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EFFECT OF DIFFERENT FLUORIDE RELEASING BONDING AGENTS IN PREVENTING OF ENAMEL DEMINERALIZATION AROUND ORTHODONTIC BRACKETS.

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ABSTRACT:

Objective: *Compare the effect of different fluoride releasing bonding agents in prevention of enamel demineralization around the orthodontic brackets.* ***Materials and methods:*** *100 premolar used, these premolars were bonded by 5 bonding agents which were:* ***group 1:*** *Twenty brackets were bonded by Transbond XT adhesive (control group).* ***group 2:*** *Twenty brackets were bonded by Transbond plus color change adhesive.* ***group 3:*** *Twenty brackets were bonded by Transbond XT and covered by Fluoride.* ***group 4:*** *Twenty brackets were bonded by GC Fuji ORTHO lC.* ***group 5:*** *Twenty brackets were bonded by Ketac Cem, subjected to pH cycle for 21 days at room temperature then examined by visual examination and examined by electron microscope.* ***Results:*** *Fuji Ortho showed the least demineralization while composite (Transbond XT showed the most one in demineralization of teeth.* ***Conclusion:*** *Fuji Ortho L.C bonding agent showed the highest property in preventing of demineralization during orthodontic treatment.*

Keywords: *Scanning by electron microscope, orthodontic bonding agents, Fuji Ortho, white spots in orthodontic.*

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INTRODUCTION

Fixed orthodontic appliance (brackets) increases the risk for development of carious lesions as the orthodontic appliance creates areas of new plaque retention. Thus, enamel demineralization around orthodontic brackets increases which is an adverse effect of the brackets in patient with bad oral hygiene.

Placement of an orthodontic appliance consisting of metals and polymers is accompanied by the creation of surfaces with properties, alien to those of the natural oral hard and soft surfaces. In addition, the number of retention sites is much larger in orthodontic patients.

Moreover, orthodontic appliances greatly reduce the efficacy of natural oral cleansing forces and of mechanical biofilm removal by tooth-brushing.

Usually demineralization (white spots) occurs within 21 days of cariogenic condition and it may reversed by the application of fluoride. Dental plaque around orthodontic brackets and bands commonly causes enamel demineralization.

Fluoride remains as the best known cariostatic agent, but it must be constantly present in the oral cavity throughout the entire orthodontic treatment to be effective in reducing the demineralization around the orthodontic brackets.

Many investigations have been made on the effect of different materials in releasing of fluoride and its effect in preventing of enamel demineralization, this study is designed to compare different types of bonding agents (glass ionomer, compomer) in fluoride release and its ability to inhibit demineralization

This study is to evaluate the effect of different fluoride releasing bonding agents in prevention of enamel demineralization around the orthodontic brackets.

MATERIALS AND SAMPLE

Selection of teeth

A total number of 100 extracted first premolars collected from the surgical and orthodontic clinics in the Suez Canal University. The teeth were examined for caries; only caries free teeth were selected. They were stored in saline solution. The patients were told that their teeth would be taken for a study and they agreed.

Grouping:

The premolars were divided into five equal groups:

a. The **group 1:** Twenty brackets were bonded by Transbond XT adhesive*. (control group).Figure 1

b. The **group 2:** Twenty brackets were bonded by Transbond plus color change adhesive**. Figure 2

Fig 1: Transbond XT

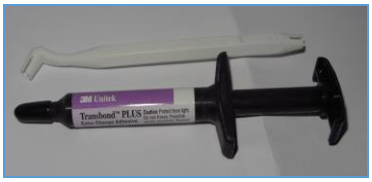

Fig 2: Transbond plus color change

c. The **group 3:** Twenty brackets were bonded by Transbond XT and covered by fluoride .Figure 3

d. The **group 4:** Twenty brackets were bonded by GC Fuji ORTHO lC. Figure 4

e. The **group 5:**Twenty brackets were bonded by Ketac Cem .Figure 5

Fig 3: Fluoride gel

Fig 4: GC Fuji Ortholc Capsule

Fig 5: Ketac Cem

Testing procedures:

Specimen Preparation

The crown of each premolar was cleaned with rubber cup for 10 seconds the brackets bonding preceded by etching with 37% of phosphoric acid* (figure 6) for 15 seconds according to manufacture instructions *except group 4 and 5* according to manufacture instructions, then rinsed with water and dried. Bonding of the brackets was done using different materials. The teeth were covered by var nish on the occlusal surface and the palatal/ lingual surface.

Before placement in the solutions the teeth were examined and photographed by digital camera at T_1.

First, the teeth were immersed in an artificial saliva solution*** **according to Hadi et al (2010)[58]** (Table1) , at a pH (7.4) for 20 hours per day . The teeth then were immersed in a demineralizing solution with pH adjusted at 4.4 for four hours.

Figure 6: The etchant tube

Material	Weight in gram
NaCl	**0.700**
KCl	**1.200**
NaHCO3	**1.500**
KSCN	**0.330**
Na2HPO4	**0.260**
KH2PO4	**0.200**

Table 1: Ingredients of Artificial Saliva

The pH of the solutions was adjusted by the using pH indicator paper, acidic pH gives yellow color (figure 7) while neutral pH gives green color (figure 8) according to pH indicator chart. The pH of the neutral solution was adjusted by the addition of lactic acid to be the demineralization solution. Then specimens were returned to the neutral artificial saliva these cycles were done for 21 days **according to Wilishire and Rensbreg (1995)**[57].

Fig 7: acidic pH

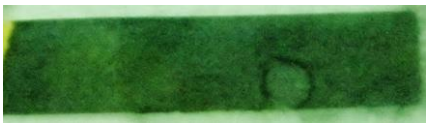

Fig 8: neutral pH

During the transfer of teeth they were washed by distilled water. The solutions were changed every 4 days. After the last cycling period, all specimens were washed with distilled water, dried with compressed air and examined, then photographed again and considered as T_2, then the images at T_1 and T_2 compared. The steps of the study were shown in figure 9.

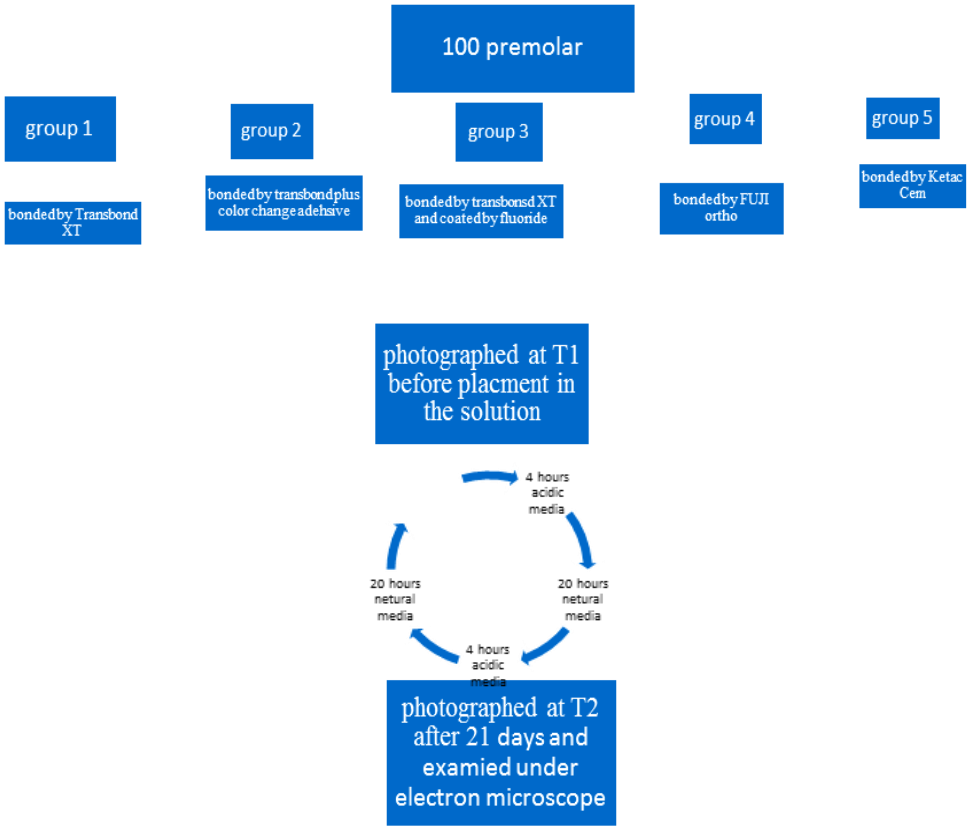

Fig 9: A diagram showing the steps of the study

Fig 9: A diagram showing the steps of the study

Measurements

Visual examination

After 21 days the teeth were removed from the solutions and washed by distilled water then a visual score for enamel demineralization (table 1) was created for comparison between the different groups, score 0 attributed to no demineralization had identified around the brackets by visual examination (figure 10), while score 1 (figure 11) was given when a white spots found adjacent to the brackets.

Fig 10: No demineralization score 0

Fig 11: Demineralization score 1

Table 2: The scores of visual examination

Score	***Effect***
0	***No demineralization***
1	***Showing demineralization***

Scanning by electron microscope:

Preparation of teeth for electron microscope scanning

1- Before scanning the teeth were sectioned from the cemento-enamel junction (figure 12).

Fig 12: Sectioning of the teeth at the cemento- enamel junction

2- Then the brackets were removed from the surface of the teeth. (Figure 13)

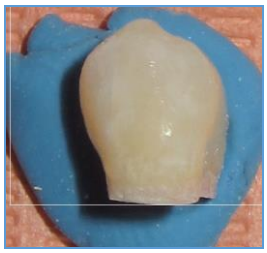

Fig 13: Teeth after debonding of the brackets

3- After debonding of the brackets the buccal surface of the teeth were covered by layer of gold this was done to increase the conductivity of the scanning of electron m01icroscope, in order to do so the teeth were covered by 20 or 30 microns of gold by using SPI module Sputter coater* modeling machine. (Figure 14)

Fig 14: SPI machine

4- Finally the specimens were mounted in the Scanning Electron Microscope SEM** operated at accelerating voltage of 19 KV and had a resolution of 200A. After a process of magnification and amplification. The center of interest was photographed using black and white film as in figure (15, 16). Examination also was done for a tooth not subjected to the pH cycle for further comparisons (had normal structure of enamel).

Fig 15: Electron microscope

Fig 16: Specimen mounted on the electron microscope

STATISTICAL ANALYSIS

Statistical analysis was carried out using SPSS program Chicago (SPSS)[59].

Descriptive statistics was calculated using Descriptive Statistics of SPSS (SPSS, analyze, Descriptive Statistics, Descriptive).

One way analysis of variance (SPSS, analyze, compare means, one way ANOVA) was used to test the effect of group on fluoride particle number. Duncan Post-Hoc Multiple Comparisons (Post-Hoc) at $p \leq 0.05$ was used for means comparison

RESULTS

Cross-tabulation and Chi square test (SPSS, analyze, descriptive statistics, crosstabs) were used to test the prevalence of demineralization. They were also used to test the relationship between visual demineralization, demineralization under electronic microscope. Results:

The sample included 100 teeth (first premolar caries free) divided into 5 groups, **First group** (bonded by composite control group) include 20 premolar, **Second group** (bonded by compomer) include 20 premolar, **Third group** (bonded by composite and fluoride material applied on it) include 20 premolar, **Fourth group** (bonded by FUJI Capsule) include 20 premolar and the **Fifth group** (bonded by Ketac Cem)

include 20 premolar. Descriptive statistics was calculated using Descriptive Statistics of SPSS (SPSS, analyze, Descriptive Statistics, Descriptives). **Cross-tabulation and Chi square test** (SPSS, analyze, descriptive statistics, crosstabs) were used to test **Teeth showing demineralization by visual examination with different bonding agents.** The results showed statistically ***significant*** differences between control (Composite alone) and all the other groups, statistically ***significant*** differences between **groups 4 , 5** (fuji ortho group, ketc cem group) with **group 3** (composite with fluoride). NO statistically ***significant*** differences between **groups 2, 3**. NO statistically ***significant*** differences between **group 4 and 5**. As shown in table 2 and figure17.

Table(3): Teeth showing demineralization by visual examination with different bonding agents.

Visual demineralization	Bonding agent										Total	
	Group 1		Group 2		Group 3		Group 4		Group 5			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
No demineralization	3	15	9	45	6	30	14	70	12	60	44	44
Demineralization	17	85	11	55	14	70	6	30	8	40	56	56
Total	20	100	20	100	20	100	20	100	20	100	100	100
P	c		Ab		bc		a		a			

Prevalence with the same letter are not significantly different at p=0.05.

Group 1= Composite alone

Group 2= Fluoride release composite (Plus color change adhesive)

Group 3= Composite and covered by fluoride

Group 4= Fuji Ortho GC

Group 5= Glass ionomer (Ketac-Cem)

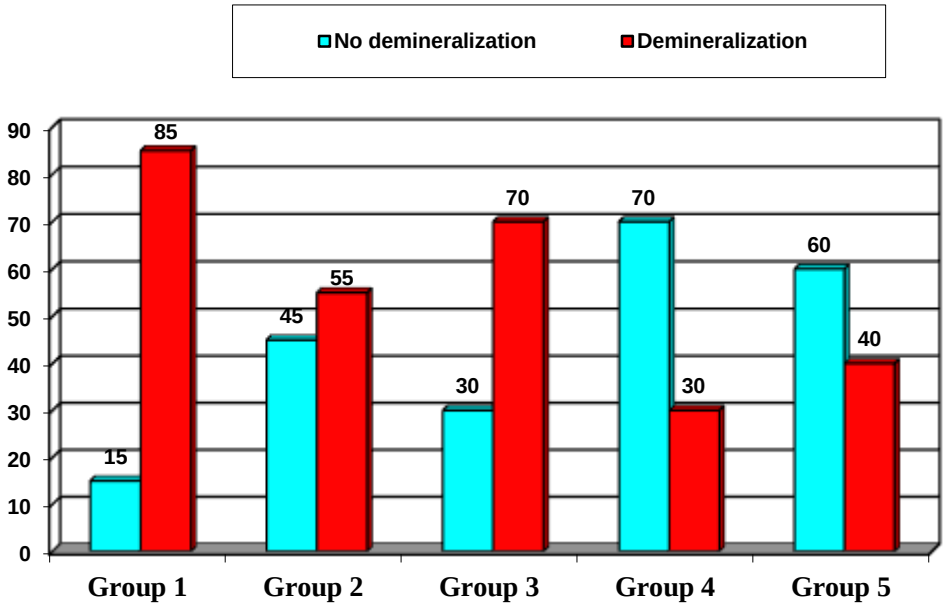

Fig (17): Teeth showing demineralization by visual examination with different bonding agents.

Cross-tabulation and Chi square test (SPSS, analyze, descriptive statistics, crosstabs) were used to test **Examination of teeth demineralization under electron microscope with different bonding agents.** The results showed statistically ***significant*** differences between control group and all the other groups, statistically ***significant*** differences between **groups 4, 5** with **group 3**. NO statistically ***significant*** differences between **groups 2, 3**. NO statistically ***significant*** differences between **group 4 and 5**. As shown in figure18 and table 3

Table (4): Examination of teeth demineralization under electron microscope with different bonding agents.

Demineralization	Bonding agent										Total	
	Group 1		Group 2		Group 3		Group 4		Group 5			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
No demineralization	2	10	7	35	4	20	14	70	11	55	38	38
Demineralization	18	90	13	65	16	80	6	30	9	45	62	62
Total	20	100	20	00	20	100	20	100	20	100	100	100
P	c		bc		c		a		ab			

Prevalence with the same letter are not significantly different at p=0.05.

Group 1 = Composite alone

Group 2 = Fluoride release composite (PLUS Color change adhesive)

Group 3 = Composite and covered by fluoride

Group 4 = Fuji Ortho GC Group 5 = Glass ionomer (Ketac- Cem)

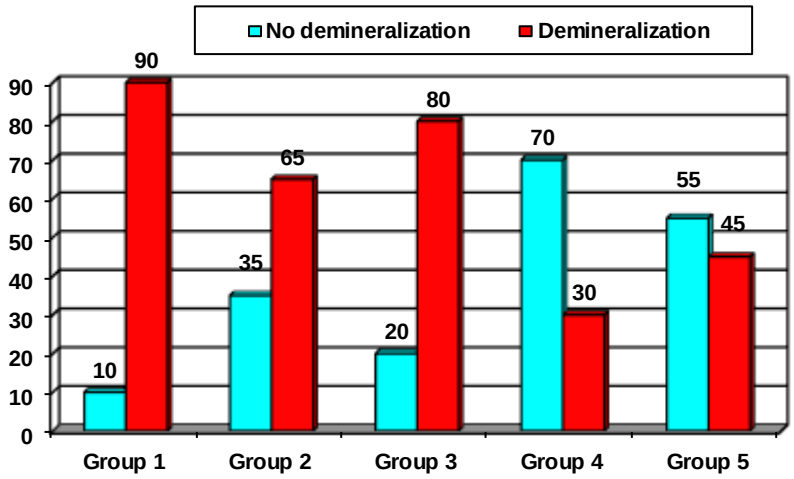

Fig (18): Examination of teeth demineralization under electron microscope in different bonding agents groups.

Electron microscopic images:

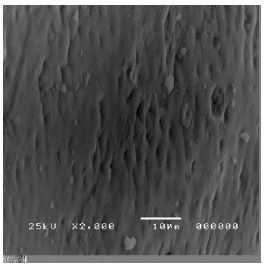

Fig 19: An electron microscopic showing the normal enamel structure

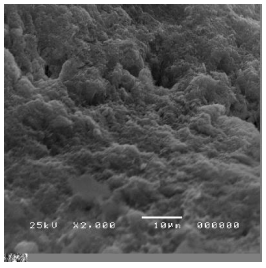

Fig 20: An electron microscopic showing the destruction of the enamel surface due to demineralization of the enamel surface

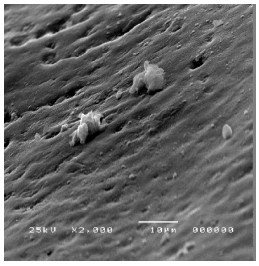

Fig 21: An electron microscopic image showing fluoride particles accumulate on the enamel surface

DISCUSSION

Fixed orthodontic appliance (brackets) increases the risk for development of carious lesions as the orthodontic appliance creates a new plaque retention sites. Thus, enamel demineralization around orthodontic brackets increases which is an adverse effect of the brackets in patient with bad oral hygiene.

Therefore, the use of restorative and bonding materials that release fluoride had been an alternative to prevent demineralization; Fluoride had been added to the composition of resin composites, which are widely used for bracket bonding. Several commercial brands had introduced fluoridated resins as compomers, glass ionomers on the market.

The aim of this study was to evaluate the effect of different fluoride releasing bonding agents in preventing of enamel demineralization around the orthodontic brackets.

In our study the samples included 100 first premolar (caries free), the selected premolars divided into five groups each group contain 20 premolar, **First group** bonded by composite alone (Transbond XT)

(control group), **Second group** bonded by compomer (Transbond plus color change), **Third group** bonded by composite and fluoride gel applied on it, **Fourth group** bonded by resin modified glass ionomer (FUJI ORTHO) and Fifth **group** bonded by glass ionomer (Ketac Cem) for 21 days[57].

Many investigations had been made on the effect of different materials in releasing of fluoride and its effect in preventing of enamel demineralization; this study was designed to compare different types of bonding agents in fluoride release and its ability to inhibit demineralization.

Pervious study that used fluoridated materials during brackets bonding such as fluoridated varnish associated with conventional resin, conventional glass ionomer cements ,resin modified glass ionomer composite showed lowering the mineral loss around the orthodontic brackets when compared with conventional brackets bonding adhesives which agreed with Chin et al(2009)[21.]

Composite (group 1)as a bonding agent showed the highest material showing demineralization around the orthodontic brackets and this agreed with Mark et al (1989)[9], Basdra et al (1996)[10],Corry et al (2000)[15], Rebbeca and Wilson(2001)[16], Paschos et al(2009)[20], Chin et al(2009)[21], Savariz et al(2012)[29], Yetkiner et al(2013)[29] and Eissaa et al (2013)[40]. This may be due to the polymerization shrinkage that occurs to the composite which provided a gap between the brackets and the tooth surface and this caused accumulation of bacteria around the orthodontic brackets. In addition, composite have a rougher surface at which bacteria can adhere more easily. Moreover, composite did not produce fluoride, which had a good effect in preventing demineralization.

Glass ionomer (Ketc Cem) as bonding agent showed good effect in preventing enamel demineralization around orthodontic brackets which agreed with Chun et al (2008)[21], Melissa et al(2000)[25]. While Dos Santos did not agree which may be due to 0.22% sodium fluoride exposure, although conventional glass ionomer cement was capable of releasing fluoride and preventing enamel demineralization their bond strength were limited and not recommended for clinical usage.

In the following study it was found that Fuji Ortho as a bonding agent showed the higher agent showing preventing enamel demineralization around the orthodontic brackets which agreed with Basdra et al (1996)[10], Chung et al (1999)[11], Vorhies et al (1998)[12] , Corry et al(2000)[15], Rebecca and Wilson (2001)[16], Arthur et al (2002)[17], Chun et al (2008)[19], Paschos et al(2009)[20], this may be due to the fluoride effect released by the Fuji Ortho (resin modified glass ionomer).

Tranbond Plus color change adhesive in the following study showed that it had the ability to prevent enamel demineralization which due to its ability to release fluoride, but at a lower rate than the Fuji Ortho which agreed with Basdra (1996)[10], Chung et al (1998)[11], Vorhies et al (1998)[12], Rebecca and Wilson (2001)[16], Chun et al (2008)[19], Passalini et al (2010)[22], Dos Santos et al (2013)[34].

In this study a human extracted premolars was used which agreed with Corry et al (2000)[15], Rebecca and Wilson (2001)[16], Paschos et al (2009)[20], Dos Santos et al (2012)[30], Barat et al (2013)[31], Kan et al (2013)[33], while Passalini et al (2010)[22], Erika et al (2012)[28], Yetkiner et al (2013)[32], the usage of the human teeth in order to have the same structure in the human oral cavity to which the brackets bonded.

It was found that the application of fluoride around the orthodontic brackets had shown a positive effect in preventing of enamel demineralization when compared with composite which agreed with Wagner and Szepictowska (2013)[35], Alexander and Ripa (2000)[14], Khan and Antony (2013)[33]. While disagreeing with Corry et al (2000)[15] which may be due the sample size and the pH cycling period.

In this study a scanning with the electron microscope for teeth was performed in order for better detection of demineralization which was done also by Chatzistavrou et al (2010)[24], Wagner and Szepietowska (2013)[35] as the scanning by electron microscope had the ability to examine the enamel surface efficiently.

This study was performed in Vitro to allow a greater control of the variables this agreed with Paschos et al (2009)[20],Passalini et al (2010)[22], Namboori et al (2012)[27]and Erika et al (2012)[28].

Conclusion: it was found that the Fuji Ortho is the least one showing demineralization and white spot formation around the orthodontic brackets, followed by the Ketc Cem then the componear and composite it the most showing demineralization around the brackets.

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