

Comparison of enamel color alteration between bonded and free unbonded surfaces of maxillary anterior teeth after fixed orthodontic therapy (A prospective clinical study)

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ABSTRACT

Background: The purpose of this study is to compare the color changes ΔE between the bonded middle third and the unbonded gingival and incisal thirds, following fixed orthodontic treatment

Material and method: The color parameter L, a, b has been recorded for each thirds in upper anterior teeth by mean of easy shade device. The ΔE has been calculated for gingival, middle and incisal thirds for the upper anterior teeth in 34 patient, 17 males and 17femals, those subject undergone fixed orthodontic treatment

Results: The ΔE in middle bonded third is highly significant higher than that in incise and gingival thirds $p < 0.01$ because the middle third isn't expose to oral fluid and dental brushing since it covered by the bracket. Also there was no significant difference in ΔE between the 2 sex groups

Conclusion: The discoloration that happened in teeth due to orthodontic treatment occur in middle thirds more than the incisal and gingival thirds and there no difference between the 2 sex groups

Key words: Bonded surface, unbonded surface, discoloration. (J Bagh Coll Dentistry 2015; 27(3):174-178).

INTRODUCTION

Occlusal relationship and correction of malocclusion nowadays is not only the aims of a orthodontists ⁽¹⁾; but great interest is paid to enhance the esthetic as a patient request ^(2,3). A color of a tooth play a role in dental esthetics, since a white and light (less yellow) color of teeth will reduce a common complication of orthodontic ⁽⁴⁾. A reaction between enamel surface with incident light, and a perception of human eye act as contributing factors for developing a color of a tooth ^(5,6).

It is proved that fixed orthodontics treatment will effect adversely on the tooth color ⁽⁷⁻⁹⁾, both vitro and vivo studies were done and confirming tooth color alteration following debonding of orthodontic bracket even with different type of adhesive, method of removing adhesives, polishing ^(2,4,7,10-17) in vivo the color of the tooth can be evaluated by 2 methods the first one the naked eye ⁽¹⁸⁾ this method is low cost but it subjective and cant cover all shade of the teeth ^(19,20). The 2nd method by aid of instrument it is more precise and reliable, nowadays several commercial system available in market like tristimulus color meters, spectroradiometer, spectrophoto meters, and digital color analyzers all these devise develop as result of converting the commission international de eclairage into numeric data. So the computer can deal with it and make them more applicable ^(21,22).

Generally speaking the labial aspect of the anterior teeth can be divided into gingival, middle and incisal third. All the labial aspect of anterior teeth will receive acid etching and primer, and will be expose to oral environment during orthodontic treatment period except the center of the middle third were the bracket with adhesive place on ^(23,24) so it is wise to split the gingival and incisal third and regard them as free unbonded surface, while the middle third as bonded surface

The aim of this study to evaluate and camper the color change due to orthodontic treatment, between the bonded and free unbonded surface of the labial aspect of the upper teeth, gender difference was also investigated.

MATERIALS AND METHODS

Forty patient (twenty males and twenty females) aged between 18-40 years old were attending the orthodontics clinic, all of them need for fixed appliance therapy, all those patient has been signed the consent form for this research the sample criteria of the patient selection

- (1) All of them have full permanent dentition and they need fixed orthodontic appliance of crowding less than 4mm
- (2) No caries, restoration, prosthesis and decalcification in the teeth
- (3) No gingival inflammation
- (4) No smoking habit.

All the patient instructed to follow oral hygiene protocol including regular brush the with fluoridated tooth paste and never use any mouth wash like chlorhexidine to overcome the

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possibility of teeth staining, all the patient has been followed periodically to confirm the condition of oral hygiene, all of them subjected to motivation for the teeth brushing as they not adapted to brush their teeth with presence of fixed appliance

At the time of bonding procedure cheek retractor was applied then the teeth were polished with non fluoridated pumice with rubber cup, after that all teeth were rinse with water, ⁽²⁷⁾ the teeth should kept in wet condition to avoid any color changes due to dryness. Color measurement occurs by using spectrophotometer vita easy shade compact (vita Zahn Fabrik, Bad Sackingen, Germany) ⁽²⁵⁾, the teeth included in this study are 6 anterior teeth so the color of the gingival third, middle third and incisal third for the upper anterior teeth has been recorded before the bonding procedure. The color of the teeth can be explained by 3 parameter (L,a,b) according to commission of international of del'Eclairage ⁽²⁶⁾, were the L parameter represent to the value or degree of lightness in munsell system, ranging from 0 (black) to 100 white, the a parameter represent a measure of redness (a >0) or greenness (a<0) and b represent parameter of yellowness (b>0) or blueness (b<0) ⁽¹⁰⁾. The easy shade device has been used according manufacturer instruction to avoid any error in color measurement. All of these measurement occurred in morning under the same fluorescent lamp of the dental unite and by the same operator who undergone the calibration for using this device 3 week before starting of this study. So the operator will take 3 color parameter (L,a,b) for each third of upper anterior teeth.

By holding the sterile intra-oral device tip (mouth piece) at the right angle to the labial surface of the tooth, near the gingival margin, at center of middle third and near the incisal margin for recording the gingival, middle and incisal third respectively. The same procedure color recording will repeated after the end of orthodontic treatment, when deboning and cleaning of adhesive and polishing being complete. the average of each color parameters (L, a, b) has been calculated to facilitate the color explanation the gingival, middle and incisal third of the upper anterior teeth, so we will deal with gingival thirds of upper anterior teeth as one unite by calculating the average of it, the same things for middle and incisal third.

The color difference ΔE for gingival middle and incisal thirds calculated using the difference in L, a. and b values pre and post fixed appliance therapy according to fallowing equation

$$\Delta E = [(L_1-L_2)^2 + (a_1-a_2) + (b_1-b_2)]^{1/2}$$

Where the L1, a1, b1 represent average value for each third preoperatively and L2, a2, b2 corresponding the average value for each third postoperatively

As result of poor oral hygiene and development of gingival inflammation, the patients can't tolerate and obey the strict oral hygiene measures 6 males and females had been excluded from this study. So the rest only 34 subject 17 males and 17 females as sample of the current study. After the first registration of the color parameter complete, conventional acid etching has been applied for all labial surfaces of the teeth. Then rinsed with water for 30 sec and dried with oil free compressed air till chalky appearance happened, the bond system used is light cure Ormco Enlight (USA) were the primer applied to whole labial surface of the teeth then the stainless steel bracket with adhesive paste placed, all the bonding procedure has happened according the manufacturers instruction. The excess of the adhesive was removed from brackets borders by probe; light cure was applied for 20 second (10second for mesial and 10 second for distal aspect).

At the end of orthodontic treatment the brackets were removed by help of bracket removing pliers, the remnants of the adhesive was removed by using 12 fluted tungsten carbide bur (Komet Gebr, brasseler, lamgo, Germany), With low speed and water cooling, then finishing occurs by extra fine sof-lex polishing discs (3m FSPE Dental product; 3M center) till restoration of the luster of the enamel, new burs and discs were used for each patients. The process of adhesive removal and finishing happed at level of naked eye, ⁽¹³⁾ by the some operator in same environment ⁽¹³⁾. Following the adhesive removal and polishing, 2nd color measurement were record for the same teeth included in this study and in the same manner as the first measurement recorded.

The intra-examiner calibration has been done before the beginning of study to confirm the reliability and accuracy of color measurements. Seven patients were randomly selected, so the color measurement recorded to them for their teeth, and after 2 week the second color measurement recorded, t-test show non-significant difference between the first and second records

Statistical analysis

Descriptive statistics for male and female groups also the independent sample t-test was applied to detect the gender difference. One way ANOVA test was used in this study to compare

the color changes between the gingival, middle and incisal thirds

RESULTS

Table 1 shows descriptive statistics , including mean and standard deviation of the ΔE in both gender for the incisal , middle and gingival thirds, it seems that the mean of the ΔE in middle thirds is 4.948 and 4.967 for the males and females groups respectively which are higher than that in the incisal and gingival third for both gender ; the independent sample t test shows non significant difference in ΔE between the males and females

groups in gingival , middle and incisal, so the both groups was pooled into one group

In table 2 shows the descriptive statistics for whole sample, and the one way ANOVA test shows highly significant differences between the value of the

ΔE for the gingival, middle and incisal thirds $P < 0.001$, while table 3 the LSD test shows that the ΔE in middle third is highly significantly differ with both incisal and gingival third , while no significant difference in ΔE presence between the incisal and gingival third.

Table 1: Descriptive statistics and gender difference for the ΔE

Regions	Descriptive statistics				Gender difference		
	Males (N=17)		Females (N=17)		(d.f.=32)		
	Mean	S.D.	Mean	S.D.	Mean Difference	t-test	p-value
Gingival	3.710	1.241	4.393	0.871	-0.683	-1.425	0.171 (NS)
Middle	4.948	0.686	4.967	1.181	-0.019	-0.044	0.965 (NS)
Incisal	3.756	0.852	3.532	1.267	0.224	0.464	0.648 (NS)

Table 2: Descriptive statistics and regions' difference for the ΔE

Regions	Descriptive statistics			Regions difference	
	N	Mean	S.D.	F-test	p-value
Gingival	34	4.052	1.101	8.441	0.001 (HS)
Middle	34	4.958	0.940		
Incisal	34	3.644	1.057		

Table 3: LSD test after ANOVA for the ΔE

Regions		Mean Difference	S.E.	p-value
Gingival	Middle	-0.906	0.327	0.008 (HS)
	Incisal	0.408	0.327	0.218 (NS)
Middle	Incisal	1.314	0.327	0.000 (HS)

DISCUSSION

Day by day the attention toward the esthetic dentistry increase, the color of the teeth is one of the important factors in determination of the esthetic, in this prospective vivo study we are focus on upper 6 anterior teeth which regards as the most exhibited during smiling³. This study confirm the finding of previous studies regarding the color of the teeth become darker following the orthodontics treatment , so it agrees with other vivo studies like Karamouzou et al⁽¹²⁾ and Al-Maaitah et al⁽²⁾, also our finding agrees with the other vitro studies like Zuher et al⁽¹⁵⁾, Tarkyali et al⁽¹⁰⁾ and Bonuck et al⁽¹¹⁾.

Our finding also supports the above previous studies concerning the enamel surface and texture will never return back to its original status due to changing in surface nature as result of acid etching, irreversible retention of resin tags in enamel material and micro cracking , chipping

and scratching in enamel during debonding and cleaning of adhesive ruminant following debonding , all these contributing factors will make the enamel surface more liable to absorb the colorant material and stains from different source in oral environment, in other hand the irreversible infiltrated adhesive resin tags in enamel surface to depth 30 – 50 um Johnson⁽²⁸⁾, the tags are more labial for staining according to Mandim⁽²⁹⁾, and they tend to alter the optical behavior of enamel and they will make it more dull and dark appearance .

Our finding show no significant difference between males and females groups, this finding might be explained by the fact that females are more

Interested in their esthetics so they try to take more care of their teeth and brushing them, this can be compensated for by heavy brushing manners in males, as males are more muscular

than females, but this finding was disagreed with Al-Maaitah et al⁽²⁾ the disagreement might be due to the difference in sample criteria and methodology

In this study the ΔE was investigated in each third of the upper anterior teeth separately, the middle third where the bracket placed regarded as bonded surface since this area will never expose to oral environment during the fixed orthodontic treatment, while gingival and incisal thirds will receive acid etching and primer application and are exposed to oral environment and brushing during the fixed orthodontic treatment, so these two thirds term as unbonded free surface, so these two thirds were encountered different environment if we compare them with middle third which is terms as bonded surface while the incisal and gingival thirds term as unbonded free surface, so in this study we were deal with bonded and unbonded free surface as two separated entity.

To facilitate the statistical analysis, the average of the gingival, middle and incisal thirds of the upper anterior teeth were calculated for the value l, a, b so when we count the ΔE , it will be for the gingival thirds of the all upper anterior, the same things for the ΔE for middle and incisal thirds.

The ANOVA and the LSD tests show that the ΔE in middle thirds are highly significant and they are greater than those in incisor and gingival thirds; because the primer in the gingival and incisal thirds can't persist for the long time, this might be due to dissolution of all or part of the primer resin infiltrated in enamel material in gingival and incisal thirds, as result to exposure to oral fluid and the dental brushing may plays as helpful role to remove the infiltrated primer resin via abrasion, also the primer is thin film and low viscosity (low filler content) if we compare it with the adhesive past that used in bracket cementation in middle third, the adhesive past is thick consistency and covered by bracket during the fixed orthodontic treatment, so it will be away from dental brushing and oral environment particularly the center of middle third, that is why the middle third tend to be darker in color (greater ΔE), since the resin tags in middle thirds are more heavy and persisting due to omitting the exposure to oral fluid and dental brushing as they covered by the bracket during the fixed orthodontic treatment

It is worthy to say that the human eye can recognize or detect the color difference if the $\Delta E \geq 3.7$ this regards as the threshold value of the color detection clinically, so if the ΔE is below

the 3.7 the color difference will become invisible and undetectable clinically⁽³⁰⁾, concerning our finding the only ΔE in the incisal thirds is 3,64 unite which is below the threshold, so it is clinically undetectable, while ΔE value for the middle and gingival thirds is above the threshold, so it can be detected by the human eye, this might be attributed to friction occurred in the incisal area more than that in the other area, the friction occurs during eating the foods, it may help the incisal area to get rids the primer resin and eventually the ΔE value in this area become less

As conclusion; the color of the enamel either unbonded free or bonded will become darker following the orthodontic treatment. There is no gender difference in the ΔE value between the males and females groups. Bonded surfaces have more tendencies to discoloration than the unbonded free surfaces.

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الخلاصة

الهدف من هذه الدراسة هو مقارنة تغير اللون بين السطح الملتسق (الثلاث الوسطي) والثلاثين غير الملتسقين (الثلاث اللثوي و القطعي) في الاسنان الامامية للفك العلوي الطريقة والمواد المستخدمة: معايير اللون ل ا ب اخذت لكل ثلث من الاسنان الامامية العلوية بواسطة جهاز الازيبي شديد ، بعد ذلك تم حساب تغير اللون لكل ثلث على حدى قبل عمل تقويم الاسنان الثابت وبعده لعينه من الاشخاص عددهم 34 ، 17 اناث و 17 ذكور النتائج و النقاشات: الثلاث الوسطي يعاني تغير باللون اكثر(بنسبه ذو اهميه) مما هو عليه في الثلاثين اللثوي و القطعي ، لان الاخيرين مكشوفين للسان اللعابي و تحت تاثير تفرش الاسنان. لم نجد اي فرق مهم في تغير اللون بين الجنسين الاستنتاجات: تقويم الاسنان الثابت يودي الى تغير بلون الاسنان نحو الاطوخ ويكون في الثلاث الوسطي اكثر مما هو عليه في الثلاثين اللثوي و القطعي . هذا التغير في اللون ليس فيه فرق مهم بين الذكور و الاناث