Section A-Research paper
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COMPARING THE EFFECT OF GINGIVAL CREVICULAR FLUID, BLOOD AND WATER ON THE BOND STRENGTH OF BRACKETS USING MOISTURE INSENSITIVE PRIMER (MIP)

1.Dr.R.S.Niveditha, 2.Dr. Sunil sunny, 3. Dr. Venkatachalapathy Anusuya, 4. Dr. A. Jyosthna, 5.Dr. Vedant Chhabria, 6. Dr. Vikrant Lambate

[1]Postgraduate, Department of Orthodontics and Dentofacial Orthopedics, Vinayaka Mission's Sankarachariyar Dental College, Ariyanoor, Salem

[2]Professor and Head, Department of Orthodontics and Dentofacial Orthopaedics, Vinayaka Mission's Sankarachariyar dental college, Ariyanoor, Salem

[3]Associate professor, Department of Orthodontics and Dentofacial Orthopedics, Vinayaka Mission's Sankarachariyar Dental college, Ariyanoor, Salem

[4]Senior Lecturer, Department of Orthodontics and Dentofacial Orthopedics, Sathyabama Dental College, Chennai

[5]Postgraduate, Department of Orthodontics and Dentofacial Orthopedics, Y.M.T Dental College Kharghar, Navi Mumbai.

[6]Postgraduate, Department of Orthodontics and Dentofacial Orthopedics, Mahathma Gandhi Mission Dental College and Hospital, Navi Mumbai.

Corresponding Author:

Dr.R.S.Niveditha, Postgraduate, Department of Orthodontics and Dentofacial Orthopedics, Vinayaka Mission's Sankarachariyar Dental College, Ariyanoor, Salem

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Abstract:

Objective: The aim of the study was to evaluate and compare the shear bond strength of brackets using moisture insensitive primer (MIP) when exposed to gingival crevicular fluid (GCF), blood and water while bonding. **Materials and methods:** Sixty non-carious human premolars with sound buccal surface were used in the study. Teeth were divided into 3 groups with 20 teeth in each (n=20) group I (GCF), group II (Blood) and group III (Distilled water). Bonding was done using Transbond MIP and light cure composite in the presence of GCF, blood and water. Shear bond strength (SBS) was assessed using Instron Universal testing machine. The adhesive remnant index (ARI) was calculated using scanning electron microscope (SEM). Comparative statistical analysis was done by unpaired t-test. P value of 0.05 was kept as statistically significant. **Results:** The shear bond strength value in group I was 11.55±3.94 Mpa (mean±SD), group II was 12.61±4.70 Mpa (mean±SD) and group III was 16.97 Mpa (mean±SD). The unpaired t-test comparison revealed a statistically significant difference with p value of 0.045. ARI scoring showed that in Group 1 more than half of the adhesive resin was present on the bracket base which was comparatively lesser in Group II, and Group III had maximum of the adhesive resin present on the tooth surface.

Introduction: In the evolution of fixed orthodontic appliances, aesthetics is one of the prime concerns for acceptance of any appliance by the patient. The time-consuming unesthetic banding procedure had been virtually discarded after the introduction of the acid-etch direct bonding technique in 1955. [1] The first case of bonding orthodontic brackets was introduced by Newman.[2,3] Innovations in the etching system, bonding agents, and light-cured adhesives have expanded the possibilities for attaching orthodontic brackets. The unlimited working time of light-cured adhesive allows the orthodontist to manipulate the bracket position until polymerization is initiated by the visible light source. Several Studies have shown that the SBS of the self-etching (SE) primer and resin system was significantly more or similar to the conventional system.[4-9] Among the various properties, the shear bond strength of the bonding system plays a crucial role in the successful bonding of orthodontic attachments. [10] Moisture control is another critical step for the successful bonding of orthodontic attachments as it is difficult for operators to have a moisture-free oral environment. One among the products which are widely accepted and are in use to improve bond strength even in presence of moisture contamination is Moisture Insensitive Primer. The latest entrant and the first no-mix bonding adhesive in the generations of bonding agents is the moisture insensitive primer. MIP is a hydrophilic resin that sets in the presence of moisture with comparable bond strength to the conventional primer.[10] This is of greater advantage to the orthodontist in cases of bonding on the impacted teeth.

An inflammatory exudate produced by the periodontal tissues is known as gingival crevicular fluid (GCF). It is made up of serum and locally produced substances such as tissue breakdown products, inflammatory mediators, and anti-dental plaque bacterial antibodies. The components come from a variety of sources including serum, connective tissue, and the epithelium as GCF travels through on its approach to the fissure.[11]

The presence of various fluids and continuous secretions such as saliva, gingival crevicular fluid, blood, etc. makes it very difficult to maintain a hundred per cent dry field throughout the bonding.

Despite numerous studies conducted to evaluate the shear bond strength of MIP under contaminated conditions, the efficacy of moisture-insensitive primer remains uncertain when it comes to contamination by gingival crevicular fluid.

Hence the present study was designed to find out effectiveness of MIP in moist environment. The aim of this study is to evaluate the shear bond strength of brackets using moisture insensitive primer when exposed to gingival crevicular fluid, blood and distilled water while bonding.

Materials and methodology: The study was conducted in the Department of Orthodontics and Dentofacial Orthopedics. The approval for the study was obtained from Institutional Research committee. Sixty non-carious human premolars with sound buccal surface that were extracted as part of the orthodontic treatment were used in the study. Teeth were divided into 3 groups with 20 teeth in each (n=20) group I (GCF group) group II (Blood group) and group III (Distilled Water group).

The extracted teeth were rinsed with water to clean the blood and soft tissue debris, decontaminated with 0.5% thymol and stored in distilled water at 37 degree Celsius for 2 weeks. Each tooth was embedded in an acrylic block up to 1mm apical to cemento-enamel junction with long axis of the tooth parallel to the long axis of acrylic block. Thus, the crowns were left exposed out to allow for surface preparation and bonding on the buccal surfaces. (Fig 1(a))

Fig.1: (a).Extracted teeth mounted on acrylic block (b). Transbond MIP and light cure composite (3M Unitek, Monrovia, CA, USA)

Bonding was done using MIP (Transbond MIP, 3M Unitek, Monrovia, CA, USA) and light cure composite (Transbond XT,3M Unitek, Monrovia, CA, USA) (Fig.1(b)) in the presence of GCF, blood and water. Orthodontic pre-adjusted edgewise stainless-steel brackets having 0.022x0.028 slot for premolar was used (3M Unitek, Victory series brackets). All the brackets were bonded on buccal surface of teeth by single investigator to avoid inter investigator variation. Principle investigator's blood and GCF were used as contaminants during bonding. GCF was collected from investigator using a micropipette by intra-crevicular method. Micropipette was placed inside the periodontal sulcus which collects GCF using capillary action (Fig.2). The blood used was fresh from the finger prick by using a lancet. The buccal surface of tooth was cleaned with pumice application and prophylactic cup and 37% phosphoric acid was used to etch the surface for 30 seconds followed by rinsing with three-way syringe for 10 seconds. A layer of GCF was coated on to the buccal surfaces in group I, a layer of blood was coated in gorup II and a layer of distilled water was coated in group III before the application of primer under moist conditions.

Fig.2 : Microcapillary tube used for GCF collection

The assessment of SBS was done using Instron Universal testing machine at cross head speed of 1mm/min and force passing parallel to buccal surface. Each block was secured and forces were applied using a metal zig, and the machine applied an occluso-apical force parallel to the tooth surface. The force necessary to debond each bracket was measured in Newtons and converted to Megapascals using the formula below,

Bond strength Mpa = Force in Newtons /surface area of the bracket in mm^2

Following debonding, all specimens were examined under a scanning electron microscope (25x magnification) to assess adhesive residues on tooth surfaces using the adhesive remnant index (ARI)[12] (Fig.3a-c).

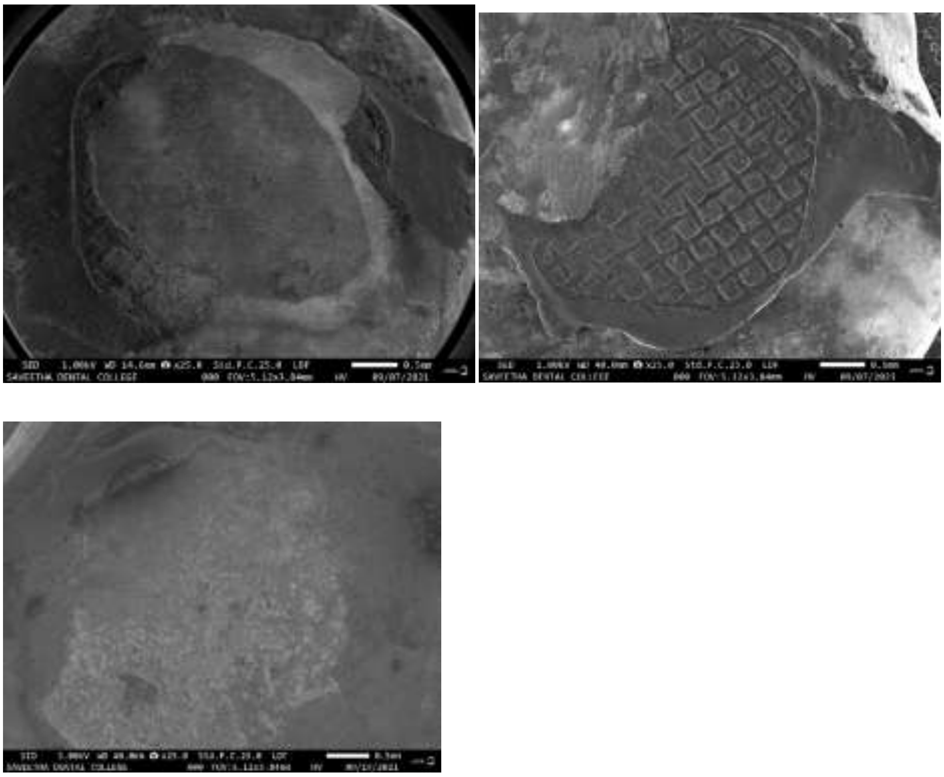

Fig.3 :SEM image used for ARI Scoring

The ARI scale has a range of 1-5:

1=The entire composite with an impression of the bracket base remained on the tooth surface. 2=More than 90% of the composite remained on tooth surface. 3=More than 10% but less than 90% of the composite remained on tooth surface. 4=Less than 10% of composite remained on tooth surface. 5=No composite remained on tooth surface

Statistical analysis: The collected data was prepared as master chart and analysed in the SPSS software (IBM, Chicago, IL, version 25.0). The data was checked for its distribution using test of normalcy. As the data was found to be normally distributed, unpaired t-test was used to compare the mean SBS between the groups, the ANOVA was used to compare the mean among the three groups and Post hoc test was used among the groups. P value of 0.05 was kept as statistically significant.

Results: The obtained results of shear bond strength for group I, group II and group III were described and compared in Table.1 (Fig.4). It showed that the mean ± SD of SBS value in group I was 11.55±3.94 Mpa, group II was 12.6±4.70 Mpa and group III was 16.97±6.64 Mpa. From Table.1, the unpaired t-test comparison revealed a statistically non-significant difference between group I and II with p value 0.45. Statistically significant difference was found between the group I and III and also between group II and group III with p value of

0.003 and 0.021. Table.2, the ANOVA test has shown a statistically significant difference between three groups with a p value 0f 0.004. Table 3, the results of post hoc test showed that significant difference is present in means of results between the group I & group III and, between group II & III. The means of results for the group I was similar with those of the groups II. Table 4 shows the ARI Scoring of group I, group II, group III. It can be noticed that group I had more than half of the adhesive resin present on the bracket base which was comparatively lesser in group II. Group III had maximum of the adhesive resin present on the tooth surface

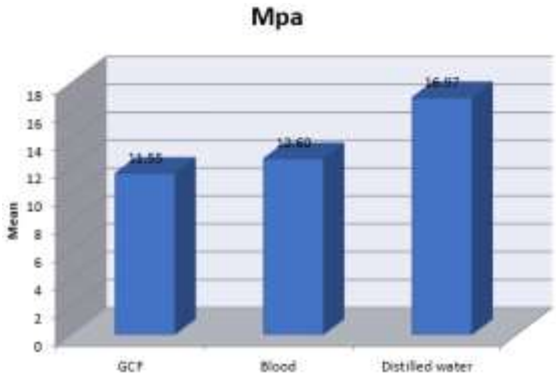

Fig.4 : Comparison of shear bond strength value in Mpa among the three groups

Discussion: The most significant aspect of orthodontic therapy is the bonding of orthodontic brackets to the teeth. It is the most essential stage since frequent bond failures might lengthen treatment time and negatively impact patient compliance. Bond failures can be caused by a number of factors other than the bonding process. Orthodontists often face challenges with bonding in areas that have a higher risk of contamination. Although, it is possible to mitigate the risk of contamination during bonding procedures by utilizing moisture control techniques, which can help prevent the presence of water. Nevertheless, bond failures continue to pose a risk in terms of delay in the treatment duration It is a widely accepted fact that the presence of moisture contaminants can lead to a reduction in the shear bond strength of brackets.[13,14]The negative impact of moisture on orthodontic bonding may be related to the adsorption of water, the exertion of a plasticizing effect in the polymer network from the formation of hydrated zones at polar monomer sites, and the oxidation of pendant c=c bonds attached to the network that release by products such as formaldehyde, thus producing plasticizing effects. [15]. As a result, there was a higher demand for hydrophilic adhesive to combat moisture contamination. Applying a layer of Transbond MIP onto enamel that has been conditioned with acid can establish a reversible hydrolytic bond mechanism. This is achieved by breaking and reforming carboxylate salt complexes formed between the ionized carboxyl groups of the methacrylate functionalized-polyalkenoic acid co-polymer and residual enamel calcium. The co-polymerization of the methacrylate moieties of the co-polymer with the resin adhesive is facilitated by the rapid responding monomer hydroxyethylmethacrylate. This helps to counterbalance the reduced conversion of the methacrylate groups due to steric hindrance. By setting a dynamic equilibrium at the interface, the bonding mechanism incorporates the otherwise detrimental plasticizing effect of water, while also providing stress relaxation capacity through micromechanical retention.[15]
Contamination of tooth surface with blood during disimpaction of a tooth orthodontically and gingival crevicular fluid during routine bonding could also pose a risk factor for orthodontic bonding which have not been considered widely as a contaminant in the field of orthodontics.

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There are only handful of studies comparing the effectiveness of moisture insensitive primer in the presence of contamination with gingival crevicular fluid, and blood. Therefore, this study was taken up to compare the shear bond strength of orthodontic brackets using moisture insensitive primer when exposed to gingival crevicular fluid, blood and distilled water. The results of this study had shown that there is a noticeable reduction in bond strength between the groups with higher bond strength for blood than group contaminated with gingival crevicular fluid. Mean bond strength achieved for the group I, group II and group III were 11.55 Mpa, 12.61 Mpa and 16.97 Mpa respectively

By using multidimensional protein separation and tandem MS technology, a study conducted by Carneiro et al, had documented a proteome data set of gingival crevicular fluid from periodontally healthy areas. This method, along with the collection of samples on periopaper, allowed the discovery of 199 unique proteins in gingival crevicular fluid, none of which were associated with proteins from salivary secretion. [16]. It appears that higher levels of organic compounds hinder primer-adhesive bonding. Saliva and blood react differently because they contain different types and quantities of inorganic and organic chemicals[17]. This might be a possible explanation for the reduction in bond strength in both group I and II in our study.

Reynolds et al. in his article had quoted that bond strength value ranging from 5.8-7.8 Mpa is clinically acceptable[18]. This indicates that the mean shear bond strength values of all the groups were clinically sufficient to withstand tensile loads.

Despite few studies reporting a decrease in shear bond strength values in the presence of contaminants, some within clinically acceptable ranges, our study found that the use of MIP can achieve bond strength levels that are clinically acceptable even in the presence of contaminants.[7,19]

However, the mean SBS of group contaminated with Distilled water remains significantly higher.

The drawback of this study is that it is an Ex-vivo study. Thus, more comprehensive clinical studies are required to evaluate the performance of this material in a clinical setting.

Conclusion:

- The GCF, Blood and Distilled water groups has shown a statistically significant difference in the shear bond strength of brackets when moisture insensitive primer is used.
- From this study it was evident that the shear bond strength values of groups were decreased when contaminated with GCF and blood but it was within the range of clinically acceptable bond strength.

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