Effect of Repeated Bonding on the Shear Bond Strength of Smartbond Cyanoacrylate Orthodontic Adhesive

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Abstract

Cyanoacrylate adhesive material is known to be used as superglue material in fields of dentistry and medicine for years. Moisture insensitivity has rendered the adhesive material useful as orthodontic bonding agent in cases where isolation is difficult. This study was undertaken to measure Shear Bond Strength with Smartbond first bonding and after debonding and repeated bonding twice. 30 test specimens were prepared from extracted maxillary and mandibular premolar teeth, which were subjected to repeat bonding (2 repetitions) using Smartbond and Shear Bond Strength was measured for each of them. Mean Shear Bond Strength of 6.13 MPa ± 2.30 was obtained after first bonding. Mean Shear Bond Strength of 4.17 MPa ± 2.44 and 4.18 MPa ± 1.49 was obtained after first and second rebonding respectively. Smartbond shows optimal Shear Bond Strength at initial bonding but shows Shear Bond Strength to be inadequate after first and second debonding rebonding procedures.

Key words: Direct bonding, Debonding, Rebonding, Shear Bond strength, Smartbond.

Introduction

Since the inception of direct bonding orthodontic brackets are commonly bonded with composite resin materials, either chemically or light-cured[1,2]. Despite the material advancement for direct bonding to increase efficacy of treatment, bond failures continue to be a challenge in clinical practice[3]. Composite resins also have several drawbacks, including moisture sensitivity[4], potential allergic reactions[5], and taste. Cyanoacrylate glues are widely used in dentistry as well as in medicine[6]. A number of studies have shown no adverse effects from long-term use of cyanoacrylates inside the human body[7,8]. Cyanoacrylates in the form of commercial "super glue" have been experimented with, as bonding agents. As reported by Hebert Ivan Cueto[9], in 1966 first direct bonding using a cyanoacrylate was done. D J Howells et al[10] (1989) conducted a study for in vitro evaluation of a cyanoacrylate bonding agent and concluded that its performance deteriorated on storage in saline, rendering the material unsuitable for clinical use. However, Bishara et al[11](2001) compared Shear Bond Strength between SmartBond (Gestenco International, Gothenburg, Sweden) and Transbond XT, (3M Unitek, Monrovia, California) and found that the use of the cyanoacrylate adhesive to bond Orthodontic brackets to the enamel surface did not result in a significantly different Shear Bond Strength(SBS) as compared to the control group and thus the adhesive had the potential to be used to bond Orthodontic brackets while reducing the total bonding time.

With this view in mind, this study was undertaken to measure Shear Bond Strength with Smartbond first bonding and after debonding and repeated bonding twice and to determine whether this adhesive was efficient for orthodontic bonding and rebonding procedures.

Materials and Methods

This in-vitro study was conducted at The Department of Orthodontics and Dentofacial Orthopaedics, Government Dental College and Hospital, Ahmedabad and Ahmedabad Textile Industry's Research Association (ATIRA), Ahmedabad, India. 30 test specimens were prepared from extracted maxillary and mandibular premolar teeth, which were subjected to repeat bonding (2 repetitions) and Shear Bond Strength was measured for each of them.

Thus, 90 samples were tested for SBS using Instron Universal Testing Machine – 5982.

Inclusion criteria for tooth specimens were as follows:

1. Intact labial enamel surface
2. Specimen correctly stored following extraction

Exclusion criteria were:

1. Caries
2. Restorations in the tooth
3. Gross enamel hypoplasia
4. Enamel defects
5. Cracking of labial enamel surface
6. Specimen stored incorrectly following extraction

All teeth were examined under normal surgery light conditions to assess suitability for inclusion.

Enamel surface preparation: Labial enamel surfaces of premolar teeth were polished with fluoride free pumice slurry using a rubber cup attached to a slow handpiece for 10 seconds. It was rinsed with air / water

spray for 15 seconds and dried with a stream of oil-free compressed air for 10 seconds. 30 test specimens were thus prepared and bonded with "SmartBond cyanoacrylate adhesive system (Gestenco International, Gothenburg, Sweden)."

Bracket placement: Brackets were bonded in all groups to the labial surface at the intersection of the long axis of the clinical crown (LACC) and the midpoint of long axis of clinical crown (LA point)[12]. These bonded brackets were subjected to debonding-rebonding-debonding-rebonding and debonding, thus forming the following 3 groups.

Group 1, 2 and 3 – 35% Phosphoric acid etch, **"SmartBond cyanoacrylate adhesive system (Gestenco International, Gothenburg, Sweden)"**, Uncoated metallic brackets 3M Unitek, Gemini.

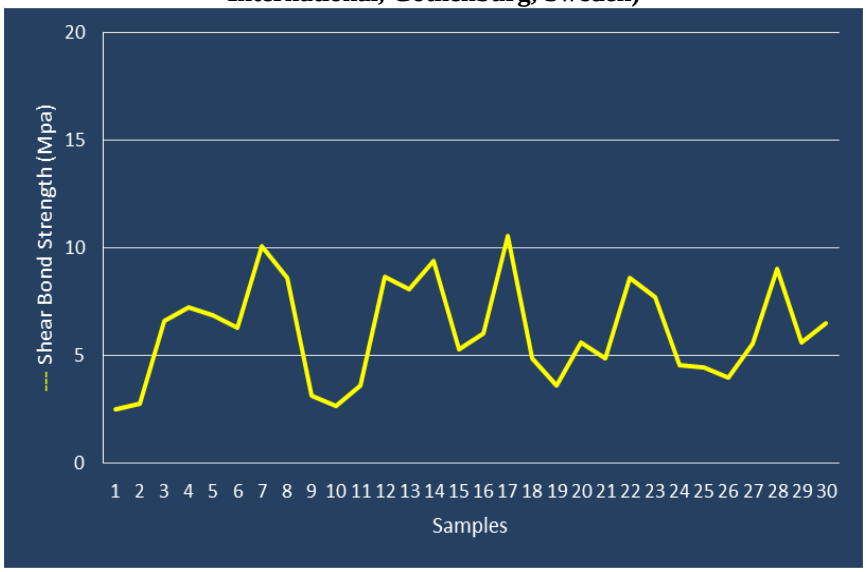
30 teeth were etched with 35% phosphoric acid applied for 10 seconds. The teeth were washed thoroughly and air dried. A moist cotton roll was used to wet the enamel surface before the adhesive was applied. In this study, the brush method was used because it allowed for the controlled application of a more uniform thickness of the adhesive on the bracket base. Each bracket was subjected to a compressive force for 10 seconds, and excessive bonding resin was removed with a sharp scaler. The cyanoacrylate adhesive will not readily set until it comes into contact with the wet enamel surface. Then the clinician has 3 to 5 seconds to adjust the bracket before the adhesive starts to set. According to the manufacturer, the adhesive will be sufficiently set in 3 to 5 minutes, and then the initial archwires can be ligated.[13]

Bond Strength Testing: Each plastic cylinder with its embedded specimen was assembled in the customized jig in the lower cross head of the Instron Universal Testing Machine – 5982. During testing, the Instron Universal Testing Machine – 5982 had a 2 KN load cell and cross-head speed of 0.5mm / min.
Bluehill-3 software electronically connected to the Instron Universal Testing Machine – 5982

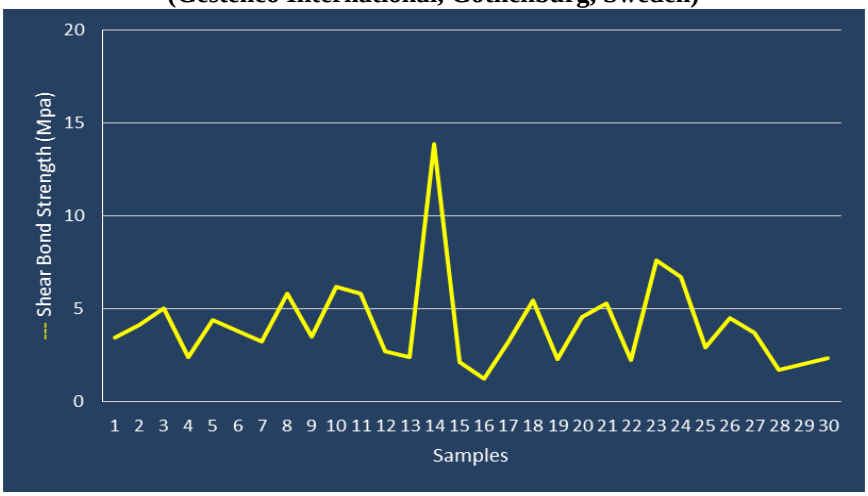
Rebonding Sequence: After each debonding, all visible residual adhesive was removed with a finishing tungsten carbide bur - Dentsply #7702. The debonded brackets were sandblasted with 110 µm aluminium oxide powder until no residual composite was seen on visual inspection and rebonded again.

Results, Graphs and Tables

Graph 1: 30 metallic brackets bonded with SmartBond cyanoacrylate adhesive system (Gestenco International, Gothenburg, Sweden)



Graph 2: 30 metallic brackets rebonded (Repetition 1) with SmartBond cyanoacrylate adhesive system (Gestenco International, Gothenburg, Sweden)



Graph 3 – 30 metallic brackets rebonded (Repetition 2) with SmartBond cyanoacrylate adhesive system (Gestenco International, Gothenburg, Sweden)

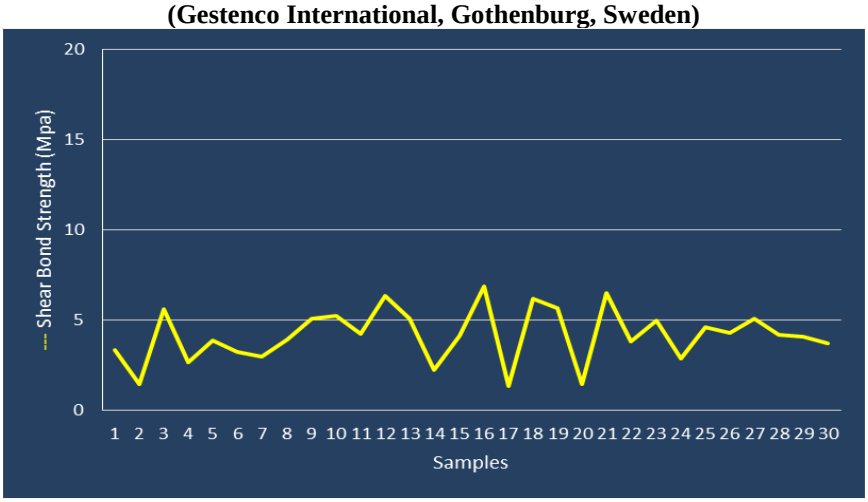


Table 1: showing the Mean (x), Standard Deviation, Median, Minimum, Maximum and Standard Error of Mean of Shear Bond Strength measurements using SMARTBOND

Group	Parameters	N	Mean	Standard Deviation	Median	Minimum	Maximum	Standard Error
Group 1	Shear Bond Strength	30	6.13	2.3	5.83	2.53	10.55	0.42
Group 2	Shear Bond Strength (Repetition 1)	30	4.17	2.44	3.62	1.26	13.87	0.45
Group 3	Shear Bond Strength (Repetition 2)	30	4.18	1.49	4.18	1.38	6.9	0.27

Table 2: showing the Mean (x), Standard Deviation, Standard Error, Range, Mean Difference and P-Value of Shear Bond Strength measurements using SMARTBOND

Groups	Smartbond	Mean	N	Standard Deviation	Standard Error	Range	Mean Difference	p value
Group 1	Shear Bond Strength	6.13	30	2.305	0.421	8.02	-1.96	**0.003
Group 2	Shear Bond Strength (Repetition 1)	4.17	30	2.439	0.445	12.61		
Group 1	Shear Bond Strength	6.13	30	2.305	0.421	8.02	-1.94	***0.001
Group 3	Shear Bond Strength (Repetition 2)	4.18	30	1.493	0.273	5.52		
Group 2	Shear Bond Strength (Repetition 1)	4.17	30	2.439	0.445	12.61	0.01	0.983
Group 3	Shear Bond Strength (Repetition 2)	4.18	30	1.493	0.273	5.52		

Discussion

Graph 1 shows the Shear Bond Strength of each sample of 30 metallic brackets bonded with SmartBond showing a mean SBS of 6.13 MPa ± 2.30. Similar results were obtained by **Vicente A et al** [14] who found a Mean SBS of 7.32 MPa ± 3.93 with Smartbond in their study. Similar findings were also obtained by **Ahmed R. et al** [15] who observed the Mean SBS of 6 MPa ± 1.07 using Smartbond.

Graph 2 shows the Shear Bond Strength of each sample of 30 metallic brackets rebonded with Smartbond showing a mean SBS of 4.17 MPa ± 2.44. This is in accordance with the findings of **Bishara et al** [16] where in the mean SBS was 2.2 MPa ± 2.6 on second debonding sequence in contrast to 5.7 MPa ± 3.8 on first debonding sequence using Smartbond.

Graph 3 shows the Shear Bond Strength of each sample of 30 metallic brackets rebonded again with SmartBond showing a mean SBS of 4.18 MPa ± 1.49. Similar results were obtained by **Bishara et al** [16] who found a significantly lower Mean SBS of 2.1 MPa ± 1.5 on third debonding sequence than Initial Mean SBS of 5.7 MPa ± 3.8 using Smartbond cyanoacrylate adhesive.

Table 1 shows statistical analysis of Shear Bond Strength measurements of brackets bonded and rebonded using Smartbond. This table shows that the initial SBS values achieved by Smart bond i.e. 6.13 MPa ± 2.30 is higher than the clinically accepted level of Bond Strength as mentioned by **Reynolds et al**[17]. The mean SBS values for Group 2 i.e. Repetition 1 is 4.17 MPa ± 2.44 and Group 3i.e. Repetition 2 is 4.18 MPa ± 1.49 which are both lower than that suggested by Reynolds.

Table 2 shows the paired sample t-test used for within group analysis for the Smartbond Group i.e. Group 1, 2 and 3. This table shows that the difference between the Initial Mean SBS of Group 1 which was 6.13 MPa ± 2.30 was statistically significant **(p = 0.003)** when compared with the Mean Shear Bond Strength of the rebonded brackets Group 2 (Repetition 1) which was 4.17 MPa ± 2.43. This difference was statistically highly significant **(p = 0.001)** when Group 1 (6.13 MPa ± 2.30) was compared with Group 3 (Repetition 2) 4.18 MPa ± 1.49.

Reynolds[17] suggested that minimum Bond Strength of 5.9 to 7.8 MPa to be adequate for most Orthodontic needs. He also reported successful clinical bonding with adhesives that provide in vitro Bond Strength of approximately 4.9 MPa. In the current study mean Shear Bond Strength of of group 1 is within the acceptable range but those of Group 2 and 3 is below the acceptable range considered adequate for Orthodontic needs as suggested by Reynolds. However in situations like hyper salivation, surgical exposure of impacted teeth where dry environment and isolation is difficult, bonding with Cyanoacrylate would help the clinician to successfully bond these teeth to achieve the results.

Conclusion

SmartBond cyanoacrylate adhesive system (Gestenco International, Gothenburg, Sweden) has optimal Shear Bond Strength at initial bonding to be considered as orthodontic adhesive for direct bonding of orthodontic brackets. After first and second debonding-rebonding Shear Bond Strength observed is inadequate for most Orthodontic needs even after debonding rebonding procedures. However, due to its moisture insensitive nature, it is highly recommended in different clinical situations where isolation is difficult which is the main cause of bond failure. Hence, Orthodontist should judiciously use the bonding material depending on the clinical situations.

Conflict of Interest: None

Source of Support: Nil

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