ISSN: 0976-3031

Available Online at http://www.recentscientific.com

CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 9, Issue, 12(A), pp. 29851-29855, December, 2018

International Journal of Recent Scientific Research

DOI: 10.24327/IJRSR

Research Article

THE EFFECT OF FLOURIDATED ADHESIVE ON ENAMEL COLOUR CHANGE AFTER DEBONDING OF ORTHODONTIC BRACKETS IN PATIENT CONSUMING ASIAN DIET - A CLINICAL STUDY

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DOI: http://dx.doi.org/10.24327/ijrsr.2018.0912.2944

ARTICLE INFO

Article History:

Received 4th September, 2018
Received in revised form 25th October, 2018
Accepted 18th November, 2018
Published online 28th December, 2018

Key Words:

Fluoridated composite,
Enamel colour change.

ABSTRACT

Aim: This in-vivo study was conducted to determine whether there is any effect of fluoride incorporated composite in the reduction of enamel colour change when compared with a conventional composite resin after debonding of orthodontic brackets, exposed to the same intraoral environment when subjected to orthodontic treatment. **Materials and methods**: Total sample of 20 patients comprising of 80 teeth was divided into two groups consisting of 40 teeth each. Group I was bonded with fluoridated composite (study group) and Group II was bonded with conventional composite (control group) using split mouth design. Debonding was done after three months. Enamel colour was evaluated by spectrophotometer at baseline and after debonding, and the corresponding colour differences ΔE and ΔL were calculated. **Results**: Both groups exhibit colour difference since all the ΔE values were more than 1 unit. However ΔE values did not exceed 3.7 units indicating the colour change is not clinically perceivable. There is a significant difference ($P<0.05$) in the ΔL values between the experimental group and control group indicating fluoride does have effect over the enamel colour change. When all the four quadrants were compared, the enamel colour change seen in the fourth quadrant is significantly higher than the other three quadrants. **Conclusion**: There is significant enamel colour change caused due to orthodontic treatment. Use of fluoridated adhesive has significantly reduced the enamel colour change caused due to orthodontic treatment.

INTRODUCTION

(Cucumis sativus L.) is one of the most popular and Enamel colour loss is one of the major iatrogenic effects of orthodontic treatment. Orthodontic debonding of the attachments has been proved to have an association with enamel loss which maybe due to decalcification and micro cracks caused by scratches or abrasion of the tooth surface.[1]

Changes in the refractive index of the region due to demineralization, absorption of food colorants, enamel loss due to debonding procedures and corrosion products from orthodontic appliance also alters the enamel colour.[2]Secondary optical properties of the tooth (i.e. translucency, opacity, and surface gloss) may be affected by several factors including quality and quantity of light reflection at the surface, dispersion, diffraction and interference of light at the surface, roughness and anatomical morphology of surface, properties and structures of enamel and dentin , and variations of blood flow in the dental pulp.[3]

Other factors which decide the enamel loss is the depth of the resin tags and the remineralization of the tags formed during acid etching.[4]Several etiological factors affected the colour variable of natural teeth by altering the surface and structural properties.[5] Certain factors were iatrogenic or environmental and some were caused due to patient's negligence in oral hygiene.[5,6]

Studies state that presence of coloring agents in the diet causes discoloration of the teeth.[6]The diet consumed in Asia particularly in India, contains ample quantity of food coloring agents. Stains from the food coloring agents, soft drinks and beverages penetrate the resin tags formed, leading to visible enamel colour change even after the remineralisation process.[7,8]Another factor was patient compliance to maintain proper oral hygiene.[9,10] Plaque accumulation around the bracket

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causes decalcification, surface colour change due to colour absorption and caries.

Discoloration of the resin infiltrated enamel could occur from the colour instability of resin composites, attributed to endogenous changes from physiochemical reactions in the material and exogenous changes from the corrosion of the orthodontic appliance.[11] Formation of oxidation by-products containing chromophore groups, polymeric structure and the concentration of amines and diketones may influence colour stability.[12]

Hitherto, fluoride has played a major role in the prevention of demineralization during orthodontic treatment.Frequent exposure of enamel to low levels of fluoride ions increases enamel fluoride content and increases remineralization.[13] Studies state that fluoride releasing material causes significant reduction in early caries lesions.[14, 15] Other clinical trials failed to demonstrate any benefit in the addition of fluoride to adhesives.[16,17]

Hence, this in-vivo study was conducted to determine the effect of fluoride incorporated composite in the reduction of enamel colour change compared with a conventional composite resin, after debonding of orthodontic brackets, exposed to the same intraoral environment when subjected to orthodontic treatment.

MATERIALS AND METHODS

This in-vivo study has been conducted on the patients who underwent orthodontic treatment at the Department of Orthodontics and Dentofacial Orthopaedics. The Methodology and protocol of the study consisting of inclusion criteria for the patient sample has been outlined below.

Inclusion criteria

- Age group of 14 - 20 years
- Dento-alveolar Angle's Class I, Class II and Class III malocclusion.
- All patients undergoing therapeutic four premolar extractions.
- All patients treated with Pre adjusted edgewise appliance (MBT prescription).(.022)
- No missing permanent tooth
- Exclusion criteria:
- Patients with history of trauma.
- Presence of Enamel discoloration due to internal or other external cause.
- Patients with history of orthodontic treatment.
- Presence of any relevant medical history.
- Presence of any genetic disorder.

Patients undergoing orthodontic treatment with all four premolar extractions were chosen.Total sample of 20 patients comprising of 80 teeth was divided into two groups consisting of 40 teeth each.

The groups were bonded as follows (Table I):

1. Brackets bonded with Transbond XT.(Group I)
2. Brackets bonded with Transbond plus colour change. (Group II)

Teeth in Group I (control) were bonded with regular light cure composite and teeth included in Group II were bonded with fluoridated composite respectively. Acid etching of the enamel was done using 37% orthophosphoric acid for 30 seconds uniformly for all the patients. Transbond primer was applied for both control group and study group and cured using LED light cure unit (Ivoclarvivadentbluephase N MC, Liechtenstein, Austria) for20 seconds.[8]

Table I Groups

Group	Tooth selected	Materials used	Fluoridated
Group I	24,44	Transbond XT	No
Group II	14, 34	Transbond plus colour change	Yes

The patients selected were in the age group ranging from 14 to 20 years. Studies stated that in younger subjects, the tooth colour change was negligible. The young premolar after eruption may not have undergone much mechanical wear and tear due to brushing and other external causes.[18]

A split mouth design was selected where brackets were bonded using conventional composite (Transbond XT) adhesive on the upper premolars of the left quadrant and lower premolars of the right and Fluoridated adhesive (Transbond XT colour change) was used on the upper premolars of the right quadrant and lower premolars on the left.[19]A split mouth design was used in order to provide similar oral environment for both study and the control group. The design was more convenient since the study group does not affect the control group.[19]

Standard pre adjusted edgewise brackets (AO brackets with MBT prescription) were bonded in both groups using light cure composite resin employing standardcuring protocol.

The colour of the enamel was recorded using a spectrophotometer before bonding the bracket on the tooth. The readings were made by the same operator twice to avoid errors during recording.

All enamel colour recordings were made on wet enamel surfaces (figure 1).

Figure 1 Before Bonding – Enamel Surface And Spectrophotometer Reading

A VITA Easy shade Compact reflectance spectrophotometer (VITA Zahnfabrik, Bad Sackingen, Germany) was used for all colour recordings according to the CIE (Commission Internationale de l10'Eclairage), VITA shade guide system which was then converted to L*C*H* order systems using Vita Lumin Vacuum shade guide; where L* corresponds to the value or degree of lightness, C* specifies chroma and H* denotes hue angle, an angular measurement of hue. The instrument employs a 0/0 optical geometry (source and receiver fiber optics are parallel and are spatially separated).[20]

The premolars were assessed for the colour variations under the same protocol after a period of three months post debonding (Figure 2). The study was conducted for 3 months duration in order for the oral environment to take effect as the effect of the food colorant and other factors affecting the enamel colour needed a minimum of 3 months.[21]

Figure 2 After Debonding – Enamel Surface And Spectrophotometer Reading

Debonding of the brackets at the end of the study after three months was performed using debonding plier (ETM 345 direct bond remover plier ETM Corp., Monrovia, Calif.).[22] Adhesive was removed with spiral 12 fluted tungsten carbide debonding bur (#118 S burs).[22,24]

Final colour recordings were recorded using the VITA easy shade compact spectrophotometer. The recordings were made from the premolars included in the study after debonding of bracket followed by polishing of the enamel surfaces. The premolars were then subjected to therapeutic extraction. Colour differences before and after bonding (ΔE) were converted to numerical data and calculated for each tooth using the following equation.[20]

$\Delta E^* = [(L_1^*\text{-}L_2^*)^2 + (C_1^*\text{-}C_2^*)^2 + (H_1^*\text{-}H_2^*)^2]^{\frac{1}{2}}$.

Where L_1 and L_2 are the values of L* at baseline and after finishing, C_1 and C_2 are the value of C* at baseline and after finishing and H_1 and $H_2$are the values of H* at baseline and after finishing.

ΔL and ΔC were calculated using $L_2 - L_1$ and $C_2 - C_1$ respectively.

ΔL* = difference in lightness/darkness value (+ve = lighter, -ve = darker)

ΔC* = difference in chroma (+ve = brighter, -ve = duller).[20]

The mean and standard deviations were calculated for the values of ΔE, ΔL and ΔC. A comparison of ΔE, ΔL and ΔC between study group and control group was done using Mann Whitney test. Correlations between ΔE, ΔL and ΔC between maxillary and mandibular arches, right and left side were done using Mann Whitney test. Significance for all statistical analysis was performed with SPSS VERSION 17. The level of significance was set at 5%.

RESULTS

The reliability of the collected data were determined by comparing three values for measuring colour components (L*, C* and H*). The obtained values where then converted to ΔE using the formula stated before. ΔE, ΔL and ΔC values were compared between fluoridated composite and conventional composite, right and left side, maxillary and mandibular arch.

80% of the teeth show ΔE values indicating colour change during orthodontic treatment. The colour change values were compared with the 'critical value for clinical detection' which was selected at ΔE=3.7 units, which shows whether the colour change was clinically perceivable or not.[23] Both the experimental and control group showed ΔE values less than the critical value, indicating colour change is not perceived clinically.

Inter group comparison of ΔE between the study groups (fluoridated composite) with the control groups (conventional composite) shows no significant difference (Table II).

Table II Comparison between Control group (Conventional composite) and Study group (fluoridated composite).(P<0.05)

Variables	Groups	N	Mean	Standard deviation	P value
ΔE	Group I	40	2.5442	2.68785	.552
	Group II	40	2.0685	2.30218	
ΔL	Group I	40	.0425	1.51622	.018
	Group II	40	-.4850	1.41123	
ΔC	Group I	40	.1325	1.87881	.937
	Group II	40	.1825	1.96507	

Inter group comparison of ΔL between the study groups (fluoridated composite) with the control groups (conventional composite) shows significant difference. This indicates the study group (fluoridated composite) shows lesser degree of variance in lightness than the control group. Control group exhibits darker shade than the study group. Inter group comparison of ΔC between the study groups (fluoridated composite) with the control groups (conventional composite) shows no significant difference.

Comparison of ΔE, ΔL and ΔC between the Right and Left side shows no significant difference (Table III).

Table III Comparison between Right and left side (P<0.05)

Variables	Groups	N	Mean	Standard deviation	P value
ΔE	Group R	40	2.3895	2.46193	.579
	Group L	40	2.2232	2.56230	
ΔL	Group R	40	-.0725	1.61579	.329
	Group L	40	-.3700	1.33305	
ΔC	Group R	40	.0100	2.11173	.443
	Group L	40	.3050	1.69962	

Comparison of ΔE between Maxillary premolar and Mandibular premolar shows no significant difference (Table IV). Comparison of ΔL between Maxillary right premolar (Fluoridated composite) and Mandibular right premolar (conventional composite) shows significant difference (P<0.05). This indicates that right mandibular premolars exhibits more darker shade than the right maxillary premolars.

Table IV Comparison of the maxillary premolar with mandibular premolar (inter arch comparison). (P<0.05)

Variables	Groups	N	Mean	Standard deviation	P value
ΔE	Group MxR	20	2.1070	2.43461	.455
	Group MnR	20	2.6720	2.51911	
	Group MxL	20	2.4165	2.90673	.897
	Group MnL	20	2.0300	2.22455	
ΔL	Group MxR	20	-.6850	1.37545	.006
	Group MnR	20	.5400	1.63623	
	Group MxL	20	-.4550	1.23309	.580
	Group MnL	20	-.2850	1.45323	
ΔC	Group MxR	20	.4800	1.99700	.162
	Group MnR	20	-.4600	2.16805	
	Group MxL	20	.7250	1.34394	.097
	Group MnL	20	-.1150	1.93697	

DISCUSSION

Generally, ΔE values in the range of one unit were considered exact colour match because they cannot be identified by independent observers.[20,24] In this system, ΔE values greater than 3.7 units and ΔL values greater than 2 units were clinically unacceptable.[20]Though difference above 2 units was a positive finding, most studies set the acceptance limit to 3.7 units, beyond which it was assessed as clinically visible colour change.[20,25]

In this study, in a single patient, four different premolars showed different ΔE values indicating varying degree of enamel colour change. However, when mean ΔE was derived there was no statistically significant difference observed between the fluoridated composite and conventional composite groups.

The results of this study showed ΔE value ranges from 0 to 2.7 hence, indicating that there was no visible colour change clinically. Though the range was more than 2 units, the degree of enamel colour change in a single patient in both study group and control group was similar. This indicated that there was little to no difference between the two groups over the influence of colour of the tooth.

ΔL signified the difference in lightness and darkness value of the tooth after orthodontic treatment. Positive difference indicated the tooth became lighter. Negative reading indicated tooth became darker.[20,25] ΔL values greater than 2 units were clinically perceivable.[20] Results of the study showed that there was significant difference in the ΔL values of the two groups. Fluoridated composite showed less change in the ΔL value while conventional composite showed more change in the ΔL value. This difference was statistically significant indicating fluoridated composite influenced the lightness of the tooth.

When ΔL values of the right lower premolars and left lower premolars compared, it showed statistically significant difference favorable towards the left side. This also showed that study group on the left lower region showed lesser colour change when compared to control group on the right.

The ΔL values of the right upper premolars and lower premolars showed statistically significant difference favorable towards upper premolars.

After comparing the premolars within the individual regions there were more of ΔE and ΔL changes seen in the lower right premolar region. This indicated that there was more enamel discoloration in the fourth quadrant when compared with other quadrants. The reason might have been due to presence of fluoridated composite in the left lower premolars and right upper premolars. Another reason may be, most patients were dominant right side chewers and tend to accumulate food in the right lower buccal vestibular region which caused more plaque formation leading to enamel colour change.[16,26]

Though the results did not show significant differences between the two groups when overall visible colour change (ΔE) was evaluated, it had to be noted that there were significant changes in the degree of lightness (ΔL) seen between the two groups.

Hence, it is better to use fluoridated adhesives which could result in minimum colour change and also employ accelerated orthodontic techniques to prevent prolonged appliance wear which could compromise final esthetic outcome.

There were few drawbacks in the study. The time limit of three months only represented one fifth of the time duration of an orthodontic treatment in total. Thus, the effect of oral environment over the enamel may also be exponentially more than the study represented.

Accidental debonding of brackets during the study should be taken into account since that might lead to cleaning of the surface of the enamel before rebonding. The remineralized enamel might have been removed and would have compromised the study.[27]

Further research should focus initially on time duration of the study; and later, on improving the bond strength in fluoride containing adhesives. Though it had enough bond strength permissible for clinical situations, it was not to the par of materials that are in vogue currently.

CONCLUSION

The results obtained showed the following conclusion

1. The enamel had a significant colour change between the pre- bonded and de-bonded surface in both the groups which is indicated by ΔE values being more than 1 unit.
2. There was a significant difference in the degree of lightness (ΔL) of the enamel between the two groups. The fluoridated composite group showed reduced ΔL (P<0.05) value than the conventional composite group. However the overall colour change evaluated with ΔE values did not show any significant difference.
3. There was no significant colour difference observed between the right and left side when evaluated with the ΔE values (P>0.05). However in mandible, fluoridated composite group have showed

significantly lower ΔL value than the conventional group (P<0.05).

4. There was no significant colour difference observed between the maxillary and mandibular tooth when evaluated with the ΔE values (P>0.05). However when ΔL values were evaluated there is a significant difference between the right maxillary quadrant and right mandibular quadrant (P<0.05).
5. When all the results were studied it showed that there is a significant increase in the degree of lightness in the mandibular right quadrant when compared to the other three quadrants.

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How to cite this article:
Chandrasekaran Prashanth *et al.*2018, The Effect of Flouridated Adhesive on Enamel Colour Change After Debonding of Orthodontic Brackets in Patient Consuming Asian Diet - A Clinical Study. *Int J Recent Sci Res.* 9(12), pp. 29851-29855.
DOI: http://dx.doi.org/10.24327/ijrsr.2018.0912.2944

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