

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service Available Online at: www.ijdsir.com

Volume – 6, Issue – 2, April - 2023, Page No. : 238 – 246

A Comparative Evaluation of Shear Bond Strength of Orthodontic Bracket Bonded to Etched Enamel Surface When Cleansed with Three Different Methods Hand Sanitizer Swab, Surgical Spirit Swab, And Water Swab to Attain Adequate Bonding Strength- An In Vitro Study.

¹Dr. Himalaya Udaniya, Postgraduate, Department of Orthodontics and Dentofacial Orthopedics, Rishiraj college of dental sciences and research Center, Bhopal, India-462038

²Dr. Ankur Chaukse, Professor, Department of Orthodontics and Dentofacial Orthopedics, Rishiraj college of dental sciences and research Center, Bhopal, India-462038

³Dr. Kshitij Gupta, Professor, and HOD, Department of Orthodontics and Dentofacial Orthopedics, Rishiraj college of dental sciences and research Center, Bhopal, India-462038

⁴Dr. Shubhi Singh, Postgraduate, Department of Orthodontics and Dentofacial Orthopedics, Rishiraj college of dental sciences and research center, Bhopal, India-462038

⁵Dr. Rajul Khare, Senior Lecturer, Department of Orthodontics and Dentofacial Orthopedics, Bhabha dental college and sciences., Bhopal, India-462038

⁶Dr. Soni Mayur Kumar, Senior Resident, NSCB Medical College and Hospital, Jabalpur MP, India-482003

Corresponding Author: ¹Dr. Himalaya Udaniya, Postgraduate, Department of Orthodontics and Dentofacial Orthopedics, Rishiraj college of dental sciences and research Center, Bhopal, India-462038

Citation of this Article: Dr. Himalaya Udaniya, Dr. Ankur Chaukse, Dr. Kshitij Gupta, Dr. Shubhi Sing, Dr. Rajul Khare, Dr. Soni Mayur Kumar, "A Comparative Evaluation of Shear Bond Strength of Orthodontic Bracket Bonded to Etched Enamel Surface When Cleansed with Three Different Methods Hand Sanitizer Swab, Surgical Spirit Swab, And Water Swab to Attain Adequate Bonding Strength- An In Vitro Study", IJDSIR- April - 2023, Volume – 6, Issue - 2, P. No. 238 – 246.

Copyright: © 2023, Dr. Himalaya Udaniya, et al. This is an open access journal and article distributed under the terms of the creative commons' attribution non-commercial License. Which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

Type of Publication: Original Research Article **Conflicts of Interest:** Nil

Abstract

Objective: To evaluate the shear bond strength of ortho dontic bracket to etched enamel surface when cleansed with three different methods hand sanitizer swab, surgical spirit swab, and water swab to attain adequate bonding strength- an in vitro study.

Materials and method: A total of 132 premolar teeth were randomly divided into six groups and brackets were bonded. In group A (Red)- twenty-two premolars are etched on the labial surface and then wiped with water. Group B (Blue)- Twenty-two premolars are etched on the labial surface and then wiped with a spirit

swab. Group-C (Black)- Twenty-two premolars are etched on the labial surface and then wiped with a sanitizer swab. Group D (Green)- Twenty-two premolars are etched on the labial surface, contaminated with blood and saliva then wiped with water. Group-E (Pink)-Twenty-two premolars are etched on the labial surface, contaminated with blood and saliva then wiped with a spirit swab. Group-F (Yellow)Twenty-two premolars are etched on the labial surface, contaminated with blood and saliva then wiped with a sanitizer swab. Bond strength was measured using the universal testing machine.

Results: kruskar-wallis test was performed and inter group comparison in non-contaminated groups, (group-B) showed the highest bond strength, followed by (group-A), and the lowest mean shear bond strength is seen in (group C), while in contaminated groups, (group-D) showed the highest bond strength, followed by the (Group E), and the lowest was observed for (group-F).

Conclusion: Among all the six groups the highest shear bond strength was seen in the non-contaminated group and the least bond strength is seen in the contaminated group.

Keywords: Bond strength, Etched enamel, Sanitizer.

Introduction

Contamination of etched tooth surface during ortho dontic bonding procedure can result in poor bond strength hence control of moisture contamination is necessary. Saliva and blood contamination is a major causes of bond failure.¹

When the etched enamel surface becomes contaminated, most of the porosities become plugged, and resin penetration is impaired. This results in resin tags of inadequate numbers and lengths. Even momentary saliva or blood contamination might adversely affect the bond because saliva and blood deposit an organic adhesive coating that is resistant to washing within the first few seconds of exposure.^{2,3}

Moisture contamination on bond strength of composite to enamel was shown by Hormati et al³ and Silverstone et al⁴ to affect shear bond strength. Hormati et al⁶ found a 50% decrease in bond strength in the presence of moisture. Silverstone et al⁴ concluded that this was the result of saliva that deposited an organic adhesive coating within the first few seconds of exposure that was resistant to washing.

Achieving an adequately strong bond between the tooth and the bracket is essential for successful orthodontic treatment because the bond must withstand forces generated during the treatment.⁵ The bond strength values for conventional adhesive systems on enamel range between 8 and 30 MPa.^{6,7}

To overcome all these challenges in ortho dontic bon ding, a simple method that can be considered to clean and dry the etched surface of a permanent tooth before bonding an orthodontic bracket is to gently wipe the etched enamel surface with alcohol-based cleansing solution (Sprit swab and sanitizer) for 5 seconds. It has been seen that alcohol-based solutions act as a drying agent which can be used on etched enamel to improve the bond strength by evaporating the residual moisture thus increasing surface tension between the adhesives and the bracket base. In addition, the drying(volatile) agent increases the bonding potential between the hydrophobic adhesives and the etched enamel by displacing the moisture and providing a more hydro phobic environment which promotes the potential for bracket bonding.

Water rinsing causes aerosol generation which is of one the major topic of concern of aerosol generation in the pandemic outbreak of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)⁸. The former involves the

application of water-spray practices in connection to enamel etching, before conditioning with bonding agents and bracket bonding; In particular, minimization of water-spray syringe utilization for rinsing is anticipated on bonding-related procedures this may be avoided or minimized by the use of alcohol-based solutions (sanitizer) which is made up of ethyl alcohol and is volatile in nature and vaporizes on its own and requires less air drying.

The purpose of the study is to minimize the time for rinsing and drying the etched enamel surface by alcoholcontaining chemical agents of different concentrations to prevent and restrict aerosol generation, especially in today's covid scenario where aerosol plays a major role in an orthodontic clinical setup.

This study focuses on the adhesion between ortho dontic brackets, adhesive, and enamel and finds methods to im prove bonding.

Materials And Methods

In this invitro study, a total of 132 orthodontically extracted premolars with intact sound crown structure and absence of caries, cracks, developmental defects, or restorations were selected. All the selected teeth were cleaned with non-fluoridated pumice for any debris or stain and stored in saline until its use. All the teeth were mounted on a dental stone block⁹ as done by Al Saleh M and El Mowafy and the blocks were then painted with acrylic colours. The buccal surface of the enamel of each tooth was treated with 37% orthophosphoric acid.

These teeth were randomly divided into 6 groups (22 samples in each group) depending on the use of cleansing solutions as follows in both contaminated and non-contaminated conditions. [Insert figure-1]



Figure 1: Sterillium alcohol (70%) containing dis infectant, Sprit (Ethanol)

Different colours were given to dental stone blocks for differentiating between various groups. The groups were as follows under various prebonding conditions.

Bonding on the buccal surface of all the teeth was performed after the etching with the premolar brackets using primer followed by light curing.

After bonding all the specimens were kept ready for checking the bond strength.

Group A (Red): Twenty-two premolars are etched on the labial surface and then wiped with water. [figure-2]



Figure 2: Post Bonded group A twenty-two Premolars non contaminated.

Page **L** '

Group B (Blue): Twenty-two premolars are etched on the labial surface and then wiped with a spirit swab. [Insert figure-3]



Figure 3: Post Bonded group B twenty-two Premolars non contaminated.

Group-C (**Black**): Twenty-two premolars are etched on the labial surface and then wiped with a sanitizer swab. [Insert figure-4]



Figure 4: Post Bonded group C twenty-two Premolars non contaminated

Group D (Green): Twenty-two premolars are etched on the labial surface, contaminated with blood and saliva then wiped with water. [Insert figure-5]



Figure 5: Post Bonded group D twenty-two Premolars contaminated

Group-E (**Pink**): Twenty-two premolars are etched on the labial surface, contaminated with blood and saliva then wiped with a spirit swab. .[Insert figure-6]



Figure 6: Post Bonded group E twenty-two Premolars contaminated

Group-F (Yellow): Twenty-two premolars are etched on the labial surface, contaminated with blood and saliva then wiped with a sanitizer swab. [Insert figure-7]

Page 🖌 🖌



Figure 7: Post Bonded group F twenty-two Premolars contaminated.

Each specimen was placed on a mounting jig in the Universal testing machine with a bracket base parallel to the shear load. [Insert figure 17]



Figure 8: Universal Testing Machine (Computerized, Software Based), Company: Star-Testing Systems, India. Model No. STS 248.

A shear force for deboning was applied to the bracket base in an occlusal gingival direction at a crosshead speed of 1 mm/min. The maximum force required to debond or fracture of the bracket was recorded in megapascal (MPa). The bond strength was calculated in Mega Pascals using following formula.

Shear bond strength = $\frac{\text{stress of failure (N)}}{\text{Area of bracket base (mm²)}}$

The testing sequence was repeated for all the samples, in all groups and the results were tabulated.

The obtained data were statistically evaluated and analyzed for probability distribution using the Kolmo gorov-Smirnov test, p value <.05 indicated that the data were not normally distributed. Descriptive statistics were performed. Inter-group comparison of the continuous variable was done using the Kruskal-Walli's test, followed by post hoc analysis.

Result

[Graph -1] indicates the mean bond strength of different groups in MPa under dry and salivary contamination. This present study stated that the bond achieved in noncontaminated groups shows the highest bond strength in comparison to contaminated groups.



Graph 1: Compressive Strength (MPa) of the samples belonging to different groups.

In the Non-contaminated groups, the spirit swab sample (Group-B) (7.63Mpa), showed the highest bond strength, followed by the shear bond strength of the water swab (control group) (Group-A) (6.37Mpa), and lowest mean

Page 24

shear bond strength was for sanitizer swab (Group- C) (5.11Mpa). The mean difference between these groups was statistically significant at p= 0.01 as observed in [Graph-1].

In contaminated (Blood and saliva) groups, water wiped (Group-D) (4.56Mpa), showed the highest bond strength, followed by water swab (Group-E) (4.33Mpa), and the lowest was observed for sanitizer swab (Group-F) (3.93Mpa).

Inter-group comparison revealed that the maximum load was significantly different between the groups (p value <.05). [Insert table 1,2]

	Median	Inter-quartile	Chi-	Р
		range	square	value ^a
			value	
Group A	6.7300	6.0100-7.2825	70.161	.001*
Group B	7.6350	7.2825-8.2100		
Group C	4.8250	4.2600-6.0100		
Group D	4.4000	3.9150-4.8825		
Group E	3.9650	3.6950-4.4625		
Group F	3.7700	3.6725-4.0250		

Table	1:	Inter-group	comparison	of	Compressive	Stre
ngth (l	MP	a) of the sam	ples belongin	ng to	o different gro	ups.

	Median	Inter-quartile	Chi-	Р
		range	square	value ^a
			value	
Group A	75.5150	67.8125-	71.530	.001*
		82.9400		
Group B	85.7950	81.8650-		
		92.0750		
Group C	54.0850	47.7700-		
		67.3675		
Group D	49.3100	43.8950-		
		54.7025		
Group E	44.4550	41.5425-		
		50.1950		
Group F	41.7850	40.7675-		
		45.0550		

Table 2: Inter-group comparison of maximum load of

the samples belonging to different groups.

Discussion

As contaminants saliva, moisture, and blood are com monly studied for their influence on decreasing the bracket bond strength. Even the slightest contamination leads to a reduction in shear bond strength.

To overcome all the challenges faced in orthodontic bonding, this study has used a simple method that can be considered to clean and dry the etched surface of a permanent tooth before bonding the orthodontic bracket to gently wipe the etched enamel surface with an alcohol-based cleansing solution (Spirit swab and Sanitizer) for 5 seconds. It has been seen that alcoholbased solutions act as a drying agent which can be used on etched enamel to improve the bond strength by evaporating the residual moisture thus increasing surface tension between the adhesives and the bracket base. In addition, the drying (volatile) agent increases the bonding potential between the hydrophobic adhesives and the etched enamel by displacing the moisture and providing a more hydrophobic environment which pro motes the potential for bracket bonding.

In the present study, under both salivary contamination and non-contamination condition, the use of 35 % ethyl alcohol as a post-etchant drying agent yielded signifi cantly better results. In non-contaminated (Group B), where the spirit swab is used as a wiping solution after etchant placement shows the highest bond strength followed by the shear bond strength of the water spray (control group) (Group-A), and the lowest mean shear bond strength for sanitizer swab (Group- C).

In the contaminated (Blood and saliva) groups, the water spray group (Group-E), showed the highest bond strength followed by the spirit swab group (Group-D) showing a bond strength, and the lowest was observed for the sanitizer swab group (Group-F).

The study also shows that the non-contaminated groups of the alcohol-containing solution group (Group C) sanitizer swab shows decreased bond strength as com pared to our spirit swab-containing group (Group B), while blood and a saliva-containing group of sanitizers (Group F) showed the least shear bond strength as compared to spirit swab containing group (Group E).

Moisture control is a key factor in achieving adequate bond strength, Moisture contamination on bond strength of composite to enamel was shown by Hormati et al³ and Silverstone et al¹⁰ Hormati et al¹¹ found a 50% decrease in bond strength in the presence of a moisture. Silverstone et al¹² concluded that this was the result of saliva that deposited an organic adhesive coating within the first few seconds of exposure that was resistant to washing.

Hobson et al¹¹, studied the effect of moisture and blood contamination on the bond strength of new orthodontic bonding material and showed a significant increase in bond strength during dry bonding when compared to, moist and blood contamination.

The result in the above study was quite comparable to our study which is also showing a significant increase in bond strength in the non-contaminated group and then blood and saliva-contaminated groups.

Prasad M et al ¹² and Hitmi L et al ¹³ studied the effect of moisture, saliva, and blood contamination on the shear bond strength of brackets bonded with a conventional bonding system and a self-etched bonding system. Their study showed that contamination reduces the shear bond strength of all the groups, especially in self-etched bonding system groups as compared to total-etched groups.

The above study on the conventional bonding system and self-etch techniques have concluded that bond strength with conventional bonding is always highest as compared to the self-etch technique.

Likewise in our present study, we have preferred to use a conventional bonding system which has shown increased bond strength in both contaminated and non-contami nated conditions.

Dennison and Craig¹⁴ showed that etching leaves an extremely sensitive and fragile enamel surface that can be damaged with the slightest abrasion. Hormati and colleagues found no significant difference in shear bond strength, however, whether the etchant was rubbed or dabbed on. Under a scanning electron microscope, the etch pattern created by rubbing was not as sharp as that created by dabbing; the prism peripheries (sheaths) were shorter and blunter. This might explain why we have found no clinical difference in bond strength after wiping an etched enamel surface with an alcohol swab. The above study by Hormati concluded that wiping the tooth surface with an alcohol swab or rinsing or dabbing with a water swab has no significant difference in their prism peripheries and no significant difference in shear bond strength.

Sandhya Jain¹⁵ conducted a study in which she used a simple method to clean and dry the etched surface of an impacted tooth before bonding to gently wipe the enamel with an alcohol swab. She also quoted that water irrigation is not needed to clean the tooth surface, and the alcohol evaporates without blow-drying. Hence reducing the use of a three-way syringe as well as minimizing the time for rinsing and drying thus reducing the chair-side time during the treatment visit.

In this present study, we have used an alcohol-based solution (sanitizer and spirit swab) volume of absolute ethyl alcohol. The use of spirit swabs with ethyl alcohol as a drying agent has been thought to improve bond strength by evaporating the residual moisture, without

.

the use of the three-way syringe, so that the hydrophobic adhesive could penetrate more into the etched enamel. The bond strength achieved by the spirit swab (Group B) is the highest of all while the other alcohol-containing agent sanitizer has achieved the lowest bond strength (Group C) because of the glycerol which acts as a humectant and aids as the main reason for declining the bond strength.

In this present study, we have used alcohol-based clear surgical spirit which contains 35% volume of absolute ethyl alcohol. The use of ethyl alcohol as a drying agent has been thought to improve bond strength by evapo rating the residual moisture so that the hydrophobic adhesive could penetrate more into the etched enamel. The drying agent may further improve the ability of the adhesive to the etched enamel resulting in superior penetration and more resin tag formation which results in an increased shear bond along with minimizing the use of a three-way syringe.

Minimization of water-spray syringe utilization for rinsing is suggested for bonding-related procedures, while temporary conditions as represented by seasonal epidemics should be considered for the decision of intervention.

One of the major concerns of the study was to look at how salivary contamination affected the level of bond strength. This was done by comparing etched, dried, and bonded teeth to those that were contaminated with artificial saliva after the etching process. Contaminated teeth were dried or wiped with the alcohol-containing cleansing solution until no moisture could be detected on the tooth. The finding suggested that salivary contami nation reduces bond strength.

The purpose of the study is to minimize the time for rinsing and drying the etched enamel surface by alcoholcontaining chemical agents of different concentrations to prevent and restrict aerosol generation, especially in today's covid scenario where aerosol plays a major role in an orthodontic clinical setup.

This thesis focuses on the interfaces and adhesion between ortho dontic brackets, adhesive, and enamel, to find methods to improve bonding.

Limitations

First, it was an in-vitro design. As a result, extra caution should be exercised when projecting results into the clinical environment. Therefore, more in vivo studies are needed to draw more clinically applicable conclusions under conditions of an oral environment.

Secondly, the lack of reported studies using the same method and materials tested in the present study is a limitation to declaring a reliable comparison with the outcomes of previous studies.

Conclusion

The results obtained concluded that bond strength achieved with an alcohol-containing drying agent spirit swab over a sanitizer swab is a suitable choice for wiping the etched enamel surface in both contaminated as well as in non-contaminated conditions respectively. This method of wiping the etchant from tooth surface with help alcohol containing drying agents (spirit and sanitizer) has found effective as it minimizes the time for rinsing and drying the etched enamel surface by minimizing the use of three-way syringe to prevent aerosol generation.

References

1. Nirupama C, Kavitha S, Jacob J, Balaji K, Srinivasan B, Murugesan R, *et al.* Comparison of shear bond strength of hydrophilic bonding materials: An *in vitro* study. J Contemp Dent Pract 2012; 13:637-43.

Gange P. The evolution of bonding in orthodontics.
Am J Orthod Dentofac Orthop. 2015;147(4): S56–63.

3. Hormati AA, Fuller JL, Denehy GE. Effects of contamination and mechanical disturbance on the quality of acid-etched enamel. J Am Dent Assoc 1980; 100: 34-8.

4. Silverstone LM, Hicks MJ, Featherstone MJ. Oral fluid contamination of etched enamel surfaces: an SEM study. J Am Dent Assoc 1985;110: 329-32.

5. Reynolds I. R. A review of direct orthodontic bonding. British Journal of Ortho dontics.1975 ;2(3): 17 1–178. Doi: 10.1080/0301228x.1975.11743666.

 Silverstone, L.M.; Hicks, M.J.; and Featherstone,
M.J.: Oral fluid contamination of etched enamel surfaces: An SEM study, J. Am. Dent. Assoc. 110:329-332, 1985.

7. W. A. Brantley and T. Eliades, Eds., Orthodontic Materials: Scientific and Clinical Aspects, Thieme, Stuttgart, Germany,2001.

8. Theodore Eliades and Despina Koletsi, Minimizing the aerosol-generating procedures in orthodontics in the era of a pandemic: Current evidence on the reduction of hazardous effects for the treatment team and patients, (Am J Orthod Dentofacial Orthop 2020; Vol – Issue.

9. Al- Saleh M, Mowafy EL. Bond strength ortho dontic brackets with new self-adhesive resin cements. Am J Orthod Dentofacial Orthop 2010:137; 528-533.

10. Silverstone, L.M.; Hicks, M.J.; and Featherstone, M.J.: Oral fluid contamination of etched enamel sur faces: An SEM study, J. Am. Dent. Assoc. 110:329-332, 1985.

11. Hobson RS, Ledvina J, Meechan JG. The effect of moisture and blood contamination of bond strength of a new ortho dontic bonding material. Am J Orthod Dento facial Orthop2001;120: 54-7.

12. Prasad M, Mohamed S, Nayak K, Shetty SK, Talapaneni AK. Effect of moisture, saliva, and blood contamination on the shear bond strength of brackets bonded with a conventional bonding system and selfetched bonding system. J Nat Sci Biol Med. 2014 ;5 (1): 123-39. 48. Hitmi L, Attal JP, Degrange M. Evaluation of acidic adhesive for orthodontic bonding. J D Res. 2000; 79:507.

 Hitmi L, Attal JP, Degrange M. Evaluation of acidic adhesive for ortho dontic bonding. J D Res. 2000; 79: 507.

14. Dennison, J.B., and Craig, R.G.: Characterization of enamel surface prepared with a commercial and exper imental etchant, J. Am Dent. Assoc. 9:799-805, 1978

15. Sandhya Jain Bonding impacted teeth without moisture contamination, ©2005 jco, volume 34 number 8.