ORIGINAL ARTICLE
DETERMINATION OF SHEAR BOND STRENGTH ON SALIVA CONTAMINATED ENAMEL USING A NEW BONDING MATERIAL
An In Vitro Study

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INTRODUCTION:

Orthodontic treatment by fixed appliance require forces from arch wire and elastics to be transferred to the teeth through attachments which are fixed to teeth. The technique of banding teeth, welding or soldering of attachments to these bands and cementing these bands has been carried out successfully for a number of years.

The introduction of the acid etch bonding technique, led to dramatic changes in the practice of orthodontics. The increased adhesion produced by acid pretreatment using 85% phosphoric acid, was demonstrated in 1955 by Buonocore[9].

In 1965 with the advent of epoxy resin bonding, Newman45 began to apply these findings to "direct bonding" of orthodontic attachments. Retief also described an epoxy resin system designed to withstand orthodontic forces[57]. The most widely used resin, commonly referred to as Bowen's resin or bis GMA (bisphenol a glycidyl dimethacrylate) was designed to improve bond strength and increase dimensional stability by cross linking.

When orthodontic brackets are bonded the durability of the bond is paramount to clinical success. When a bond failure occurs during initial arch wire placement, it is likely to be the result of salivary contamination of the bonding surfaces[61]. Both "in-vitro" and "in-vivo" studies have demonstrated that moisture contamination of etched enamel greatly reduces bond strength.

Obviously a technique that will decrease the bond failures in situations where it is impossible to maintain a dry field during bonding would be beneficial. Studies by Hitt and colleagues, using an in vitro sealant model, found that pretreating saliva contaminated enamel with Scotchbond dual cure produced bond strengths equal to those achieved with a sealant on uncontaminated enamel[24]. Further in vivo studies by the same group demonstrated similar results[15].

Recent study done by Sonis L. Andrew[62] found that the bond strengths of orthodontic brackets applied to saliva contaminated, etched enamel, treated with Scotchbond MP primer and bonding agent were found comparable to the bond strengths of brackets applied to uncontaminated enamel.

AIMS & OBJECTIVES:

The aims and objectives of the present study are as follows:

To determine and compare the shear bond strength of brackets bonded using Scotchbond MP (multipurpose) primer, Scotchbond MP adhesive (bonding agent) and light cure composite on enamel with and without saliva contamination and also that of brackets bonded with light cure composite on uncontaminated enamel as per manufacturer's instruction.

Methods: In this study 90 human premolar teeth extracted fororthodontic treatment were collected tissue debris were cleaned and these were stored in distilled water at room temperature.

The teeth were carefully checked for complete anatomy of crown, intact buccal surface, caries lesion or any previous treatment with formaldehyde or hydrogen peroxide.

Retentive grooves were placed on these teeth on the root portion perpendicular to the long axis of the tooth for better retention and were mounted along their long axis in acrylic blocks and were covered with acrylic to the level of alveolar bone and the mounted models were kept in distilled water to prevent dehydration.

All bonding surfaces were cleaned for 30 seconds with pumice and water slurry. The teeth were rinsed with water and dried with an oil free air spray for 30 seconds.

The samples were randomly divided into three groups consisting of 30 teeth in each group:

Group A - Using Scotchbond MP (multipurpose) primer, Scotchbond MP (bonding agent) adhesive and light cure composite on saliva contaminated enamel.

Group B - Using Scotchbond MP primer, Scotchbond MP adhesive (bonding agent) and light cure composite on uncontaminated enamel.

Group C - Using light cure composite on uncontaminated enamel according to manufacturer's instructions.

All the brackets in all the groups were bonded by one operator. All these bonded models were kept in distilled water for 24 hours, before testing in a universal testing machine.

After 24 hours, shear bond strength was tested using Hounsfield universal testing machine (BIET, Davangere) with a cross head speed of 0.5 mm/min (Fig: 7). The specimens were held in the lower jaw of the universal testing machine, they were mounted in such a way that bracket slot was perpendicular to the floor (Fig: 8). The bracket was held by hooking a stainless steel wire of sufficient length (10 cm) through the base of the bracket slot and the other end of the wire was held in the upper jaw of the testing machine. The shear force required to debond each bracket was recorded in kilogram force (kgf) and converted into megapascals (Mpa). The collected data were subjected to statistical analysis by using one way analysis of variance (ANOVA) and simultaneous comparison of significant difference was done by using Duncan's multiple range test at the 99% level of confidence.

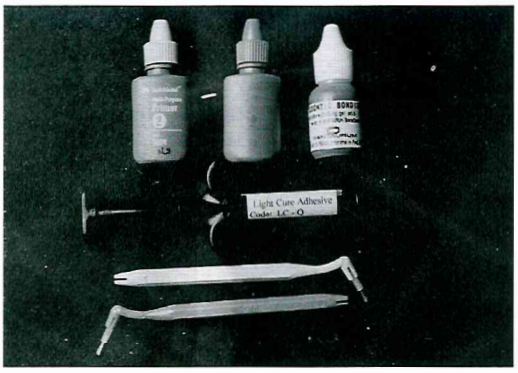


Fig: Bonding materials used

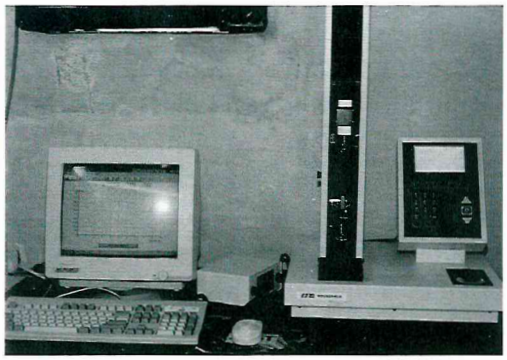


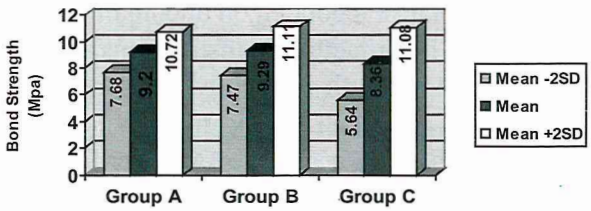
Fig: Universal testing machine

TABLE
COMPARISON OF SHEAR BOND STRENGTH BETWEEN DIFFERENT GROUPS

Groups	Shear Bond Strength (Mpa)			Variance Ratio* F-Value	Comparison between groups**		
	Range	Mean	SD		Groups	Difference	P-value
A	7.51-11.18	9.20	.0.76		A – B	0.09	Not Significant
B	7.45-10.93	9.29	0.91	7.22 P<0.01	A – C	0.84	P<.01
C	5.82-10.07	8.36	1.36		B – C	0.93	P<.01

** One way ANOVA : F test** Duncan's Multiple Range test SD – Standard Deviation*

Graph - IV
Comparison of Shear Bond Strength Between Groups



DISCUSSION:

In fixed appliance therapy banding of all the teeth was the routine method of attaching brackets to tooth surface. The study of Buonocore MG9 revealed that acid etching with 85% phosphoric acid improves the adhesion of acrylic to the tooth surface. The most widely used resin commonly referred to as Bowen's resin or bis GMA (bisphenol A glycidyl dimethacrylate) was designed to improve bond strength and increase dimensional stability by cross linking.

The bonding of orthodontic attachments to the enamel surface of teeth as an alternative to banding became popular with the introduction of the technique by Newman[45] in 1965. Since that time self-cured orthodontic resin was used for direct bonding. The polymerization of self-cured resin with the two paste system or the one paste system starts immediately on mixing, so the operator was unable to manipulate the setting time which affected bonding accuracy and positioning on the tooth surface. Tavas A. in 1980 first described the use of visible light-cured materials for orthodontic bonding[49]. The advantage of this material was that the operator got sufficient working time.

When orthodontic brackets are bonded the durability of the bond is paramount to clinical success. When a bond failure occur during initial arch wire placement, it is likely to be the result of salivary contamination of the etched enamel surface, before resin placement[61]. Both in vitro and vivo studies have demonstrated that moisture contamination of etched enamel greatly reduces bond strength. A technique that will decrease the bond failures in situations where it is impossible to maintain a dry field during bonding would be beneficial. Current research aimed to address these problems has resulted in the emergence of new material in orthodontic practice i.e. Scotchbond MP bonding system.

The purpose of the present in vitro study was to compare the shear bond strengths of brackets applied to contaminated and uncontaminated enamel using Scotchbond MP (multipurpose) Bonding system and also that of brackets bonded on uncontaminated enamel according to manufacturer's instructions.

Bond strength is usually measured in shear or tension on a universal testing machine. The units of bond strength are megapascals (Mpa) or kilogram force (kgf).

The minimum in vitro bond strength required for clinical reliability of orthodontic bonding procedures is still unknown and will no doubt vary, depending on factors such as the resin system used, bracket base design, integrity of enamel, occlusion, location of bracket, enamel resistance to etching and appliance force19. A number of independent investigators have reported laboratory results of orthodontic bonding resin systems, and comparison between these results are complicated because of lack of standardization in testing procedures[27]. Thus the values of shear bond strengths obtained in this study have not been compared with the results of other investigations.

According to Keizer, Tencate and Arends29, the maximum force exerted on a bracket during orthodontic treatment is about 29 kg/cm2. The incisal biting forces are said to be in the range of 14-17 kg. The maximum occlusal forces are indicated to be in the range of 31-35 kg. The orthodontic forces are never said to be more than 250 gms. The average force transmitted to a bracket during mastication has been reported to be between 40-120 N. According to Proffit51,52 the forces produced by mastication are highly variable with range upto 50 kg and the force required to move a tooth orthodontically, ranges approximately 15-150 gm. The recommended shear bond strength for successful clinical bonding according to various author is in the range of 5.9-8 Mpa[19,28,34,47,58].

In the present study using Scotchbond MP on uncontaminated enamel showed the highest bond strengt (9.29 Mpa) and it was not statistically significant wit Scotchbond MP on saliva contaminated enamel showing bond strength of 9.20 Mpa. But bonding with ligh cure composite on uncontaminated enamel according t manufacturer's instructions showed the least bon strength (8.36 Mpa) and the difference was statistical significant with other two groups i.e. using Scotchbon MP on contaminated and uncontaminated enamel.

These results are similar to the findings of Sonis L Andrew[62] who compared bond strength achieved wit Scotchbond MP on saliva contaminated enamel an without saliva contaminated enamel and concluded tha bond strength of orthodontic brackets applied to saliv contaminated, etched enamel treated with Scotchbon MP primer and bonding agent were found comparabl to the bond strengths of brackets applied to uncontami nated enamel.

Their results are also similar to the findings of Hitt an colleagues, who compared bond strengths achieve with Scotchbond dual cure plus sealant on saliva

contaminated enamel against those achieved with sealant only on uncontaminated enamel[24,15].

Similarly, Swift and Trilo demonstrated greater bond strength to visibly moist, etched enamel and dentin when Scotchbond MP primer and bonding agent were used[64].

How these agents have improved bond strengths when bonded to saliva contaminated etched enamel is not clear, Feigal theorizes that the hydrophilic property of Scotchbond dual cure allows it to mix with saliva and then air thinning permits enough of the material to be driven in to the etched enamel surfaces. Scotchbond MP may work differently, the primer composed of hydroxyethyle methacrylate (HEMA) and polyalkenoic copolymer behaves similarly to the liquid of a glass ionomer in that it forms stronger bonds to a moistened enamel or dentin surface. If a HEMA – type bonding agent is then applied to this primed surface, an extremely strong bond is possible[62].

In this study one sample from each group were excluded from the statistical analysis due to their inconsistent values. The inconsistent value was due to fracture of the tooth while debonding.

SUMMARY AND CONCLUSION: Bond failure during initial arch wire placement is one of the commonest problem in bonding procedure. When bond failure occurs during initial arch wire placement it is likely to be the result of moisture contamination of the bonding surface. Both in vitro and in vivo studies have demonstrated that moisture contamination of etched enamel greatly reduces bond strength.[61]

Recent studies[15,24,62,64] have found that bond strengths of orthodontic brackets applied to saliva contaminated etched enamel treated with Scotchbond multipurpose primer and adhesive (bonding agent) were found comparable to the bond strengths of brackets applied to uncontaminated enamel. The purpose of the present in vitro study was to compare bond strengths of brackets applied to contaminated and uncontaminated enamel following pretreatment of the enamel with the Scotchbond MP (multi purpose) bonding system and also to compare bond strengths of brackets applied to uncontaminated enamel as per manufacturer's instructions.

In this study a total of 90 specimens were divided into three groups of 30 each and were subjected to shear stress by using universal testing machine.

Based on the recorded data and the statistical analysis the result of the study indicates that the bond strengths of orthodontic brackets applied to saliva contaminated, etched enamel treated with Scotchbond MP primer and adhesive (bonding agent) were found comparable to the bond strengths of brackets applied to uncontaminated enamel. The use of Scotchbond MP therefore decreases the likelihood of bond failure in situation where it may be impossible to maintain a dry field during bonding.

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