	-.48267	.951	-2.3541	1.3888
	ENLIGHT with Primer	-1.06400	.507	-2.9355	.8075

The box plot (Fig 19) denotes comparison of shear bond strength within study groups from high to low:

- The shear bond strength is highest in Transbond XT withprimer (6.084)
- The shear bond strength for Aqualine LC(5.873)
- The shear bond strength for Enlight with primer(5.575)
- The shear bond strength for Transbond XT without primer(5.174)
- The shear bond strength is lowest for Enlight without primer(4.691)

IBM SPSS version 20 software (IBM SPSS, IBM Corp., Armonk, NY, USA) was used to analyze the data. The study data was analyzed using descriptive statistics, one-way analysis of variance, and Tukey's post hoc tests. Data presentation was done using a box plot and a bar chart. Table 1 shows the descriptive statistics for shear bond strength in the study groups. TRANSBOND XT with primer demonstrated highest shear bond strength (6.08 ± 1.77) followed by AQUALINE LC (5.87 ± 2.23), ENLIGHT with primer (5.75 ± 1.97), TRANSBOND XT without primer (5.17 ± 1.65), and ENLIGHT without primer (4.69 ± 1.4). Table 2 shows the differences between groups were not statistically significant as analyzed using the one way analysis of variance. Table 3 shows Tukey's post hoc tests revealed that there were no significant differences in any of the pairwise combinations performed. Highest mean difference (1.39) was observed between TRANSBOND XT with primer and ENLIGHT without primer, while least mean difference was found between AQUALINE LC and ENLIGHT with primer (0.116).

DISCUSSION

The concept of bonding various resins to the enamel surface of the tooth has developed various applications in the field of restorative dentistry, since the introduction of acid etch bond technique by Buonocore including bonding of orthodontic brackets[1]. Newman[2] was the first, who introduced bonding of orthodontic brackets to enamel surfaces of teeth using acid etch technique and epoxy-derived resin in 1968. Silverman et al. and Weisser8 were the first to use Acid etching and Bis-phenol A glycidyl methacrylate (Bis-GMA) for direct bonding of orthodontic brackets. Acid etching with phosphoric acid results in selective dissolution of the Hydroxyapatite crystals, leading to microporosities throughout the surface. The loss of enamel during etching is estimated to be 10 µm to 30 µm. When the fluid monomers of the composite resin infiltrates into the porous enamel and polymerize, a micromechanical bond is achieved between the resin and the tooth surface, similar to the one between the resin and the orthodontic bracket. Primer, which is often unfilled resin, can be used with light-cured composite material as part of the bonding process. Its primary purpose is enamel surface penetration to improve the effectiveness of the final bond. To overcome the drawbacks of chemically cured adhesives, light-cured resins were initially developed in vitro for orthodontic bonding in 1979. The clinician can appropriately place the brackets and remove the excesses on time because the application of visible light functions as a command set for the start of the polymerization, giving enough working time. The various activation methods that are currently possible with composite resins include light curing, chemical curing, and dual curing. For clinically sufficient bond strengths, it is critical to maintain the tooth surface dry over the whole bonding process, from etching to bracket curing. Revolutionary advances in adhesive chemistry are changing the process of orthodontic bonding. The constant quest for better bonding systems to reduce the technique sensitivity of the adhesion procedures, to improve the bond strength, to reduce the loss of enamel and to reduce the number of clinical application steps as well as chair side time has resulted in innovation of many bonding agents. The properties of an adhesive resin can be diminished by various intraoral factors, that include high humidity in the oral cavity, aging of the tooth, dental caries, and saliva or blood contamination of the adhesive areas. Particularly when attaching to surgically exposed impacted teeth, brief contamination with saliva or blood damages the bond because it creates an organic adhesive layer that is difficult to remove in the initial few seconds of exposure. This impairs resin penetration and compromises micromechanical retention. The type, composition, and method of curing of the adhesive, the etching time, the design of the bracket and base, the loading mode, and the oral environment are some of the many variables that might impact the bond strength between tooth enamel and orthodontic brackets. According to Eliades T. et al.[36], the degree of adhesive and filler content conversion had a significant impact on the durability of bonding in addition to polymerization shrinkage. This is consistent with our research, which found that Transbond XT had the strongest bond when compared to Aqualine LC. Materials used in the oral cavity should be robust enough to endure both short-term and long-term stresses, according to Trites B et al. In a related investigation, Samir Bishara et al.[24] reported that three distinct agents—an enamel conditioner, a primer solution, and an adhesive resin—are used by conventional adhesive systems to bond orthodontic brackets. The fact that some innovative bonding solutions in operative dentistry integrate priming and conditioning chemicals into one product makes them special. Priming and conditioning together reduce time and should be more economical for the patient as well as the clinician. The aim of this study was to ascertain how a self-etch primer affected the bracket/adhesive failure mode and shear bond strength of orthodontic brackets. According to the current in vitro results, orthodontic brackets bonded to the enamel surface using a self-etch primer (ESPE Dental AG, Seefeld, Germany) produced a significantly (P =.004) lower, but clinically acceptable, shear bond force (mean, 7.1 ± 4.4 MPa) than the control group, which used traditional bonding with Transbond XT as compared with the control group (mean, 10.4 ± 2.8 MPa) which is in accordance with our study where Group B – Transbond XT with primer showed significantly higher bond strength (mean-6.08) than Group A – Aqualine LC (5.87), Group D – Enlight with primer (5.75) , Group C – Transbond XT without primer (5.17)) and Group E- Enlight without primer (4.69) ,where all the mean were in acceptable range. The early shear bond strength of enamel-composite-bracket adhesion was assessed by Alexander T. H. Tang et al.[18] in a study that was completed without the use of liquid resin. In the test group, the buccal surfaces of extracted healthy premolars were bonded with orthodontic brackets using Transbond XT (n = 8) and Phase II (n = 8) composites; however, the liquid resins associated with these products were not utilized. As controls, brackets bonded with identical materials (n = 8 per material) and matching liquid resin were used. Following a 24-hour storage period in water at 37°C, the specimens' shear bond strength was assessed. The enamel of the test and control specimens that were chosen at random was dissolved using 20% formic acid. Consistent with our study, which found no appreciable difference in bond strength between primer and no primer, our lab results demonstrate that the enamel adhesion produced by these two commercial materials without the use of liquid resin does not differ significantly in their early in vitro shear bond strength.

A similar study was conducted by Sarabjit Singh Nandhra et al[35] to evaluate the clinical performance of APC™II Victory Series™ (3M Unitek) brackets in direct orthodontic bonding with and without the use of primer. 92 patients requiring orthodontic treatment with fixed appliances were randomly allocated to the control (bonded with primer) or test groups (bonded without primer). Results showed Failure rate with primer was 11.1 per cent and without primer was 15.8 per cent. Bonding without primer was shown statistically to be non-inferior to bonding with primer odds ratio 0.95– 2.25 (P = 0.08) which correleates with our study. Abhimanyu Rohmetra et al[34] has done a similar study to evaluate intra group and intergroup comparison between three different adhesives with and without primer. In this study the Transbond XT (with and without primer) showed higher values of shear bond strength which ranged from 5.47MPa to 16.28MPa (mean 9.69MPa) comparable with values reported by Falter Meir[38] who concluded that Transbond XT with primer has the highest strength of 8.67 ± 1.21 MPa, Bishara40 (10.40MPa ± 2.1MPa),which is in accordance with our study in inter group comparison however, our study doesn't include intra group comparison. A new bonding material which has been advocated for bonding without the step of priming is AQUALINE LC. To our knowledge, there are no studies that have evaluated the SBS of AQUALINE LC with other conventional adhesives using with and without primer. We therefore undertook an in vitro study to explore this possibility. The values of the shear bond strength scores obtained for AQUALINE LC, Transbond XT with Primer, Transbond XT without Primer ,Enlight with Primer, Enlight without Primer in the present study were statistically analysed. According to the present findings and those of previous studies, the conventional primer is ideal for bonding to dry enamel, because it produces shear bond strengths that are significantly higher than those achieved without primer. It has been demonstrated that the shear bond strength (SBS) of brackets bonded without primer showed significantly less bond strentgh from that of brackets bonded with the conventional with primer. The mean shear bond strengths for five groups in this study ranged within the acceptable bond strengths for orthodontic treatment purposes. Among all, Group B – Transbond XT with primer showed significantly higher bond strength (mean-6.08) than Group A – Aqualine LC (5.87), Group D – Enlight with primer (5.75), Group C – Transbond XT without primer (5.17)) and Group E- Enlight without primer (4.69). In comparison of shear bond strengths of all 5 groups did not show any significant difference but indicating that Aqualine LC used without primer showed similar results when compared to Transbond XT used with primer. There by eliminating a step of priming in the bonding protocol reducing the overall chairside time. The limitations of the present study were: 1) The brackets were bonded manually. Inspite of all the care taken, the thickness of etchant, primer and adhesive could vary from tooth to tooth. 2) The test conditions of present study cannot be directly compared to the complex intra-oral environment. This applies to all in vitro studies. Consequently, additional study is required to demonstrate the clinical dependability. 3) However, there may be differences in the pH, viscosity, and presence of microflora in human saliva. Hence, further studies have to be carried out using human saliva for testing the bond strength of the materials used in this study. 4) In addition, more research is needed to determine the shear bond strength of these new systems over a longer time period, eg, 24 hours and one week after bonding as well as after thermocycling. The future perspective for further studies may include: 1) Invitro studies provide very important data concerning the physical and mechanical properties of a material, but the final evaluation can only be provided when the efficiency of these materials are assessed under clinical conditions. Hence, it is necessary to assess the bond strength of AQUALINE LC clinically. Therefore, in vivo studies have to be performed to evaluate the performance of this material. 2) Future research could focus on bonding orthodontic brackets without primer in multi-operator (operators at varying levels of clinical experience) randomized controlled clinical trials, which account for clustering and avoid cross-over effects.

The following conclusion can be drawn from the study:

- Clinically acceptable bond strengths were found for all primers (Aqualine LC, Transbond XT, Enlight) used in the study.
- With primer group (Group B) showed highest bond strength than other primer groups, among all with and without primer Transbond XT had significantly higher bond strength than Aqualine LC.
- The mean shear bond strength of Aqualine LC though less than Transbond XT reduces the step of priming and chair side time.
- A one-step adhesive system has the potential to be successfully used in bonding orthodontic brackets if its shear bond strength can be increased.

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List of abbreviations:

BisGMA – Bis-phenol A glycidal methacrylate
NPG-GMA – N-phenylglycine and glycidyl methacrylate
APC–Adhesive-precoated
LC – Light cure
TPSEP – Transbond plus self-etching primer
SBS – Shear Bond Strength
SD – Standard Deviation

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