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Response of Dental Enamel to Office External Bleaching Following Fixed Orthodontic Treatment using Two Types of Orthodontic Adhesives (Clinical Prospective Study)

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Abstract: ***The aims of this study is to evaluate the response of enamel surface either (bonded or unbonded) to external bleaching following the debonding of fixed orthodontic therapy using two types of adhesive systems. Methods 48 subjects, 16 are non orthodontic individuals (control), and the 32 individuals are candidate to fixed orthodontic therapy (experimental), 16 individuals of the experimental group were bonded by enlight (composite) while the other 16 individuals were bonded by GC FuJiortho(GIC), all groups were subjected to external bleaching, color measurement has been done in term of (L, a and b) before and after the bleaching process. To get color difference Δ E which represents the enamel response to external bleaching. T test was used to exclude the gender differences, while ANOVA one way test has been used to detect the color difference inΔ E among control group, enlight composite and GC Fuji ortho, again ANOVA one way used to detect the region difference of the Δ E among incisal, middle and gingival third in all groups. Result there is no significant difference in Δ E between the genders. ANOVA one way shows no significant difference (p<0.5)in Δ E among the groups (control, enlight composite and GC Fuji ortho). Regarding the labial thirds the ANOVA one way shows no significant difference in Δ E among the three thirds in(control and GC Fuji ortho) adhesive, while in composite group the value of Δ E in middle thirds is reduced significantly (p<0.05) in comparison with incisal and gingival thirds. Conclusion enamel response to external bleaching is not affected by the bonding whether enlight composite or GC Fuji ortho. The enlight composite group shows significant reduction in response of middle thirds in comparison with the gingival and incisalthirds.***

Keywords: Dental enamel, external bleaching, fix orthodontic.

1. Review of Literatures

The adhesive bonding material is a crucial part in fixation of orthodontic bracket, which is the main part of fixed orthodontic therapy. All the bonding adhesives depend on surface etching or conditioning of the enamel, to secure the good attachment, but the bonding and debonding of the bracket can be clinically problematic [(1-7)]. At the end of the fixed orthodontic treatment the debonding of the bracket leaves residual adhesive on enamel surface and parts of that adhesive act as resin tags infiltrated inside enamel material, all the techniques used to remove the residual adhesive will cause enamel damage. On the other hand the debonding procedure itself may cause cracking of enamel. All the above factors act as contributing factors for texture defect of enamel surface[(8-10)]. Nowadays there are several bonding adhesives in the market, they can be classified into two major groups, the first group composed of acrylic or diacrylate resins, like nomix adhesive and light polymerized adhesive, this kind of adhesive needs acid etching with orthophosphoric acid 37% for 30 sec, then application of the primerto penetrate the etchedenamel surface, while the adhesive paste and bracket will lie over it, the second group composed of resin modified glass ionomer cements, this kind of adhesive need pretreatment (conditioning) of enamel surface with poly acrylic acid 11.5% to facilitate chemical bonding between the glass ionomer and enamel surface [(11)], the labial aspect of the teeth can be classified into 2 parts, the first part is an unbounded surface that includes gingival and incisal thirds, it is called so because it will be subjected to surface treatment for nothing, and it will stay exposed to oral fluid during the treatment period. The second part is bonded middle third, it is called so, since it will receive surface treatment plus adhesive with bracket that will be fixed over it, so it will stay away from exposure to oral fluid [(12)]. It is obvious that the fixed orthodontic treatment will cause discoloration of the teeth[(7,13-15,22)]. So the whitening procedure is indicated for orthodontic patients either to improve the color of teeth as esthetic reason or to overcome one of the common complication of orthodontic treatments which is white spot lesion, so bleaching procedure acts as a camouflage color approach by reducing the contrast between white spot lesion and adjacent enamel area[(23-28)]. The first research hypothesis is that the dental enamel in the labial surface will respond ina different manner to the whitening procedure, in respect to the free unbonded and bonded concepts. The second research hypothesis is that orthodontic bonding procedure will reduce the enamel response to dental bleaching.

2. Material and Method

The samples of this study were randomly selected and consist of 2 groups, the first one is a control group that consists of 16 individuals, 8 males and 8 females, those individuals have no history of orthodontic treatment, they underwent the external bleaching for aesthetic reason. So the color measurement has been done before the bleaching process and after it, to get the color differenceΔ E, which represents the dental response to the bleaching process, while the second experimental group that consistsof 32subjects who wereindicated for fixed orthodontic treatment. The experimental group has been further subdivided into 2 sub groups, each consists of 16 subjects(8

males and 8 females). The first experimental sub group will be undergoing fixed orthodontic therapy by bonding the bracket using light cure composite adhesive (Enlight light cure adhesive Ormco co, made in Italy), in this subgroup the labial aspect of the teeth were acid etched for 30 seconds with 37% phosphoric acid, rinsed with water for 30 second and dried with an oil free compressed air[29], then application of primer and adhesive with bracket, all the procedure was done according tomanufacturer instructions[12].

The second experimental sub group also consists of 16 individuals (8 males and 8 females),it will be undergoing fixed orthodontic therapy by bonding the bracket by self cure resin reinforced glass ionomer cement (GIC), (brand name GC FuJiortho, made in Japan).In this subgroup the labial aspects were conditioned with 10% polyacrylic acid[30]for 20 seconds and after that rinsed thoroughly with water and dried partially to keep the surface moistened, this will increase bond strength of the GC fuJiortho that has been used according to the manufacture instructions to cement the bracket on tooth surfaces[3]. The bracket used in this study is Morelli Brand Roth 0.022, mini size made in Brazil[31].

Sample criteria for all subjects included in this study

1) No active initial lesions, nor white spot lesion (patch appear chalky and dull after cleaning and drying) [32].
2) No hypersensitivities [33].
3) No proximal caries, prosthesis andrestorations in the teeth [12]
4) All of the individuals have full permanent dentition[12]
5) All the patients aged between 14 to 25 years old[33].
6) No gingival disease[12].
7) For experimental group time elapsed after debonding was less than 3 months[33].
8) Treatment period ranged from 18 to 26 months[34].

All the participants and their guardians gave an informed consent for taking partin the study. The design and setup of this study is given in figure 1. For both experimental sub groups when the debonding occured, a water – cooled fine tapered diamond bur was used for resin removal (the adhesive removal process depends on naked eye to simulate the clinical procedures), followed by enamel surface finishing using a commercially available micro abrasion paste[1].

Teeth included in this study are the upper six anterior teeth[12,34], the labial aspect of each tooth divided into gingival, middle and incisal third, to be more specific, the color measurement of each third has been taken separately. The color measurement has been done by using spectrophotometer vita easy shade compact (Vita Zahn Fabric, bad sackingen, Germany), the color of the teeth can be explained by 3 parameters (L, a and b) according to commission of international of del' Eclairage[12]. Where the L parameter representsthe value or degree of lightness in munsell system, ranging from 0 (black) to 100 (white), while a parameter represents a measure of redness (a>0) or greenness (a<0) and b representsthe parameter of yellowness (b>0) or blueness (b<0) [35].

All groups included in this study either control group or the 2 experimental groups will be undergoing scaling and then polishing by rubber cup and fluoride free pumice, then color parameter in term L, a and b. has been recorded for the gingival, middle and incisal thirds of each tooth included in this study (Upper anterior teeth). All color measurements in this study occurred in the same environment and under the same ambient fluorescent light, and done by the same operator, who has passed the intra-examiner calibration before starting this study, to confirm the reliability and accuracy of color measurement. Seven patients were randomly selected, so the color measurement has been recorded for their teeth and after two weeks the second color measurement was recorded, t-test shows insignificant difference between first and second records[12]. Color measurement has been done by holding the sterile intra-oral device tip (mouth piece) at right angle to the labial aspect of the tooth[34], near the gingival margin, at the center of middle third and near the incisal margin for recording the gingival, middle and incisal thirds respectively.

Fixed orthodontic individuals bond by enlight → composite following debondin → first color record bleaching Process → 2nd color records
Fixed orthodontic individuals bonding by GC FuJiortho → following debonding first color records → bleaching Process → 2nd color records
Control group → first color records → bleaching process → 2nd color records

Figure 1: Setup of the study

Bleaching process:

All groups included in this study will be undergoing an in-office bleaching procedure by using bleaching material called Quick white, made in U.K. the material has been used according to manufacturer instructions the bleaching time for each patient is 10 minutes the bleaching is done by application of light WHITE smile Whitening lamp 2(made in France).

After the in-office external bleaching process has been completed for all participants in this study, 2nd color measurement was done for each thirds of all upper anterior teeth. So the color differenceΔ E between the first color measurement (before bleaching) and the 2nd color measurement (after bleaching) will represent the response of the dental tissue (enamel) to the bleaching procedure. The color differenceΔ E for each third of the labial surface of the teeth in this study can be calculated by the following equation:

$$\Delta E = [(L_1-L_2)^2 + (a_1- a_2)^2 + (b_1-b_2)^2]^{1/2}$$ [12]

Where Δ E represents the color difference or changes, while L1 represents the mean of the L value for each specific third, for example counting L1 for the gingival thirds of upper anterior teeth according to following equation.

L1 of the gingival

Thirds of upper teeth=$\frac{\text{sum of L value for gingival thirds of all upper anterior teeth before bleaching}}{\text{No.of upper anterior teeth}}$(12)

before bleaching

In the same manner we can count(a1)and(b1) for the gingival third according to the upper equation, we will deal with gingival thirds of upper teeth as one unit by calculating the mean of L,a and b, the same things for middle and incisal thirds so each third either gingival, middle, incisal had its own average or mean of L1, a1, b1.(12)
In the same way we got L2,, a2 and b2

3. Statistical Analysis

Descriptive statistics including mean and standard deviation has been counted for the Δ E value in gingival, middle and incisal thirds in both male and female groups, the t test has been used to detect gender difference.Anova test has been used to detect the difference in value of Δ E within the group (gingival, middle and incisal thirds) and among the groups.

4. Result

Table 1 revealed the mean value and standard deviation of the ΔE in both males and females in all groups included in this study.To exclude the gender differences in all of these groups an independent sample t test has been used, as in table 2, the t test showed no significant difference (P value<0.05) between males and females in all of groups included in this study. So it is wise to collect the males and females as one pool in each group as in table 3, that showed the value of ΔE in middle thirds was less than that of incisal and gingival thirds in all groups, this means that middle thirds are least responsive to the external bleaching process. The ANOVA one way test has been used as in table 4, to detect the difference in value of ΔE among incisal, middle and gingival thirds in each group included in this study, it revealed that significant difference occurred only in the composite group where the ΔE of middle third was less than that of both incisal and gingival thirds (significant difference) (P value<0.05).

Again the ANOVA one way was used as in table 5, it showed no significant difference in value of ΔE among control, composite and GIC groups in each third of the tooth structure.

Table 1: Descriptive statistics of the ΔE in both genders according to the area (In Control, GIC and Composite Groups).

	No	gender	control		GIC		composite	
			mean	SD	Mean	SD	mean	SD
ΔE incisal third	8	male	3.8	0.9	2.0	0.5	3.7	0.8
	8	female	3.6	0.9	3.5	0.7	3.8	0.8
ΔE middle third	8	male	1.8	0.3	1.9	0.2	2.0	0.4
	8	female	2.2	0.3	3.6	1.1	1.8	0.2
ΔE gingival third	8	male	4.0	0.9	2.7	0.5	3.8	0.6
	8	female	3.3	0.8	3.0	0.6	3.7	0.6

Table 2: T test to detect the gender difference of the ΔE in control, GIC and composite groups

	Control P value	GIC P value	Composite P value
ΔE incisal	0.89(NS)	0.11(NS)	0.92(NS)
ΔE middle	0.56(NS)	0.16(NS)	0.63(NS)
ΔE gingival	0.64(NS)	0.73(NS)	0.95(NS)

Degree of freedom =14

Table 3: Descriptive statistic including mean and standard deviation of the ΔE control, composite and GIC groups regardless the gender

	No	Incisal third		Middle third		Gingival third	
		mean	SD	Mean	SD	mean	SD
Control	16	3.7	0.9	2	0.3	3.6	0.85
Composite	16	3.7	0.9	1.9	0.3	3.8	0.6
GIC	16	2.8	0.6	2.7	0.65	2.8	0.7

Table 4: ANOVA one way test and LSD test to detect the difference of the ΔE among the incisal, middle and gingival thirds in each groups in this study.

	ANOVA one way		LSD test for composite		
			Incisal-middle	Incisal-gingival	Middle-gingival
	P Value		P Value	P Value	P Value
Control	0.06	NS			
Composite	0.04	S	0.015S	0.99NS	0.013S
GIC	0.9	NS			

N= 48 Degree of freedom =47

Table 5: ANOVA one way test to detect the difference in ΔE among Control, GIC and composite groups in each third in tooth structure

	N	F test	P value
Incisal third	48	0.95	0.39NS
Middle third	48	1.23	0.3NS
Gingival third	48	1.05	0.36NS

Degree of freedom =47

5. Discussion

In this study, the tooth surface has been divided into 3 thirds, 2 thirds are free unbonded surfaces (gingival and incisal) and one third bonded surface (middle)[12], this technique is quite sensitive since it will explain precisely the response of each third of enamel surface in terms ofΔE to external bleaching process. The ΔE of the middle thirds in all groups is less than that inincisal and gingival thirds (table1,3), this means that the middle third of the enamel is the least responsive to external bleaching than other thirds, this may be due to the histological structure according to Michael etal[33]. Although it is significant (P<0.5) only in composite group, this is due to the infiltrated resin tags in middle thirds of teeth[8-10,12]. These resin tags may decrease the permeability of dental enamel to bleaching agent. So the penetration power of the bleaching agent will decrease Hintz, Bradley andEliades [36], that is why ΔE was decreased. so the first research hypothesis was accepted only for the

composite groups and rejected in GIC and control groups since there is infiltrated resin tags in composite groups and absent in both GIC and control groups. The second research hypothesis was rejected because the ANOVA one way table 5 showed no significant difference in value of ΔE among the control, composite and GIC groups in all thirds of the enamel surface. This means that all the sample groups responded all but the same to the office external bleaching agent, this finding agreed with Luciannaetal[32], this finding can be explained due to normal wear which is a physiological phenomenon that must be considered in any discussion of tooth surface appearance after debonding, wear occurs as a results of tooth brushing, habit and abrasive food stuffs[11]. So this wear process will make new enamel surface exposed all the time since continuous wear is regarded as a normal physiological process that is cabable of reducing the surface difference following debonding.

6. Conclusion

1) In control and GIC groups there is no regional difference between bonded andunbonded surface in enamel response to external bleaching, while in composite group, the middle thirds response was reduced significantly in comparison to the incisal and gingival thirds.
2) There is no significant difference in response of the enamel to external bleaching among the groups (control, composite and GIC).

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