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Evaluation and Comparative Study of Micro-leakage under Orthodontic Brackets Bonded with Different Adhesives Systems- An In-vitro Study.

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Abstract

Aims: The aim of this study is to compare the extent of stability of four different commercially available orthodontic adhesives around bracket and enamel surface.

Objectives: To assess the amount of micro leakage of a tooth-adhesive-bracket complex when metal brackets are bonded with different adhesive systems over the teeth.

Materials and method: A total of 40 human premolars extracted for orthodontic reasons was randomly divided into four groups of adhesives used for bonding brackets to dental enamel (i) Transbond XT primer + Transbond XT light cure adhesive, (ii) Ortho Solo primer and Ormco enlight light cure adhesive, (iii) Ivoclar vivadent Heliocit orthodontic composite and (iv) Transbond Plus Self-Etching primer+ Transbond XT Light Cure adhesive. Following bonding, all teeth underwent 2500 cycles of thermal cycling in baths ranging from 5°C to 55°C and immersed in 2% methylene blue for 24 hours. All the samples were sectioned and examined under a stereomicroscope to assess the degree of microleakage at bracket and enamel interface in the gingival and occlusal regions of the brackets.

Results: Microleakage was detected in all the groups. No statistically significant difference was seen in the microleakage under orthodontic brackets at gingival margin and occlusal when compared among four study groups as p>0.05.

Conclusion: All of the brackets exhibited some amount of microleakage. This result means that microleakage does not depend on the type of adhesive used.

Keywords: Microleakage, Orthodontic, Adhesive Systems

Introduction

For bracket bonding, light-activated resin-based orthodontic adhesives are frequently employed because they enable dentists to accurately position brackets on teeth and have a lengthy working duration. It's crucial to achieve a solid adhesive connection between an orthodontic attachment and tooth enamel in everyday orthodontic practice. Orthodontic attachment retention techniques that save time and preserve teeth are replacing more time-consuming and traditional techniques, although there is still a high risk of caries under and around multiple bonded appliances [1]. In orthodontics, the white spot lesion, which is thought to be the precursor of frank enamel caries, has been linked to the persistent buildup andretention of bacterial plaque on the enamel surface next to the appliances.

Numerous studies have demonstrated that orthodontic equipment physically change the microbial environment to promote the expansion of the facultative bacterial population in addition to stimulating an increase in the amount of dental plaque [2]. It has been established that the primarydisadvantage of adhesive materials is polymerization shrinkage during curing, which leaves a gap between the adhesive and the enamel surface, allowing bacterial fluids, ions, and even air from the oral cavity to infiltrate—a phenomenon known as microleakage. Harper coined the phrase "microleakage" in 1912 [3]. The development of a gap between the bracket and the adhesive or between the enamel and the bracket is one of the factors that contribute to the failure of the orthodontic bracket bond.

Bonding materials are susceptible to temperature fluctuations in the mouth cavity brought on by the consumption of food and beverages, in addition to photo polymerization shrinkage, which might potentially result in volumetric changes. These occurrences would lead to adhesive joint fatigue, which results in microleakage. In order to stop enamel demineralization and lower bond failure, several regimens have been devised. Demineralization and bond failure still have an impact on how well orthodontic treatment works, despite these efforts. Micro leakage is the result of a bonding material's stability being weakened. Microleakage may very well result in the development of white-spot lesions at the adhesive-enamel interface from an orthodontic point of view [4]. There are, however, few studies that assess the microleakage under braces. Therefore, the purpose of this study was to assess and contrast the microleakage under orthodontic brackets attached to the teeth using various adhesive techniques.

Materials and methodology

Materials

- Metal brackets (leonembt.022slot).
- Etchant (3M ESPE Transbond Etchant) 37% Phosphoric Acid Solution

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- Four distinct adhesive kit sets.
- Forty complete, caries-free premolars.
- Coltene Coltolux LED light curing equipment for photopolymerization.
- A 2% Methylene blue coloring substance.
- Thermal cycling device.
- Diamond disk for cutting brackets and teeth into sections.
- Binocular microscope at 10X magnification to analyze the microleakage.
- Other items: regular salt, self-curing resins, sticky wax, and nail varnish.

Figure 1: Metal brackets

Methodology

Extracted premolars were collected and placed in normal saline to prevent bacterial contamination and dehydration until use. They also had an intact sound crown structure and no caries, cracks, developmental defects, or restorations (Figure 2). Before bonding the brackets, the teeth were ultrasonically scaled and polished. The cleaned teeth were sorted into four groups of ten samples each at random, and each group was given a color code.

Figure 2: Extracted Premolars.

Grouping (Figure 3)

Group 1 with red color code: A 3M ESPE Transbond Etchant solution containing 37% phosphoric acid was used to etch the teeth's buccal surface. Using 3 M Unitek Transbond XT primers and light cure adhesive, metal brackets (figure 2) were glued to the teeth.

Group 2 with blue color code:Buccal surface etching is carried out first. Using Ortho Solo primer and Ormcoenlight light cure glue, metal brackets were attached to the teeth.

Group 3 with green color code: The teeth's buccal surface was etched with a 37% phosphoric acid solution. With the use of Ivoclar Vivadent Heliosit orthodontic Composite, brackets were attached to the teeth.

Group 4 with orange color code: On the buccal surface of the teeth, a primer made of 3M Transbond plus Self Etching was applied. With the aid of 3M Transbond XT Light Cure glue, metal brackets were attached to the teeth.

All of the teeth went through 2500 cycles of thermal cycling at bath temperatures of 5°C (Figure 4) and 55°C (Figure 5) with a dwell period of 30s.

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Figure 3: Varnished and sealed samples

Figure 4: Thermo cycling Chamber at 5ºc.

Figure 5: Thermo cycling Chamber at 55ºc.

Based on the color code allocated to each group, two coats of varnish were applied on the teeth, leaving a 1mm space around the borders of the bracket. The samples were submerged in 2% methylene blue for 24 hours after the samples' apices were sealed with sticky wax.

Figure 6: Bonded tooth embedded in acrylic block.

The samples were thoroughly rinsed with distilled water before being allowed to air dry before being implanted in self-curing acrylic resin (Figure 6). A diamond saw was used to cut a parallel longitudinal segment in the buccolingual direction through the centre of the bracket. Using a diamond saw to cut the tooth in a buccolingual orientation. At a 10X magnification, a stereo microscope was used to examine each segment.

Scoring criteria

Scores were given to the various levels of microleakage at the bracket enamel surfaces in the gingival and occlusal areas of the bracket.

Score 0: There is no dye leaking through the enamel or adhesive-bracket contact.

Score 1: Between bracket adhesive or adhesive enamel contacts, dye penetration is just 1mm.

Score 2: Between the bracket adhesive or adhesive enamel contact, there is up to 2mm of dye penetration.

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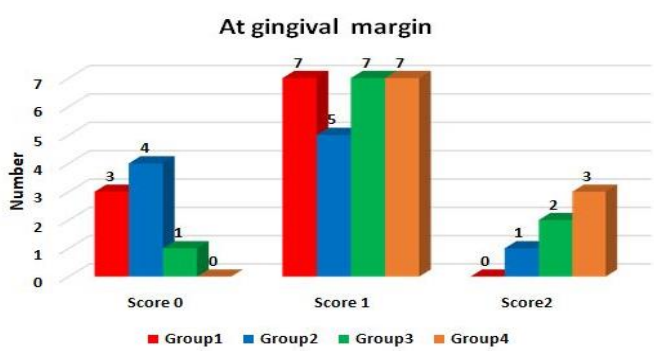
Score 3: Between the bracket adhesive or adhesive enamel contact, there is up to 3mm of dye penetration.

Results

An Excel spread sheet was used to enter the data, and any inconsistencies were examined. Tables and graphs were used to show the summarized data. Utilizing version 21.0 of SPSS, the data was examined. The chi square test was employed to see if category variables were associated. The p-value cutoff for statistical Significance was 0.05.

Table 1: Intergroup comparison of gingival margin microleakage under orthodontic brackets

			Gingival			Total
			Score0	Score1	Score2	
Group	Group1	N	3	7	0	10
		%	30.0%	70.0%	0.0%	100.0%
	Group2	N	4	5	1	10
		%	40.0%	50.0%	10.0%	100.0%
	Group3	N	1	7	2	10
		%	10.0%	70.0%	20.0%	100.0%
	Group4	N	0	7	3	10
		%	0.0%	70.0%	30.0%	100.0%
Total		N	8	26	6	40
		%	20.0%	65.0%	15.0%	100.0%
P-value						0.185

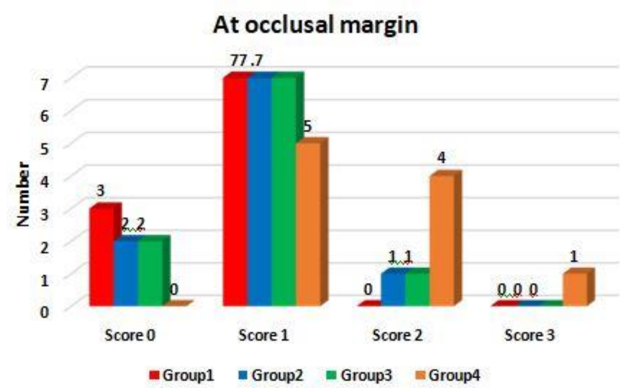


Graph 1: Microleakage at the gingival margin beneath orthodontic brackets is compared across groups.

When the microleakage under orthodontic brackets at the gingival border was studied between the four research groups, there was no discernible difference as p>0.05 (Table 1 and Graph 1).

Table 2: Microleakage under orthodontic brackets at the occlusal edge is compared across groups.

			Occlusal				Total
			Score0	Score1	Score2	Score3	
Group	Group 1	N	3	7	0	0	10
		%	30.0%	70.0%	0.0%	0.0%	100.0%
	Group 2	N	2	7	1	0	10
		%	20.0%	70.0%	10.0%	0.0%	100.0%
	Group 3	N	2	7	1	0	10
		%	20.0%	70.0%	10.0%	0.0%	100.0%
	Group 4	N	0	5	4	1	10
		%	0.0%	50.0%	40.0%	10.0%	100.0%
Total		N	7	26	6	1	40
		%	17.5%	65.0%	15.0%	2.5%	100.0%
P-value							0.204



Graph 2: Microleakage at the occlusal border under orthodontic brackets is compared across groups.

When the microleakage under orthodontic brackets at the occlusal edge was compared between the four research groups, there was no discernible difference as p>0.05 (Table 2 and Graph 2).

Inference

Microleakage under orthodontic brackets at the gingival and occlusal edges was discovered to be statistically insignificant when evaluated using the Chi-square test and maintaining the threshold of significance atp<0.05.

Discussion

Clinical detection of microleakage, which is the passage of germs, oral fluids, ions, and chemicals into the interface between the filling material and the tooth, is impossible. It may cause the region around orthodontic brackets to become decalcified or lessen the bond strength of the brackets in the case of orthodontics [5]. The polymerization shrinkage of the resin, the

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differing temperature expansions of the enamel and the adhesive and insufficient adherence have all been found to contribute to microleakage [6]. Long-term fixed orthodontic treatment involves increasing caries in the areas under and around the brackets and white spot lesions that are focused on microleakage [7]. Therefore, finding bonding materials with greater adhesion and fewer tendencies to leak at the edges is a significant advance for orthodontic adhesive materials.

One of the four patients receiving fixed orthodontic equipment had white spot lesions. Thermal expansion has an impact on the adhesive substance's ability to adhere to the tooth. Temperature variations cause the "bracket adhesive enamel" complex to go through various dimensional changes that may lead to fractures and fissures that permit microleakage [8].*Kubo et al.* [9] investigated the microleakage of self-etching primers in restorative dentistry after thermal and flexural load cycling and observed that the primers' marginal integrity remained preserved even after 5000-10,000 heat cycles and flexural loads.

In-vitro microleakage experiments in orthodontics used a dye solution, and the sections were inspected under a stereo microscope to assess dye penetration. The dye penetration method was also used in the current study. For 24 hours, the samples were immersed in a 2% Methylene blue solution.

The advantages of this method are the availability of aqueous solutions, the determination of visible light, the rapid and direct assessment of microleakage, the lack of reactivity with hard structures, the low cost, and the absence of toxicity. Heliosit Orthodontic composite was used in group 3. Flow able composites stand out among composite resins that might be used as orthodontic adhesives due to their simplicity of usage in clinics [10]. Flowable composites have two desirable clinical handling characteristics: no stickiness and injectable fluid, which were previously unavailable for composites [11].Heliosit Orthodontic was created to simplify orthodontic attachment bonding by removing the requirement for primer preparation on both the bracket base and the etched tooth surface.

In this investigation, the SEP Transbond plus Self etching primer was employed in Group 4. This approach combines the etching and bond phases and eliminates the rinse step, reducing chair time and simplifying the whole bonding process. The Transbond plus Self-etching system includes phosphoric acid methacrylate, which acts as both an etching agent and a priming agent in one step.

Cal-Neto and Miguel[12] examined the tooth surface with a scanning electron microscope and determined that utilizing self-etching techniques results in a more uniform etch pattern and less enamel loss. Despite the fact that longer resin tags may etch and rinse deeper into the enamel, the significance of resin tag length to the amount of microleakage is still controversial. Several studies have found no significant relationship between the lengths of resin tags and binding strength on microleakage [13].

The purpose of this study was to examine the degree of stability of four widely available orthodontic adhesives around bracket and enamel. All groups in this investigation had varying degrees of microleakage at the tooth-adhesive contact. This might be due to adhesive material shrinkage during polymerization, resulting in gaps.

In this study, all groups had varying levels of microleakage beneath the brackets at the occlusal and gingival junction. Based on the findings, it was discovered that all of the groups had microleakage. As

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the value of P>0.05, no significant difference in the amount of microleakage was seen in any of the four groups.

These results were comparable to those achieved with *Alkisetal.*[14]. After comparing microleakage beneath orthodontic brackets, they reported that there were no statistically significant variations in adhesive microleakage ratings. Microleakage between enamel-adhesive and adhesive-bracket contacts at the occlusal and gingival borders was described by *Yagci et al*[15]. According to Li et al [16], the bonding method had no effect on the quantity of microleakage under orthodontic brackets. They also determined that the type of adhesive used had no effect on microleakage, which is consistent with our findings.

In their study on the evaluation of microleakage under orthodontic brackets, Atash et al [17] concluded that the Transbond XT adhesive group had the least amount of microleakage and the Transbond plus Self-etching adhesive had the highest microleakage scores, which contradicted our findings.

According to *Uysal et al.*[18], brackets bonded using a self-etching system had greater microleakage scores than brackets bonded using traditional complete etching techniques. Their findings contradicted those found in this investigation. In this investigation, the microleakage ratings of SEP and other conventional systems were almost identical.

Conclusion

The microleakage scores of four various adhesive solutions were examined and assessed in this study when metal brackets were adhered directly to the enamel surface. All of the adhesives utilized showed microleakage. Between the four groups, there was no statistically significant difference in the quantity of microleakage. There was no statistically significant quantity dental microleakage at the brackets' gingival and occlusal edges. There is no connection between the type of adhesive system and the microleakage occurrence. Preventive therapy options should be employed to stop the development of white spot lesions.

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