Effect of moisture, saliva, and blood contamination on the shear bond strength of brackets bonded with a conventional bonding system and self-etched bonding system

Mandava Prasad,
Shamil Mohamed¹,
Krishna Nayak²,
Sharath Kumar Shetty³,
Ashok Kumar Talapaneni¹

Department of Orthodontics and Dentofacial Orthopedics, ¹Conservative Dentistry and Endodontics, Narayana Dental College and Hospital, Chinthareddypalem, Nellore - 524 003, Andhra Pradesh,
²Orthodontics, ABSM Institute of Dental Sciences, Deralakatte, Mangalore - 576 119,
³KVG Dental College, Sullia, India

Address for correspondence:
Dr. Mandava Prasad, Department of Orthodontics and Dentofacial Orthopedics, Narayana Dental College and Hospital, Chinthareddypalem, Nellore - 524 003, Andhra Pradesh, India.
E-mail: mandavabrune9@hotmail.co.in

Abstract

Background: The success of bonding brackets to enamel with resin bonding systems is negatively affected by contamination with oral fluids such as blood and saliva. The new self-etch primer systems combine conditioning and priming agents into a single application, making the procedure more cost effective. Objective: The purpose of the study was to investigate the effect of moisture, saliva and blood contamination on shear bond strength of orthodontic brackets bonded with conventional bonding system and self-etch bonding system. Materials and Methods: Each system was examined under four enamel surface conditions (dry, water, saliva, and blood), and 80 human teeth were divided into two groups with four subgroups each of 10 according to enamel surface condition. Group 1 used conventional bonding system and Group 2 used self-etched bonding system. Subgroups 1a and 2a under dry enamel surface conditions; Subgroups 1b and 2b under moist enamel surface condition; Subgroups 3a and 3b under saliva enamel surface condition and Subgroup 4a and 4b under blood enamel surface condition. Brackets were bonded, and all the samples were then submitted to a shear bond test with a universal testing machine with a cross head speed of 1mm/sec. Results: The results showed that the contamination reduced the shear bond strength of all groups. In self-etch bonding system water and saliva had significantly higher bond strength when compared to other groups. Conclusion: It was concluded that the blood contamination showed lowest bond strength from both bonding systems. Self-etch bonding system resulted in higher bond strength than conventional bonding system under all conditions except the dry enamel surface.

Key words: Blood contamination, self-etching bonding system, shear bond strength

INTRODUCTION

Orthodontics, as dentistry’s first speciality, has seen its share of evolution and growth. An avid example is the change of guard from the metallic multibanded appliance to the more esthetic bonded appliance. Buonocore, who is considered to be the pioneer of adhesive dentistry, demonstrated that the adhesion of acrylic restorative materials increased significantly when it was preceded by an acid-etching technique, on enamel surfaces.[1] Acid-etching differentially dissolves the enamel crystals in the prism structure, which results in a roughened surface amenable to micromechanical retention. Acid-etching creates a porous enamel surface layer that ranges in depth from 5 to 50 μm.[2] Newman attempted this technique for the direct bonding of orthodontic brackets to the tooth surface, which opened up new horizons in orthodontics and the era of bandless treatment was born.[3]
Over the years, a great deal of attention has been paid to improve the acid-etching technique, primers, and adhesives. However, adhesive failures still exist. Many factors can affect the bond strength between tooth enamel and the orthodontic brackets, including the type, composition, and mode of curing of the adhesive; etching time and concentration of the etchant; bracket material and base design; loading mode, and oral environment. [4] Zachrisson cited contamination as an important cause of bond failure. [5] Clinical procedures like surgical exposure and orthodontic alignment of unerupted ectopic teeth do not provide an ideal working condition. In such situations, oral contaminants (saliva, blood, gingival fluid, water) reduce the bond strength significantly, and this is considered to be the most common reason for bond failure with composite resin. [6]

Enamel surface contamination can occur at two critical times of the bonding procedure: After the tooth surface has been etched and after the primer has been applied. Contamination on an acid-etched enamel surface reduces the surface energy and renders the surface less favorable for bonding. [4] Contamination before priming would inevitably cause the formation of a smear layer. This layer, consisting mainly of proteins, covers the etched surface within seconds. Most of the porosities become plugged, and the penetration of the resin is impaired, which results in resin tags of insufficient number and length.

In an attempt to overcome this problem, self-etching primers (SEPs) and adhesives are used. Self-etching primers are relatively recent innovations. The rationale behind the self-etching primer systems is the formation of a continuum between the etched tooth surface and the adhesive by simultaneous demineralization and penetration of the tooth surface with acidic monomers that can be polymerized in situ. These products reduce the number of steps in the bonding procedure, eliminating the necessity to rinse the etchant and dry the surface, thus simplifying the bonding technique. SEPs present a methacrylate phosphoric acid ester molecule composed of phosphoric acid and a methacrylate group. These groups are united in the acid ester molecule and as the primer is applied to the enamel or dentin, the phosphate group dissolves and removes the calcium from the hydroxyapatite. Instead of being rinsed away, the calcium forms a complex with the phosphate group, and the complex is incorporated into the network during primer polymerization. Etching and monomer penetration of the exposed enamel rods is synchronized; therefore, the depth of etching is the same as that of primer penetration. The results of combining conditioning and priming in a single stage of treatment have improved the chair-side efficiency, cost savings for the clinician, and time savings for patients. [7]

The study of bond strength with blood, moisture, and saliva contamination needs updating because new materials are always being introduced. The purpose of the study was to investigate the effect of moisture, saliva, and blood contamination on the shear bond strength of orthodontic brackets bonded with the conventional bonding system and self-etch bonding system.

**MATERIALS AND METHODS**

Eighty freshly extracted intact caries-free human premolars were collected. The teeth were cleaned of soft tissue and stored in a solution of thymol. The teeth were then embedded in self-cure acrylic blocks such that the crown and 2 mm of the root were exposed above the resin [Figure 1]. This was done for the purpose of holding the samples during testing.

The teeth were randomly assigned into two groups, with four subgroups. Each subgroup consisted of 10 samples. Each group and subgroup were color coded. Group I and Group II were color coded in clear and pink self-cure acrylic, respectively. Subgroups Ia and IIa in white, subgroups Ib and IIb in blue, subgroups Ic and IIc in yellow, and subgroups Id and IIId in red.

The bonding procedure was done as follows:

**Group I (conventional bonding system):** - All samples (40 teeth) in Group I were cleansed and polished with pumice and rubber prophylactic cups for 10 seconds and consequently etched with 37% phosphoric acid for 15 seconds and then rinsed with water and air dried.

**Group Ia:** The enamel surface was kept dry. **Group Ib:** The enamel surface was contaminated with water. **Group Ic:** The enamel surface was contaminated with human saliva from a male donor, who was instructed to brush his teeth, and thereafter, to refrain from eating for one hour before...
collecting the saliva. Group I: The enamel surfaces were contaminated with human blood. Fresh capillary blood was collected from the fingertip of a male donor; his index finger was cleaned with alcohol and then punctured with a hypodermic needle. One drop of blood was applied directly to the enamel surface of each sample, and was left undisturbed for 15 seconds [Figure 1] and then blown off with an oil-free air syringe for five seconds.

All the 40 samples were treated with a thin layer of Transbond XT primer and the brackets were bonded onto the center of the buccal surface of the teeth with Transbond XT (3M Unitek), a light cured composite adhesive. Before curing, the excess resin material was removed, without disturbing the bracket position; the adhesive was light cured for a total of 40 seconds, following the manufacturer’s instruction.

Group II (Self-etching bonding system):- All samples (40 teeth) in Group II were cleansed and polished with pumice and rubber prophylactic cups for 10 seconds. Group IIa, Group IIb, Group IIIc, and Group IV samples’ enamel surfaces were treated similar to the Group I samples. The surfaces were then etched and primed by using a self-etching primer, that is, Transbond Plus (3M Unitek) [Figure 1], which contains both the acid and primer, and it was applied on the enamel surfaces for 3 seconds and gently evaporated with air according to the manufacturer’s instructions. For activation, the two components were squeezed together, and the resulting mixture was applied directly onto the tooth surface. It contained a black (largest) reservoir, which was squeezed into the white (middle) reservoir, and then into the purple (smallest) reservoir of the blister package, using controlled pressure. The brackets were bonded using Transbond XT adhesive (3M Unitek) and light cured for 40 seconds, in the same manner as for Group I.

A universal testing machine was used to test the shear bond strength. The blade was positioned in such a way that it touched at the junction of the bracket and tooth and the specimens were stressed in an occlusogingival direction [Figure 1]. The shear bond strength was measured at a cross head speed of 1 mm/minute.

**Statistical analysis**

The results were statistically analysed using the analysis of variance (ANOVA), as there were more than two subgroups for comparison and analysis. As ANOVA showed a significant difference between the means, the Tukeys multiple comparison tests were done to identify the homogenous subset of means that were not different from each other and also to find which ones differed from each other. A t-test was also done to assess whether the means of the two groups were statistically different from each other.

**RESULTS**

The ANOVA statistics was done to compare the mean shear bond strength for the conventional bonding system group. The mean shear bond strength values of the subgroups - dry, moisture, saliva, and blood were 16.38, 7.09, 5.94, and 3.78, respectively [Graph 1]. Among the subgroups, dry (control) showed the highest shear bond strength followed by moisture and saliva, respectively. The lowest shear bond strength was seen with blood contamination. The Tukey multiple comparison tests of the conventional group showed that all the subgroups were statistically significant. Among the subgroups, dry (control) with blood was very highly significant. Even though moisture and saliva had got significant results, comparatively they had got the least significance.

The ANOVA statistics was done to compare the mean shear bond strength for the self-etch bonding system group. The mean shear bond strength values of the subgroups - dry, moisture, saliva, and blood were 15.16, 14.15, 13.66, and 5.02, respectively [Graph 2]. Among the subgroups, dry (control) showed the highest shear bond strength followed by moisture and saliva, respectively. The lowest bond strength was seen with blood contamination. The Tukey multiple comparison tests of the self-etching group showed a statistically significant result, except in the moisture and saliva groups. Among the subgroups dry and blood showed high statistical significance.

The t-test was used to compare two groups. When the dry (control) subgroup was tested with the conventional and self-etch bonding systems, it showed a statistically significant result with the conventional group showing a higher level than the self-etching bonding system. All other subgroups showed statistically significant results, but the self-etching bonding system was at a higher level [Graph 3].

**DISCUSSION**

One of the revolutionary changes in the field of orthodontics is the successful bonding of the brackets to the teeth replacing the old system of banding. This was made possible by the introduction of the acid-etching technique by Buonocore.[6] G.V. Newman[7] was the first to bond orthodontic brackets to the teeth by means of the acid-etching technique. Since then, efforts are on to find newer and better bonding materials for the future, which could make the bonding procedure convenient for both the operator and the patient. A good orthodontic
bonding agent should have the following criteria – excellent bond strength, adequate working time, should not cause decalcification, and should permit its usage in wet conditions.

Initially only three-component adhesive systems were available for bracket bonding. These adhesive systems had three agents: An enamel conditioner, a primer solution, and an adhesive resin, for bonding brackets to the conditioned tooth surface. However, this procedure was time consuming, and there could be saliva contamination between those steps. To simplify the technique and decrease the amount of enamel loss, efforts were made to reduce the number of steps in the bonding procedure. Hence, self-etching primer products were developed, containing a mixture of acidic functional monomers and other constituents. Diffusion of monomers and partial dissolving of hydroxyapatite was enabled simultaneously, affecting a resin-infiltrated zone entrapped with minerals.

Most of the self-etching primers are two-component systems with the etching and priming procedures combined in the first step. An adhesive must be applied on the bracket for bonding in the second step. New one-component, self-etching and self-adhesive resin systems have been introduced. It is suggested that these dual cure systems can be used without surface preparation. These products combine the etchant, primer, and adhesive resin in a single paste. The elimination of steps with this new bonding agent minimizes the probability of contamination, because the etchant and the sealant are applied simultaneously, without the intermediate step of washing and drying the tooth in between. Oral contaminations are believed to be the major factors for bond failure.

In this study, among the conventional bonding system groups, a dry enamel surface condition showed high bond strength (16.38 MPa), when compared with wet conditions (moisture, saliva, and blood). This finding was in agreement with the previous studies. According to Reynolds 6-8 Mpa was adequate for most clinical orthodontic needs. This bond strength was considered to be able to withstand masticatory and orthodontic forces. In the conventional bonding system the clinical acceptable bond strength was only attained when the enamel surface was dry. This was because the conventional bonding system was hydrophobic in nature, and hence, a wet surface would lead to reduced bond strength.

The introduction of a newer simplified adhesive system called a self-etch primer, which combines acid etching and priming in a single step, has overcome the drawbacks of the conventional technique. One obvious advantage of using a self-etching primer is to expedite the bonding procedure by combining etching and priming into a single step. In addition to saving time, fewer steps in the bonding process may translate into fewer procedural errors.

The self-etching bonding system uses acidic primers that combine the acid etchant and primer into one material and one clinical step. The acidic monomer consists of a methacrylate ester derivative that provides the etch, binds to the enamel calcium, and polymerizes into retentive resin tags when exposed to a curing light. In a self-etching primer, the active ingredient is a methacrylated phosphoric acid ester. The phosphoric acid and the methacrylate group are combined into a molecule that etches and primes at the same time. The phosphate group on the methacrylated phosphoric acid ester dissolves the calcium and removes it from the hydroxyapatite. The calcium then forms a complex with the phosphate group, rather than being removed by rinsing, and is incorporated into the network when the primer polymerizes. The acid group is neutralized by the reaction with calcium. Agitating the primer on the
tooth surface serves to ensure that the fresh primer is transported to the enamel surface. Etching and monomer penetration to the exposed enamel rods are simultaneous. In this manner, the depth of the etch is identical to that of the primer penetration. Three mechanisms act to stop the etching process. First, the acid groups attached to the etching monomer are neutralized in a similar way, as is phosphoric acid, by forming a complex with the calcium from the hydroxyapatite. Second, as the solvent is driven from the primer during the airburst step, the viscosity rises, slowing the transport of acid groups to the enamel interface. Finally, as the primer is light cured and the primer monomers polymerized, transport of the acid groups to the interface are stopped. These new systems have also been found to be effective when bonding the brackets to the enamel.

In this study, among the self-etching bonding system groups, the dry enamel surface condition showed high bond strength. Moisture and saliva contamination had little influence on the shear bond strength, with mean shear bond strengths of 14.15 and 13.66, respectively. The shear bond strength between moisture and saliva had no significant result. These findings are in agreement with the previous studies.

The difference between shear bond strengths under dry and wet contamination, like moisture and saliva, might be attributed to the effect of contamination on the etching pattern. With the contamination, the primer gets diluted and the penetration of the primer might decrease. Scanning electronic microscopy photomicrographs revealed a homogeneous appearance of contamination. Even though moisture and saliva showed less bond strength when compared to the dry (control) subgroup, they had clinically acceptable bond strength. This was in agreement with the other previous studies. This result could be explained by the properties of the self-etching primers. These hydrophilic enamel primers were formulated with acetone and/or alcohol, which displaced moisture from the enamel surface isolated for bonding. However, blood contamination showed a very high statistical significance when compared with all the other subgroups (5.02 MPa). This result was in agreement with the other previous studies.

The different degrees of interference caused by water, saliva, and blood on bonding procedures are the result of the differing compositions of the substances. Saliva is more complex than water, and the difference in the type and amount of inorganic and organic substances in the blood makes it a greater mechanical barrier than saliva. Thus, it is reasonable that even with a hydrophilic bond system, blood interferes the most with SBS and is followed (in interference intensity) by saliva and water. The specific components of blood that are involved in this process are still not clear, and it is therefore, not possible to fully explain why blood moisture interferes with bonding more than saliva or water. The fact that no anticoagulants have been used in this experiment may have made the blood a mechanical barrier interfering directly in bonding. This result differs from the findings of Oonsombat et al. The variability of the results can be attributed to different etching/primers and to the use of fresh blood in the present study, whereas, Oonsombat et al. used blood mixed with anticoagulants.

Shear bond experiments that tested similar materials under various enamel surface conditions have produced differing results; this may be the result of a number of other variables, such as thermocycling tests, shear bond machines, direction of the force used to debond the brackets, cross head speed, substrate, type of brackets, absence of standardization for applied moisture, the quantity and the application of different products, or other small variations in the materials and methods used.

When Group I (conventional bonding system) and Group II (self-etching bonding system) were compared, the shear bond strength under the dry enamel surface condition showed a statistically significant result, with Group I showing a higher value. Many recent studies too showed that the shear bond strength of the brackets bonded with the self-etch primer was significantly less than those of the conventional two-stage bonding system. The possible explanation for this could be the difference in chemical composition and concentration of the etchant between the two systems. The self-etching primer used phosphoric acid esters, whose concentration was not known, whereas, the conventional two-stage bonding system was based on 37% phosphoric acid. In addition, the mode of etching/priming between the two bonding systems was also different (simultaneous etching/priming with the self-etching primer and separate etching, and priming stages for the conventional two-stage bonding system).

In this study, moisture and saliva contamination showed significantly lower shear bond strength in the conventional bonding system than in the self-etch bonding system. This could be explained by the fact that conventional primers were composed of glycidal methycrylate (Bis GMA), which revealed a hydrophobic characteristic that prevented them from penetrating the saliva on the etched enamel. In addition, minerals and saliva proteins compromised the setting of the adhesive on the contaminated tooth surface. The self-etching adhesive contained fewer hydrophilic monomers than conventional adhesives, and the fact could explain, in part, its better performance in wet...
conditions. Although the self-etching adhesive contained less than 2% in weight of bisphenol A diglycidyl ether dimethacrylate (bis-GMA), it included polyethylene glycol dimethacrylate (PEGDMA) in its composition, which might have enhanced its tolerance of wet conditions.\(^{[25]}\)

In this study of bonding in the presence of contamination in the self-etching group, it has been seen that the addition of PEGDMA allows the bond material to tolerate greater concentrations of water. Diffusion of bis-GMA monomers over an area of a wet enamel surface is less than with adhesives without PEGDMA\(^{18}\) because the relatively hydrophobic bis-GMA cannot adequately infiltrate under wet bonding conditions. Thus, the addition of PEGDMA may favor the infiltration of bis-GMA-based adhesives into the wet enamel and may promote the homogeneous distribution of hydrophobic components throughout the interface.

Blood produced the worst conditions for both bonding systems when compared with other contaminations. With the presence of blood the bond strength was significantly lower in conventional bonding than in the self-etch bonding system. However, the self-etch primer in the presence of blood showed a bond strength lower than the clinically acceptable bond strength. These findings were supported by many other studies.\(^{[13,26,27]}\)

The ranges of shear bond strength were different in all groups when compared with other studies. This might be the result of variability in proper fit between the bracket base and the premolar crown, due to unavoidable anatomic variability.\(^{[7]}\) Also, the operator’s inability to position the testing machine’s blade precisely might account for the wide variation. Some studies reported the use of a wire loop around the bracket to connect it to the machine to measure shear-peel bond strength.\(^{[6,28]}\) This approach had not reduced the variability in the data. Thus, a wide range might be considered an inherent finding when in vitro shear bond strength studies are conducted.\(^{[8,0,21,28-34]}\)

**CONCLUSION**

Within the parameters of the study, it could be concluded that

- The conventional bonding system showed higher shear bond strength values than the self-etch bonding system under dry enamel surface conditions
- The self-etch bonding system showed higher shear bond strength values than the conventional bonding system under all wet conditions
- In both the systems, the weakest mean bond strength was achieved in the presence of blood contamination
- The use of the self-etch bonding system showed clinically acceptable bond strength under moisture and saliva contaminations.

**REFERENCES**

1. Buonocore MG. A simple method of increasing the adhesion of acrylic filling materials to enamel surface. J Dent Res 1955;34:849-53.
2. Dorminey JC, Dunn WJ, Talounis LJ. Shear bond strength of orthodontic brackets bonded with a modified 1-step etchant-and primer technique. Am J Orthod Dentofacial Orthop 2003;124:410-3.
3. Newman GV. Epoxy adhesives for orthodontic attachments: Progress report. Am J Orthod Dentofacial Orthop 1965;51:901-12.
4. Grandhi RK, Combe EC, Speidel TM. Shear bond strength of stainless steel orthodontic brackets with a moisture-insensensitive primer. Am J Orthod Dentofacial Orthop 2001;119:251-5.
5. Zachrisson BU. A posttreatment evaluation of direct bonding in orthodontics. Am J Orthod Dentofacial Orthop 1977;71:2.
6. Sfondrini MF, Cacciafesta V, Scribante A, Angelis MD, Klersy C. Effect of blood contamination on shear bond strength of brackets bonded with conventional and self-etching primers. Am J Orthod Dentofacial Orthop 2004;125:357-60.
7. Maia SR, Cavalli V, Liporoni PC, do Rego MA. Influence of saliva contamination on the shear bond strength of orthodontic brackets bonded with self-etching adhesive systems. Am J Orthod Dentofacial Orthop 2010;138:79-83.
8. Faltermeier A, Behr M, Rosentritt M, Reicheneder C, Müssig D. An in vitro comparative assessment of different enamel contaminants during bracket bonding. Eur J Orthod 2007;29:599-603.
9. Rajagopal R, Padmanabhan S, Gnanamani J. Comparison of Shear Bond Strength and Debonding Characteristics of Conventional, Moisture-Insensitive, and Self-etching Primers. In vitro Evaluation. Angle Orthod 2004;74:264-8.
10. Bishara SE, Oonsombat C, Ajlouni R, Dehney G. The effect of saliva contamination on shear bond strength of orthodontic brackets when using a self-etch primer. Angle Orthod 2002;72:554-7.
11. Buyukyilmaz T, Usumez S, Karaman AL. Effect of self-etching primers on bond strength: Are they reliable?. Angle Orthod 2003;73:64-70.
12. Klocke A, Shi J, Kahl-Niebe B, Bismayer U. In vitro Evaluation of a moisture-active adhesive for indirect bonding. Angle Orthod 2003;73:697-701.
13. Santos BM, Pithon MM, Ruellas AC, Sant’Anna EF. Shear bond strength of brackets bonded with hydrophilic and hydrophobic bond systems under contamination. Angle Orthod 2010;80:963-7.
14. Sayinsu K, Isik F, Sezen S, Aydemir B. Light Curing the Primer: A moisture-active adhesive for indirect bonding. Angle Orthod 2007;76:310-3.
15. Reynolds. A review of direct bonding. Br J Orthod 1975:2:171-8.
16. Oonsombat C, Bishara SE, Ajlouni R. The effect of blood contamination on the shear bond strength of orthodontic brackets with the use of a new self-etch primer. Am J Orthod Dentofacial Orthop 2003;123:547-50.
17. Arnold RW, Combe EC, Warford JH Jr. Bonding of stainless steel brackets to enamel with a new self-etching primer. Am J Orthod Dentofacial Orthop 2002;122:274-6.
18. Zeppieri IL, Chung CH, Mante FK. Effect of saliva on shear bond strength of an orthodontic adhesive used with moisture insensitive and self-etching primers. Am J Orthod Dentofacial Orthop 2003;124:414-9.
19. Cacciafesta V, Sfondrini MF, De Angelis M, Scribante A, Klersy C. Effect of water and saliva contamination on shear bond strength of brackets bonded with conventional, hydrophilic, and self-etching primers. Am J Orthod Dentofacial Orthop 2003;123:633-40.
20. Webster MJ, Nanda RS, Duncanson MG Jr, Khajotia SS, Sinha FK. The effect of saliva on shear bond strengths of hydrophilic bonding systems. Am J Orthod Dentofacial Orthop 2001;119:54-8.
21. Klocke A, Shi J, Kahl-Nieke B, Bismayer U. In vitro investigation of indirect bonding with a hydrophilic primer. Angle Orthod 2003;73:445-50.
22. Oztoprak MO, Isik F, Sayinsu K, Arun T, Aydemir B. Effect of blood and saliva contamination on shear bond strength of brackets bonded with 4 adhesives. Am J Orthod Dentofacial Orthop 2007;131:238-42.
23. Scougall-Vilchis RJ, Ohashi S, Yamamoto K. Effects of 6 self-etching primers on shear bond strength of orthodontic brackets. Am J Orthod Dentofacial Orthop 2009;135:424.e1-7.
24. Bishara SE, VonWald L, Laffoon JF, Warren JJ. Effect of a self-etch primer/adhesive on the shear bond strength of orthodontic brackets. Am J Orthod Dentofacial Orthop 2001;119:621-4.
25. Vicente AJ, Mena A, Ortiz AJ, Bravo LA. Water and saliva contamination effect on shear bond strength of brackets bonded with a moisture-tolerant light cure system. Angle Orthod 2009;79:127-32.
26. Abdelnaby YL, Al-Wakeel El S. Effect of early orthodontic force on shear bond strength of orthodontic brackets bonded with different adhesive systems. Am J Orthod Dentofacial Orthop 2010;138:208-14.
27. de Carvalho Mendonça EC, Vieira SN, Kawaguchi FA, Powers J, Matos AB. Influence of Blood Contamination on Bond Strength of a Self-Etching System. Eur J Dent 2010;4:280-6.
28. Isci D, Sahin Saglam AM, Alkis H, Elekdag-Turk S, Turk T. Effects of fluorosis on the shear bond strength of orthodontic brackets bonded with a self-etching primer. Eur J Orthod 2011;33:161-6.
29. Campoy MD, Plasencia E, Vicente A, Bravo LA, Cibrián R. Effect of saliva contamination on bracket failure with a self-etching primer. A prospective controlled clinical trial. Am J Orthod Dentofacial Orthop 2010;137:679-83.
30. Vicente A, Bravo LA. Shear bond strength of precoated and uncoated brackets using a self-etching primer. Angle Orthod, Vol 77, No 3, 2007.
31. Scougall Vilchis RJ, Yamamoto S, Kitai N, Yamamoto K. Shear bond strength of orthodontic brackets bonded with different self-etching adhesives. Am J Orthod Dentofacial Orthop 2009;136:425-30.
32. Cehreli ZC, Keçik D, Kocaderelic I. Effect of self-etching primer and adhesive formulations on the shear bond strength of orthodontic brackets. Am J Orthod Dentofacial Orthop 2005;127:573-9.
33. Kimura T, Dunn WJ, Taloumis LJ. Effect of fluoride varnish on the in vitro bond strength of orthodontic brackets using a self-etching primer system. Am J Orthod Dentofacial Orthop 2004;125:351-6.
34. Brauchli L, Eichenberger M, Steineck M, Wichelhaus A. Influence of decontamination procedures on shear forces after contamination with blood or saliva. Am J Orthod Dentofacial Orthop 2010;138:435-41.

How to cite this article: 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 self-etched bonding system. J Nat Sc Biol Med 2014;5:123-9.

Source of Support: Nil. Conflict of Interest: None declared.