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Impact of ICON on the Adhesive Microleakage Underneath Orthodontic Bracket

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ABSTRACT

Objectives: the aims was to assess the changes in tooth orthodontic bracket interface micro-leakage after applying a caries resin penetrated to the sound enamel tooth surface. **Materials and Methods:** sixty human maxillary first premolars were collected, randomly separation of the teeth into two groups. The experimental one (treated with ICON) was categorized in to three subgroups (n= 10 each) (ICON in distal water, ICON in cow milk, ICON in Coca cola) while control group was classified three subgroups (n=10) (control in distal water, control in cow milk, control in Coca Cola) incubation time persisted three weeks in total. **Results:** A one-way analysis of variance (ANOVA) produced a significant difference between all experimental groups (ICON in distal water, ICON in milk, ICON in Coca Cola drink) and control subgroups (control in distal water, control in Cow milk, Control in Coca Cola). According to the results of the Mann-Whitney U test, ICON pretreatment tooth samples had significantly lower mean values of microleakage than non-ICON tooth samples. The control group in the energy drink subgroup had the highest mean microleakage value when compared to the other subgroups, whereas the resin infiltrated group in distal water had the lowest mean value. **Conclusions:** Orthodontic adhesive (control group) revealed that a resin penetrate on a sound enamel surface prior to orthodontic bracket bonding reduced bracket tooth interface microleakage in all examined groups. The ICON-infiltrated surface was discovered to provide a secondary preventive strategy against white spot lesion development and reducing micro-leakage under orthodontic brackets.

Keywords: Caries infiltration; Enamel; ICON; Microleakage, White spot lesion

INTRODUCTION

Microleakage is a complicated situation with such a fixed orthodontic appliance therapy. It is a loss of marginal integrity that permits white lesions to grow around and under the bracket, potentially resulting in reduction the bracket bonding strengths [1]. White spot lesions are clinical and cosmetic issues characterized by enamel demineralization, tooth discoloration, corrosion, and bond strength deterioration [2].

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Since orthodontic braces, bands, ligatures, and other orthodontic accessories are difficult to clean and increase bacterial biofilm accumulation on tooth surfaces, white spots develop around them [3,4]. White spot lesions have become more predominant with fixed orthodontic appliances [5,6]. Oral hygiene, sex, orthodontic treatment time, wheat consumption, and diet all have an influence on the appearance of white spots lesions [7,8]. To avoid additional demineralization and cavitation, these lesions should be recognized early [9]. Restorations, crowns, and veneers, which necessitate enamel reduction beyond the demineralized area, possibly even to the dentin [10], are among the options for treating white spot lesions. To remineralize these lesions on the surface, casein phosphopeptide amorphous calcium phosphate (CPP-ACP) products as MI Paste and MI Paste plus, as well as fluoride dentifrice, mouthwash, gels, varnish, and gels, can be utilized.

A resin infiltration material (ICON), have recently been encouraged [11,12]. Which is a substance with a low viscosity [13]. The primary knowledge of resin infiltration is to use capillary forces to enter and encloses the porosity volume of underlying imperfections, replenishing missing minerals, enclosing hydroxyapatite crystals, and micromechanically linking the residual enamel prisms [14,15]. The current research was deliberate in order to evaluate the variations in tooth orthodontic bracket interface microleakage after smearing a caries resin penetrated to the sound enamel tooth surface.

MATERIALS AND METHODS

The ethical approval was attained by the REC of the University of XXX.

Study sample design

Sixty human maxillary first premolars extracted for orthodontic purposes were used in the study. In order to avoid microbial growth, teeth were maintained at room temperature in a glass container in a solution of normal saline (Panther, USA) containing 0.1 percent thymol (Sigma, USA) that was altered daily [16,17].The study excluded teeth having caries, enamel abnormalities, abrasions, attrition, fractures, or any other developmental problems [18]. Buccal surfaces were scrubbed and polished for 15 seconds with a slow speed hand piece and non-fluoridated pumice and a rubber polishing cup, then rinsed and dried with oil-free air steam for another 15 sec [19,20].

Group A: control group samples of teeth not treated with ICON material.

Group B: experimental group samples of teeth treated with ICON material.

Bracket bonding

In the control group, (37%) phosphoric acid etching gel (Ivoclar, Vivadent, Liechtenstein) was placed to the buccal enamel surface for 30 sec, then its washed with plenty of water for 15 sec. and dried until the etched surface looked chalky [21]. 60 new Stainless-steel maxillary first premolar 0.022 slot Roth brackets (Dentarum Germany) was used. The bracket's base surface area was measured to be 9.786 mm2 [22]. Brackets were attached to the teeth by application of a thin layer of 3M adhesive (USA) applied to the buccal surface of the enamel in the middle middle third [21]. A weight of 200 grams was overloaded to the bracket for [23]. All unnecessary bonding excess around the bracket was cleaned by sharp probe. The adhesive was cured with a light cure unit (IOS) with a light intensity greater than 1200 mW/cm_2 and a wave length 600 nm [24]. The light curing device was fitted on a shaft to standardize the distance between the light device and the braces base to 2mm [25]. The whole curing time is 20s, 10s for each mesial and distal sides [26]. Concerning the ICON group, ICON was smeared according to the production as the following:

1. Apply ICON Etch. Let sit for 120 sec.
2. Water rinsing for 30s, then dry in a water oil free air.
3. ICON Dry is used. Lie on the site for 30s to conduct a visual assessment. The whitish opaque lesion discoloration must diminish significantly; otherwise repeat steps 1-3. Dry with water oil free air.
4. Switch off the operatory light. Apply Icon Infiltrate. Let it sit for at least for three minutes. Maintain the wet lesion surface with an occasional twist of the syringe.
5. Disperse with air, and floss. Light cure for 40s.
6. Substitute applicator tip. Smear ICON Infiltrate. Let sit for one minute and eradicate excess and floss. Light cure for 20 seconds, Polish.

3M adhesive and brackets were applied likewise to the group A. in order to prevent microleakage from the pulp chamber; tooth apices were covered with sticky wax to seal the root apices. To prevent microleakage from other places of the tooth, clear nail varnish was applied in two layers on buccal tooth surfaces, except for 1 mm around the orthodontic bracket base [16,27].

Packing of groups

Each group (control, experimental) was subdivided into three equal subgroups (n=10) based on storage media:

Subgroup A: Distal water was used to retain tooth samples immersed.

Subgroup B: Tooth samples were saturated in an energy drink for fifteen minutes three times/day at 1 hour intervals [28]. They were previously stored in distal water.

Subgroup C: Tooth samples were immersed in fresh cow milk drink for 10 minutes three times daily at 1 hour intervals. They were previously stored in distal water. The incubation phase lasted 2 weeks in entire [28].

Microleakage Evaluation

Teeth were then submerged for 24 hours at room temperature in a 0.5% solution of basic fuchsine (0.5 gram powder dissolved in 100 ml distilled water). The samples were rinsed with running water; A nail varnish and the superficial pigment were dressed with a brush [27]. At about the center of the bracket a slow speed disk was used to part each tooth in a bucco lingual direction [16].

A light microscope was used to evaluate microleakage in millimeters at enamel adhesive contacts on the occlusal and gingival sides for all pieces. The same and other investigator randomly checked half of the samples for a second time to calculate the microleakage. We get no significant variations in microleakage ratings between the first and second measurments.

The following principles were used to score the work: [22]

Score 0: There is no dye penetration thru the adhesive-enamel contact.

Score 1: At the adhesive enamel contact, dye penetration is limited to 1 mm.

Score 2: At the adhesive enamel contact, dye infiltrates into the inner half (2 mm).

Score 3: At a depth of 3 mm, the dye penetrates the adhesive enamel contact.

Statistical Analyses

One-way ANOVA was used to evaluate the results, followed by Mann-Whitney U tests to compare group's means. Statistical significance was settled to be $P \leq 0.05$.

RESULTS

A significant difference was discovered using (ANOVA) between all ICON treated teeth subgroups, although the comparisons in control subgroups (without ICON treatment), were revealed a significant difference. The Mann-Whitney U tests findings showed that the mean value differed significantly for ICON groups. The resin infiltrated group in deionized water had the lowest mean value of microleakage. There was the highest microleakage value in Coca Cola subgroup's than in control one when compared to the other subgroups, and there was a significant difference between all subgroups at $P \leq 0.05$.

DISCUSSION

There was a significant difference between all subgroups (distal water, cocacola drink, cow milk) in both control and experimental groups.

The effect difference of the microleakage test between control and experimental groups was shown in tables (1 and 2), where showed a highly significant difference at $P \leq 0.05$ between groups, and evaluating the microleakage test with and without using ICON, which was used as a preventative mean on the induced white spot lesions at the enamel surface [29,30], table (3) shows a obvious difference in microleakage between groups.

Table 1. Storage media, PH, Ingredients.

Storage media	pH	Ingredients
Distal water	7.1	
Coca Cola	3.2	Carbonated water, sugar, citric acid, sodium citrate, benzoic Acid, taurine, glucuronolactone, caffeine, inositol, caramel, acidity regulators, stabilizer, natural fruit flavors, vitamins like B2, B5, B6 and B12.
Milk	6.2	8.5% non-fat milk solids, 3% butterfat (full cream milk), Vitamins D and A, butterfat, purified water, stabilizer and Emulsifier.

Table 2. Statistical analysis of microleakage for standard groups.

Groups	Occlusal Mean ± SD	Gingival Mean ± SD
Control	0.8130 ± .02358 A	.9951 ± .05912 A
Control in cow milk	2.0221 ± .12454 B	2.6351 ± .12031 B
Control in coca cola drink	3.4921 ± .06051 C	3.8971 ± .07817 C
***P* value**	0.000	0.000

Table 3. Statistical Analysis of Microleakage for Experimental subgroups.

Groups	Occlusal Mean ± SD	Gingival Mean ± SD
ICON	0.3251 ± 0.01081 A	0.4411 ± 0.01196 A
ICON in cowMilk	0.6121 ± 0.01750 B	0.9460 ± 0.04743 B
ICON in cocacola Drink	1.6171 ± 0.07904 C	1.9631 ± 0.09614 C
F value	2070.553	1549.178
***P* value**	0.000	0.000

As the coca cola drinks include acids, they discovered the highest microleakage value at adhesive enamel interface, which was reliable Pulgaonkar and Chitra findings of (2021) [31,32] studying in explaining a detrimental influence on the brackets. Enamel demineralization carry about enamel erosion and adhesive material loss, as well as an increase in the microleakage after the brackets, this might also be linked to the existence of great doses of refined carbs, which encourage greater levels of acid. Also, Citric acid and citrate are adept of binding to calcium in the teeth enamel, possession the pH low for extended periods of time and promoting microleakage, as pronounce by Oncag et al., 2005 [33].

For the all tested subgroups, gingival sides showed significantly greater microleakage than occlusal sides. This is consistent with the results of Arhun et al., 2006 [34], who related difference to relative surface curvature, which might lead to higher adhesive on the gingival side. Microleakage can occur as a result of infusion, which is produced by a difference in the thermal expansion coefficients of brackets, enamel, and adhesive. This is approximately that both Salman and Al-Ani, (2021) approve with [35]. After the control in Coca cola drink, the control in cow milk group had a significant high microleakage. As milk lipids are insoluble in water, they would assign to the surface of the bonded teeth. Fat gathering weakens the resin and increased the microleakage. This is reinforced by Anicic et al. (2020) [36].

ICON's low viscosity permits it to competently penetrate the teeth enamel. Microleakage in the ICON groups (ICON, ICON in cow milk, and ICON in Cocacola drink) was lesser than in the other control subgroups, which approves with Li et al. (2021) [37]. Their findings are linked to the capacity of resin infiltration to effectively seal porous structures in the enamel and improvement the ability of sound enamel surfaces to endure acid erosion and demineralization, produce it harder for external acids to admittance the holes in the enamel. As a result, resin penetration may assistance in preventing acid erosion and demineralization of dental enamel. Arnold and Naumova (2016) [38] also established that addition resin infiltrate to enamel caries can quantity and reservation effects on the enamel.

CONCLUSION

Icon infiltrated surface could be used as a secondary preventative approach beside white spot lesion development in orthodontic patients by inhibiting microleakage under the brackets. Also the consumption of the acidic solution and fatty beverages increased the microleakage under the orthodontic braces.

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