The staining effect of chlorhexidine mouthwash on non-metallic brackets (An in vitro comparative study)

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ABSTRACT
Background: Since it is needed to have means other than mechanical plaque control to achieve good oral hygiene in orthodontic patients, and since eliminating the metallic appearance of orthodontic appliance is always desired to achieve a maximum esthetic appliance, so this study was done to investigate and compare the staining effects of chlorhexidine mouthwash 0.2% on the un-bonded ceramic brackets, ceramic brackets bonded with no mix adhesive, ceramic brackets bonded with light cured adhesive, un-bonded composite brackets, composite brackets bonded with no mix adhesive and composite brackets bonded with light cured adhesive.

Materials and Methods: The effect of the chlorhexidine was studied through immersion the brackets and bonded brackets in the mouth wash for three different time intervals: 1, 2 and 3 hours, which represent the accumulated daily use of the mouthwash for 1, 2, and 3 months respectively and compared them with corresponding control groups which not immersed in chlorhexidine 0.2%. The sample consisted of two hundred eighty eight brackets. A Shimadzu, UV 160A UV-Visible spectrophotometer was used to perform a light absorption test for each subgroup with twelve brackets each.

Results: ANOVA and LSD post Hoc tests were used to identify the significant effects of the mouthwash at a significance level P ≤ 0.05, A significant effects identified with ceramic brackets bonded with no mix adhesive, ceramic brackets bonded with light cured adhesive, un-bonded composite brackets, composite brackets bonded with no mix adhesive and composite brackets bonded with light cured adhesive, while non significant effect of un-bonded ceramic brackets.

Conclusions: It can be concluded that the chlorhexidine mouthwash do not have a staining effect on the un-bonded ceramic brackets while significant changes in staining effect when ceramic and composite brackets bonded to no mix adhesives and that effect decrease when bonded to light cured adhesives. The mouthwash has a staining effect on the un bonded composite brackets also.

Key words: Ceramic bracket, composite bracket, chlorhexidine. (J Bagh Coll Dentistry 2012;24(2):109-113).

INTRODUCTION
The esthetic requirements of orthodontic treatment prompted the development of tooth-colored brackets as alternatives to metal brackets (1). Many types of nonmetallic brackets fabricated from alumina and zirconia ceramics, as well as a variety of plastic brackets and composite brackets had been introduced during the past decades (2). Some of the earliest applications of chlorhexidine for the control of plaque and gingivitis go back to 1970s, when the dental literature reported on the use of 0.2% chlorhexidine gluconate rinses; twice a day; to prevent plaque accumulation and subsequent gingivitis (3). The adequate plaque control was difficult in patients undergoing orthodontic treatment, especially in the cases of children and adolescents and when bands and auxiliaries were involved (4). Many researchers classified staining as either extrinsic or intrinsic (5, 6). There was confusion concerning the exact definitions of these terms. Feinman et al. (7) described extrinsic discoloration as occurring when an agent stains or damage the enamel surface of teeth and intrinsic staining as occurring when internal structure is penetrated by a discoloring agent; according to his definition; the term staining and discoloration were used synonymously. However; extrinsic staining defined as staining that could be easily removed by normal prophylactic cleaning, intrinsic staining was defined as endogenous discoloration that had been incorporated in to the structure matrix and thus could not be removed by prophylaxis (8). The etiology of the dental discoloration is multifactorial in which different part of the tooth could take up different stains (9). Mouth wash containing chlorhexidine caused superficial black and brown staining of the teeth (10, 11). Ceramic brackets are more esthetic than metal brackets, and unlike plastic or composite brackets, they resisted staining and discoloration (12). Orthodontic adhesives could have intrinsic and extrinsic discoloration, chlorhexidine could discolor composite extrinsically and with time become intrinsically throughout a resin matrix, which was usually attributable to chemical degeneration of the filler–resin bond and solubility of the resin matrix (13).

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MATERIALS AND METHOD

Two types of brackets were used in this study, they were of standard edgewise (22×30 slot dimension), and with horizontal grooves in the base of bracket to generate a macro-retention undercuts to achieve maximum mechanical bonding surface. They include: Reflections® ceramic brackets which was made from 99.9% pure polycrystalline alumina, Rave® composite brackets were made from Injection Molded High Quality Reinforced Composite to increase bracket body strength with precise slot dimensions(Ortho Technology/U.S.A.). Resilience® No-Mix orthodontic adhesive, Resilience Primer®, Resilience® Light-Cure orthodontic adhesive, Resilience light cure Primer®(OrthoTechnology/U.S.A.) were used for bonding.

Corsodyl® Chlorhexidine digluconate 0.2% W/V, (GlaxoSmithKline, UK) was used as a test immersion media in the study.

Bonding procedure:
The sample composed of 144 Reflections® ceramic brackets and 144 Rave® composite brackets, the brackets were divided according to bond material into three groups of 48 brackets:

- Un bonded brackets which were not bonded to any bond materials.
- Chemically cured bonded brackets in which the brackets were bonded using chemically cured adhesive resin.
- Light cured bonded brackets in which the brackets were bonded using light cured adhesive resin.

The ceramic and composite brackets were bonded with a chemically cured, light-cured orthodontic adhesive as follow:

- Resilience Primer® was applied by brush on each bracket base or Resilience light cure Primer® used with Resilience® Light-Cure orthodontic adhesive.
- A small amount of the adhesive paste was applied onto the bracket base, and then by using a clamping tweezer the bracket was placed lightly onto a horizontal flat plastic plate mounted on the table of surveyor(Dent aurum, Germany) covered by a celluloid strip to facilitate detachment of the bracket–adhesive complex with a recovery of the set material.
- A constant load of two hundred grams was placed on the bracket to ensure a uniform thickness of the adhesive, the load fixed to the upper part of the vertical arm of the surveyor, a surveyor rod was fixed in the lower part of the vertical arm of the surveyor and put it in contact with the bonded bracket, excess adhesive was removed from around the bracket base with a sharp scalar (Bishara et al, 2005)
- The visible light-cured adhesive specimens were photopolymerized with a light-curing unit (YDL/ Hangzhou Yinya Co.,China); the light guide of curing light unit was directed toward the bracket, the light shined through the bracket for 20 second (according to manufacturer instruction.) The bonded brackets were allowed to bench set for 24 hr to ensure complete polymerization of adhesive material, then after setting; the celluloid strips were removed and the resultant bracket-bonded adhesive were flat.

Immersion in chlorhexidine:
Un bonded and bonded brackets were farther subdivided according to time interval immersion in chlorhexidine 0.2% into four groups with 12 brackets each which include 1 hour,2 hours ,3 hours immersion in chlorhexidine and one control group which not immersed in chlorhexidine. Then the immersion procedure was done by positioned each bracket on a black rectangular cardboard (35×45×0.2 mm) with central window, the cardboards were numbered and using the number of the card as a reference .The specimens then immersed in Chlorhexidine 0.2% solution contained in inert plastic containers. Immersion was done according to the different time intervals for one, two, and three hours in Chlorhexidine gluconate mouth rinse 0.2% at 37˚C in the incubator.

Assessment of staining :
The samples were taken out of the immersion media; then Staining measurements were performed over the 800 to 200 nm visible wavelength range with UV-Visible spectrophotometer (Shimadzu; UV160A; Japan.). The chamber of the spectrophotometer was opened, and then the black rectangular cardboard with bracket positioned in central window was used to position the bracket in the front part of the analytical beam holder of spectrophotometer. Then the chamber was closed and the machine was given the order to start scanning starting from 800nm wavelength in the infra-red zone to 200nm wavelength in the UV zone passing through the entire visible spectrum.

The light passes through the sample; then the intensity of the remaining light was measured with a light sensor, the results appeared as a graph from which the amount of light absorption was plotted and the amount of absorbed light at a 345nm wavelength visible light was obtained and used in the later statistical analysis.
RESULTS

The staining effect of chlorhexidine 0.2%-

Effect of time:
Generally, for most groups the amount of light absorption increase as time of immersion in the chlorhexidine increase. But, in un bonded ceramic brackets group the readings of light absorption in control and after 1, 2 and 3 immersion hours in the chlorhexidine 0.2% was not changed, the peak reading in the immersion 3 hours reading.

Ceramic bracket group (Table 1 and Fig. 1)
The Un bonded Ceramic bracket group showed a statistical non-significant difference among readings of control, 1, 2 and 3 immersion hours in Chlorhexidine 0.2% by ANOVA test. The ceramic bracket bonded with chemically cured orthodontic adhesive group (No mix) and The ceramic bracket bonded with light cured orthodontic adhesive group showed statistical significant difference among readings of control, 1, 2 and 3 immersion hours in chlorhexidine 0.2% by ANOVA test. LSD test for the ceramic bracket bonded with chemically cured orthodontic adhesive group (No mix) revealed a statistical significant difference when comparing the control vs. 1 hours; a high significant difference when comparing the control vs. 2 hours and control vs. 3 hours; non significant difference when comparing 1 hour vs. 2 hours; while a high significant difference when comparing 1 hour vs. 3 hours and 2 hours vs. 3 hours.

Ceramic bracket group (Table 1, Fig. 1)
One way ANOVA test showed a statistical significant difference among readings of control, 1, 2 and 3 immersion hours in chlorhexidine 0.2% for the Un bonded composite bracket group, the composite bracket bonded with chemically cured orthodontic adhesive (No mix) group and the composite bracket bonded with light cured orthodontic adhesive group.

LSD test for the Un bonded composite bracket group revealed a statistical significant difference between the control and 1 immersion hours, control and 2 immersion hours, control vs. 3 immersion hours and when comparing 1 hour vs. 2 hours and comparing 1 hour vs. 3 hours; while a non significant difference when comparing 2 hours vs. 3 hours.

LSD test for the composite bracket bonded with chemically cured orthodontic adhesive (No mix) group revealed a statistical significant difference for all pair comparisons. LSD test for the composite bracket bonded with light cured orthodontic adhesive group revealed a statistical significant difference between the control and 1 immersion hours, control and 2 immersion hours, control vs. 3 immersion hours, and when comparing 1 hour vs. 2 hours and comparing 1 hour vs. 3 hours; while a non significant difference when comparing 2 hours vs. 3 hours.

DISCUSSION
The Un bonded Ceramic brackets was made from Aluminum oxide which is an inert material due to the crystalline structure of ceramic; as a result, it cannot chemically interact to any of the chlorhexidine molecules; also the glazed surface of the bracket reduce the overall surface roughness and the adsorption of chlorhexidine on bracket surface. (Table 1, Fig. 1)
Orthodontics, Pedodontics, and Preventive Dentistry

Chromatically cured orthodontic adhesive (No mix) when bonded to ceramic brackets might affect the staining resistance of ceramic brackets or the significant difference might due to staining of orthodontic adhesive alone.

One of factors that affects light absorption values is the time so that when time of immersion increased; the adsorption of water molecules (physiosorption) increased, water is a softener of plastics and increases the deterioration of the resin matrix, and therefore water-soluble chlorhexidine 0.2% could penetrate the composite causing chemical degeneration of the filler–resin bond and solubility of the resin matrix, chlorhexidine also contain 15% of alcohol; which increase the monomer release from composite and increase the surface degradation of adhesive; produce rough surface which increase the chlorhexidine deposition but this degradation effect might require time so the non significant difference was found in LSD test when comparing 1 hour vs. 2 hours in ceramic + no mix group (Figure 1) when ceramic brackets bonded with light cured orthodontic adhesive; the bonded adhesive might affect the staining resistance of ceramic brackets which explain the statistical significant difference among reading of control, 1, 2 and 3 immersion hours in ANOVA test(Figure 1); or the significant difference might due to the “incomplete polymerization” phenomenon of light cure adhesive which occur due to number of factors that affect the depth of photo activated cures, including factors of illumination from the edges of bracket and critical total transmittance value of bracket in which duration and intensity of light exposure may be attenuated by the bracket structure, incomplete polymerization increase monomer leaching and cause alteration in light absorption values indicating a decreased color stability of light cure composite.

Chlorhexidine infusion to Un bonded composite bracket during immersion caused degradation of composite bracket, swelling of composite, fissures and cracks formation, a drastic reduction of the polymer's molecular weight and lead to discoloration. The degradation might be somewhat retarded because the saturation of composite bracket by chlorhexidine. So a non significant difference when comparing 2 hours vs. 3 hours in LSD tests. (Figure 1)

The presence of no mix in composite bracket bonded with chemically cured orthodontic adhesive might provide additive effect by increasing the bulk of material that interact with chlorhexidine (bracket composite and adhesive composite); Also the intensity of light passes through the bulk of the resin material decreases greatly, thus a statistical significant difference among readings of control, 1, 2 and 3 immersion hours showed in ANOVA test, and the significant difference for all pair comparisons in LSD test( Figure-1).

The light cured orthodontic adhesive bonded with composite bracket present a non homogenous profile due to oxygen inhibition at the surface during polymerization. Oxygen causes deactivation of the free radicals and reacts with the photo initiator, which decreases curing efficiency of the oxygen-rich surface layers of the material, the oxygen-rich surface layers could hydroxylated by water absorption form negative ionic layer that interact with positive cationic group of chlorhexidine which increases the deterioration of the resin matrix causing increase in light absorption reading so a statistical difference among readings of control, 1, 2 and 3 immersion hours in ANOVA test and a statistical significant difference between all pair comparisons except when comparing 2 hours vs. 3 hours in which a non significant difference revealed in LSD test, that because the degradation might be somewhat retarded due to the saturation of composite and the adhesive resin by chlorhexidine and the reaction reached an electrostatic balance.

From this study we can conclude that:

1. Un bonded Ceramic brackets were not affected by staining of chlorhexidine mouth wash 0.2%.
2. Ceramic and composite brackets bonded with no mix orthodontic adhesive affected by staining of chlorhexidine 0.2% slightly during the first time of exposed to chlorhexidine then the staining increase significantly with time.
3. Ceramic brackets bonded with light cured orthodontic adhesive affected by staining of chlorhexidine 0.2% less than ceramic brackets bonded with no mix orthodontic adhesive.
4. Un bonded composite brackets and Composite brackets bonded with light cured orthodontic adhesive affected by staining of chlorhexidine 0.2% and this effect become limited with time.
5. Chemically cured orthodontic adhesive were affected by staining effect of chlorhexidine 0.2% more than light cure orthodontic adhesive; when it was bonded to ceramic or composite brackets.

References


Table 1: Descriptive statistics of the amount of light absorption by different bracket groups at different time interval of immersion in chlorhexidine 0.2%

<table>
<thead>
<tr>
<th>Brackets</th>
<th>Time</th>
<th>N</th>
<th>Un bonded Brackets</th>
<th>Bracket +no mix</th>
<th>Bracket +Light cure</th>
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<td></td>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>SE</td>
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<td>2.072</td>
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<tr>
<td></td>
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<tr>
<td></td>
<td>3 HR</td>
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<td>0.007</td>
<td>0.002</td>
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<tr>
<td>Composite</td>
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<td>0.002</td>
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</table>

Figure 1: the amount of light absorption of ceramic and composite bracket groups at different time interval of immersion in chlorhexidine 0.2%