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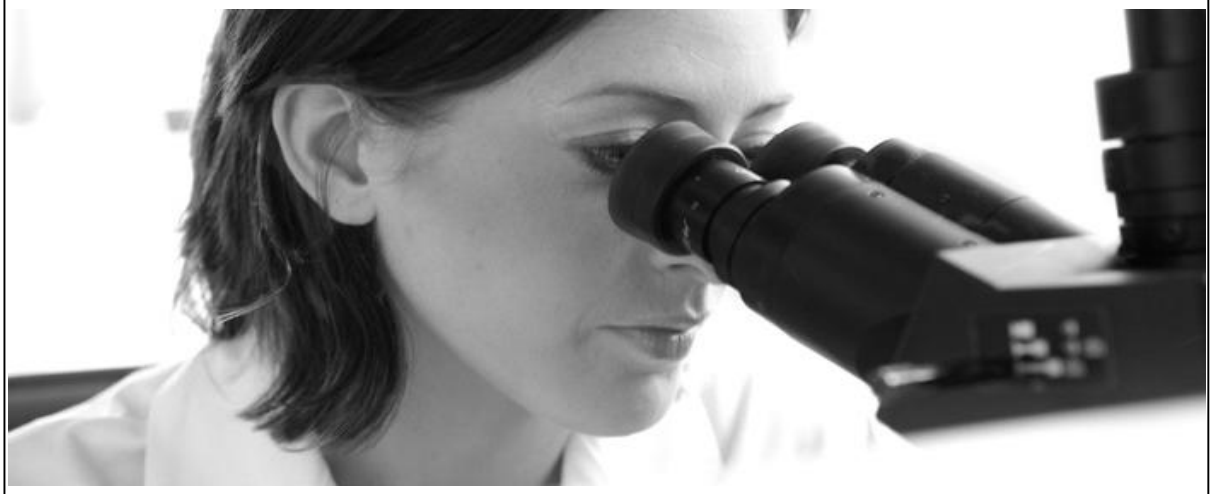

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RESEARCH ARTICLE

SHEARING BOND STRENGTHS OF ORTHODONTIC BRACKETS BONDED TO FLUOROTIC TEETH WITH SELF-ETCHING PRIMER. AN IN VITRO STUDY

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ABSTRACT

The aim of this study was to compare the bonding strength of orthodontic brackets bonded to fluorotic and non fluorotic normal teeth. Sixty extracted human mandibular premolars (30 fluorotic and 30 non-fluorotic) were collected. The first control group (CG) was the non-fluorotic teeth while the second group (FG) the teeth were fluorotic. Orthodontic adhesive (Transbond XT) with self-etching primer (Transbond Plus) were used to bond 60 metal brackets. Shearing strength was applied at the bracket body to debond the bracket using Testometric Machine. Data were then analyzed with Independent Samples t-test (α=.05).Modified Adhesive Remnant Index -ARI was used to determine the mode of bond failure. The mean shearing bond strength (SD) was 8.33±3.2 MPa in the study group and 10.17±3.1 MPa in the control group. Although it was higher than the minimum required bonding strength, Independent Samples t-test revealed that bonding strength in the fluorotic teeth group was statistically lower than that in the non fluorotic teeth group at p=0.027. Chi-squared test showed that adhesive remnant index (ARI) was statistically higher in the non fluorotic teeth. Light cured composite with self-etching primer produce clinically accepted bonding strength when used to bond metal brackets to fluorotic teeth.

INTRODUCTION

Fluorotic teeth are the one with a high resistance ability to acid etching, require an increased etching time(Powers *et al*. 2006), or removal of the hypermineralized layer(Al-Sugair *et al*. 1999).WHO,2006 reportedthat more than 70 million people all over the world are affected by dental fluorosis, most of them are living at the east of white sea, India, China and Africa(Fawell *et al*. 2006). Adhesives had been used in orthodontics more than 40 years ago (Newman 1965). The ideal requirements of orthodonticadhesive material are; clinically accepted bonding strengths, easily cleaned after bracket removal and enhances demineralization prevention (Newman *et al*. 2001). Reynolds suggested a minimum average of bonding strengths in vitro studies ranging between 5.9 – 7.8 MPa (Reynolds 1975), whereas Lopez suggested the bonding strength should not be less than 7 MPa (Lopez 1980).

Numerous factors play a significant role in orthodontic bonding process; bonding strength and time consumed for bracket bonding and debonding. These factors include bracket base (Algera *et al*. 2008),curing light system (Ishikawa *et al*. 2001), acid etching time (Osorio *et al*. 1999) and concentrations (Brannstrom *et al*. 1982)and type of enamel surface conditioner including acid etch and self-etch primer-SEP (Cehreli *et al*. 2005).SEP is a 6th generation bonding system presented in a disposable blister with a brush which was more hygienic. The blister contains hydrofluoric complexes, water, orthophosphoric acid, methacrylate esters, activators and stabilizers (Velo *et al*. 2002). Moreover, it was first introduced to orthodontic purposes by conservative dentistry (Bishara *et al*. 1999). However,SEP was reported inappropriate for orthodontic bonding (Cehreli *et al*. 2005).Since orthodontic SEP (Transbond Plus SEP) had been developed by Miller (Miller 2001)and the description of clinical steps and mechanisms is well recognized. SEP system yields many advantages over the acid etching system; longer working time (Arnold *et al*. 2002), better conservative electromicroscopic appearance (Hosein *et al*. 2004) and less bonding time due to application of etching and primer agent simultaneously without washing and drying steps (Bishara *et al*. 2005). In relation to the orthodontic brackets bonding strengths with SEP, there is a wide contra version among authors; some concluded that SEP system gives a low bonding failure rate(Pandis *et al*. 2005)and

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others observed the failure rate was high in SEP system when compared to traditional acid etching system, however, the failure rate remained clinically accepted(Cal-Neto *et al*. 2009). Ng'ang'a *et al*. compared the bonding strength of orthodontic brackets in fluorotic and non fluorotic teeth using acid etching system and reported no statistical difference between the two groups(Ng'ang'a *et al*. 1992). The aim of this study was to compare the shear bond strengths of Transbond Plus SEP in bonding orthodontic brackets to fluorotic and non fluorotic extracted teeth. The null hypothesis, Transbond Plus SEP will not influence the shear bond strengths of bonding orthodontic brackets to fluorotic and non fluorotic teeth.

MATERIALS AND METHODS

Test groups

Thirty fluorotic (score 3 and 4 according to Thylstrup and Fejerskov Index-TFI) and thirty non fluorotic (score 0 according to TFI) recently extracted human premolars teeth (free from buccal caries, cracks, chemical bleaching, endodontic therapy and previous orthodontic bonding) for orthodontics were used in this study. All selected premolars were stored in 5% formol/saline solutionat room temperature. Later they were cleaned with a hand scalar and stored in distilled water at room temperature for at least 72 hours. After that, the teeth roots were embedded into an auto-polymerizing resin (Idofast Unipol, Unidesa-Odi, Madrid, Spain) up to 2 mm apical to the cementoenamel junction with the long axes perpendicular to horizon using a custom-made surveyor. Firstly, the buccal surfaces of the selected teeth were cleaned using rubber cup and fluoride-free pumice (Art. No.: 2336 Klint Voco Cuxhaven-Germany) for 10 seconds and dried with oil free air for another 10 seconds. Then the metal brackets(The Majestic Appliance - Edgewise .018-IOS Houston-USA) were bonded to the buccal surfaces of all teeth using Transbond^{TM} Plus SEP (Ref.: 712-090, Lot: 320559, 3M Unitek, Monrovia, CA, USA) which prepared according to manufacturer's instructions, the SEP contents were mixed for 5 seconds then rubbed on the buccal surface of the tooth for 5 seconds. A gentle air jet was applied for 3 seconds over the buccal surface to form a thinner layer of the primer. In addition the tooth surface was kept dry till the bonding process was finished. A small amount of light cured Transbond^{TM}XT composite (Ref.: 712-035, Lot: 8FK, 3M Unitek, Monrovia, CA, USA) was applied on the bracket base. Then, the bracket was placed as close as possible to the buccal surface with firm pressure. Excess composite all around the bracket base was carefully removed by a sharp carver. Thereafter, all samples were cured using LED light curing device (LITEX^{TM} 695C, Dentamerica, Taiwan) for 40 seconds/tooth (10 seconds for each side). After bonding procedure, all teeth were returned to the distilled water in incubator at 37 $C^0$for three days.

Loading of the Specimens

Shearing bond strength was applied perpendicularly to the bracket body area (ligature groove) at crosshead speed 1mm/min (Fig. 1) in a universal testing machine (Testometric AX M350, UK). Once the bracket had been debonded, the machine showed the amount of applied force in newton which was converted to Mpa. The buccal surface was examined under x10 magnification using scope (Model SC-S90) to determine the amount of adhesive remained using the index-ARI developed by Artun and Bergland(Artun *et al*. 1984).

Score 0= no adhesive remained on buccal surface.
Score 1= <50% of adhesive remained.
Score 2= ≥50% of adhesive remained.
Score 3= all adhesive remained.

Scores 0 and 1 were combined (0-50% of adhesive remained), and scores2 and 3 were combined (>50-100% of adhesive remained) for comparison purpose. This method was cited from Zeppieri *et al*. (Zeppieri *et al*. 2003)

Statistical analysis

Data was collected, summarized, coded and entered to the Statistical Package for Social Sciences (SPSS) program (version 18) in the computer. The data was analyzed in the form of tables. Independent Samples t-test was used to compare the shearing bond strengths of the two groups at $P<0.05$.Chi-squared test and Mann-Whitney test were used to compare the adhesive remained index (ARI) of the two groups.

RESULTS

A total of 60 extracted premolars teeth (30 fluorotic and 30 non fluorotic) were used in the current study. On examining the buccal teeth surfaces under the light scope, two enamel fractures had been observed in the study group and one enamel fracture in the control group (Fig.2).

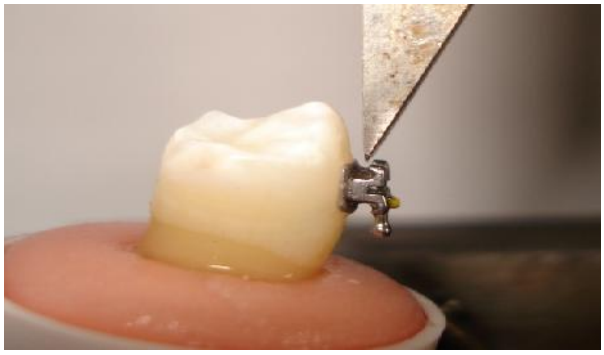

Fig.1 Application of shear bond strength on bracket's body

Fig.2 Enamel fracture during bracket removal

The shearing bond strengths of the two groups were compared, Independent Samples t-test showed that bonding strength of orthodontic brackets was significantly higher in non fluorotic teeth group *P<0.05* (Table1).For the purpose of comparing ARI, we combined scores 0 and 1 (<50%) and scores 2 and 3 (≥50%) adhesive remained on tooth surface (Table.2).Chi-squared test and Mann-Whitney test showed that the adhesive remained on tooth surface was significantly higher in the non fluorotic teeth group (Table.3).

Table 1. Means and standards deviation of the examined sample

Group	No.	Mean/MPa	St.. error	*P* value
FT	30	8.33±3.2	.59	.027*
NFT	30	10.17±3.1	.57	

FT= Fluorotic teeth, NFT= Non Fluorotic teeth, MPa= Mega Pascal.
*significant difference between the two groups at *P<0.05*

Table 2 Combined of scores 0 and 1 (<50%) and scores 2 and 3 (>50%adhesive remained on tooth surface).

ARI		0	1	2	3	EF
Group	FT	10	14	4	0	2
	NFT	6	9	12	2	1

ARI: Adhesive Remnant Index. FT: Fluorotic Teeth. NFT: Non Fluorotic Teeth. EF: Enamel Fracture.

Table 3 Chi-squared test and Mann-Whitney test between two samples

Group	Mean Ranks	Difference	Mann-Whitney	*P* value
FT	24.07	9.69	268.000	.006*
NFT	33.76			

DISCUSSION

This is an experimental study for sixty extracted human mandibular premolars teeth (30 fluorotic and 30 non-fluorotic). Orthodontic adhesive (Transbond XT) with self-etching primer (Transbond Plus) were used to bond metal bracket to both teeth groups. The results revealed that bonding strength in the fluorotic teeth group was statistically lower than that in the non fluorotic teeth group at p=0.027. Chi-squared test showed adhesive remnant index (ARI) was statistically high in the non fluorotic teeth. Ideal orthodontic adhesive material is that one which produces clinically accepted bonding strengths and can easily be cleaned after brackets debonding (Newman *et al*. 2001). Reynolds suggested a minimum range for orthodontic bonding strengths in laboratory studies accepted for clinical use ranging between 5.9 – 7.8 MPa(Reynolds 1975). Klocke and Kahl showed that the debonding force applied on the bracket body (ligature groove) equals to nearly 50% of debonding force applied on bracket base area(Klocke *et al*. 2005). Self-etching primers-SEP produce shallow surface etching patterns comparing with phosphoric acid etch. This characteristic does not negatively affect the bonding strength of adhesives to unground enamel (Pashley *et al*. 2001).It was found that the adhesive strength of the resin bonded to enamel surface basically depends on the resin ability to penetrate between enamel crystallites not on the depth of enamel demineralization created by phosphoric acid (Shinchi *et al*. 2000).In SEP, the depth of enamel demineralization and the depth of resin penetration are equal, since the two processes occur simultaneously, there for, creating three dimensional micro adhesion surface pattern (Hannig *et al*. 2002).The present results showed that the mean bonding strengths in non fluorotic normal teeth with the use of TBP-SEP was higher than what is required for clinical orthodontic purposes (10.71 MPa) which is in agreement with previous studies(Buyukyilmaz *et al*. 2003; Zeppieri *et al*. 2003; Bishara *et al*. 2005). In spite, the results showed that the mean bonding strength in fluorotic teeth group was high compared to the minimal required strength suggested by Reynolds(Reynolds 1975),however, it was significantly less than non fluorotic group, which is in agreement with Weerasinghe result; the severity of dental fluorosis affects negatively the bonding strength of SEP on fluorotic teeth (Weerasinghe *et al*. 2005). Whereas, Ng'ang'a *et al*. (Ng'ang'a *et al*. 1992) found no significant differences between fluorotic and non fluorotic teeth when the traditional acid etch was used instead of SEP. In this study, the adhesive remnant index- ARI was used which was developed by Artun and Bergl and(Artun *et al*. 1984), with a modification cited from Zeppieri *et al*.(Zeppieri *et al*. 2003). The amount of adhesive remained on enamel surfaces after brackets removal was less than 50% in about 80% of the fluorotic group samples and in about 50% of the non fluorotic group samples in the present study. It can be partially attributed to less adhesion of the orthodontic adhesive material to the fluorotic teeth than non fluorotic normal teeth (Weerasinghe *et al*. 2005).

CONCLUSION

- Light cure composite with self-etching primer produce an accepted bracket bonding strength, adequate for clinical use in both fluorotic and non fluorotic normal teeth.
- Care should be taken during bracket debonding specially with teeth affected by dental fluorosis to avoid enamel fracture or even cracks.

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