ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

EFFECT OF VARIOUS FLUORIDE VARNISH ON BRACKET SHEAR BOND STRENGTH: INVITRO STUDY.

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Manuscript Info

Manuscript History:

Received: 18 January 2016
Final Accepted: 22 February 2016
Published Online: March 2016

Key words:
shear bond strength, fluoride varnish, Adhesive Remnant Index.

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Abstract

Aim:- The present study has been taken-up to evaluate the effect of topical fluoride varnish application on enamel surface and the effect of the same on the shear strength of orthodontic bracket bonding.

Methods:- 120 extracted premolar teeth without any decay or visible defect were collected from the Department of Oral and Maxillofacial surgery, Farooqia Dental College and Hospital, Mysore Karnataka. These 120 orthodontic bracket bonded to premolars were subjected to the shear bond strength. The teeth were divided into control group, Duraphat varnish group, Varnish 3M group, ClearShield^{TM} group. The samples were tested on day 1, 8 and15. The samples were coated with their respective varnish, followed by bonding of brackets using ENLIGHT light cure adhesive system. Each specimen was subjected to shear force on universal testing machine until the bracket gets deboned and the same of 120 specimens were subjected to Adhesive Remnant Index test. The whole data was analysed using ANOVA analysis.

Results:- At day 1 the mean shear bond strength of ClearShield^{TM} group has shown a significant difference from other groups. Whereas at day 8 and 15 Duraphat varnish group had significantly higher range of shear bond strength. The shear bond strength in comparison to all groups in all days has shown no significance. ARI scores for the same specimens, has no significant difference in mean in between the groups.

Conclusion:- The application of fluoride varnish, irrespective of the time interval between fluoride treatment and bonding procedure, does not affect the shear bond strength. Adhesive Remnant Index test has shown no significance in all groups.

Introduction:-

Orthodontic treatment complicates difficultly in maintaining the oral hygiene due to the presence of orthodontic brackets, molar bands, springs, coils and arch wires intra orally.[1]

The enamel demineralization observed on adjacent to orthodontic appliances which is a significant clinical problem. These appliances tend to lower the access to the oral hygiene aids and create an atmosphere which is in absence of good oral hygiene which can lead to rapid enamel demineralization.[2] In addition, acid-etching also trims down around 5–10 μm of the enamel surface, which results in a demineralization of enamel. [3] Moreover, the excess composite around the bracket base creates a room for the dental plaque accumulation. [1] All these factors subsequently increase the risk of decay during orthodontic therapy.

There have been many reports which have stated that half of the patients who receive fixed orthodontic therapy develop white spot lesions [4]. Since patient compliance is unreliable & variable, there is a strong need for compliance free methods that are not time consuming for reduction of enamel lesions. Fluoride varnish application is one such measure for susceptible & uncooperative patient. [5].

An Investigation has shown that the topical application of fluoride can interfere with the etching effect of phosphoric acid on enamel surfaces, resulting in possible reduced bond strength of bonding resins. [6]. In other study, however, the topical application of fluoride to enamel surfaces did not significantly affect the bond strength. [7].

Adequate clinical bond strength in orthodontics ranges from 5.9 to 7.9 MPa. [8]. The contrary results of enamel bond strength in previous studies reported that the additional topical application had little or no effect on strength. [9]

Hence, the purpose of this study has been to evaluate the effect of topical fluoride varnish application on shear bond strength in between enamel surface and orthodontic brackets at different post-fluoride application timings. We also aimed to examine the resin remnants by Adhesive Remnant Index (ARI) based on 4 point scale of Arun and Bergland [9's ref 13] with Stereomicroscope (Lawrence and Mao) with 10X magnification. It was expected that specimen treated with various fluoride varnish prior to the bonding of orthodontic brackets would show reduction in the shear bond strength on the same day or after few days.

Materials and Methods:-

The sample consisted of 120 extracted premolars without any decay or visible defect were collected from the Department of Oral and Maxillofacial surgery, Farooqia Dental College and Hospital, Mysore – Karnataka. The teeth were divided into 4 test groups (fig 1) with 10 sample in each group (N=10) for each day [Group 1 with Varnish^{TM} varnish (3M ESPE, MN, USA), Group 2 with Kolorz ClearShield^{TM} varnish (DMG America, NJ, USA), Group 3 with Duraphat varnish. (Colgate), Group 4 without varnish (control group)].

All the teeth were cleaned with non-fluoridated prophylaxis paste and stored in artificial saliva. The whole root surface was mounted on a cylindrical acrylic blocks leaving the clinical crown visible. (Fig 2)

The premolar teeth in group 1, 2 and 3 were precoated with various topical fluoride varnishes following the manufactures instructions and suspended immediately in artificial saliva at 37^0C for either 1, 8, and 15 days prior to bracket bonding. After storing the samples for the required time intervals all the surfaces of premolars were cleaned with oil and fluoride free pumice, then followed by rinsing with water and little bit of air drying for five seconds. ENLIGHT primer (Ormco corporation) (fig 3) was applied to the teeth with light continued pressure for five seconds. An oil and moisture free air source was used to gently dry the primer into a thin film, after which ENLIGHT Light cure adhesive system (Ormco corporation) was applied to Ortho Organizer MBT 022 slot bracket and pressed firmly until excess adhesive extruded onto the tooth surface which is removed using an explorer and the brackets are cured using Tungsten Halogen curing unit-Hilux curing light from Kulzer with a distance of 2-3mm from the bracket for 10 seconds on each side of a tooth which is totally 40 seconds. All sample groups were then stored in artificial saliva at 37^0C for 1 day (24 hours) before debonding.

(Fig 1)

(Fig 2)

(Fig 3)

Debonding and shear bond strength testing:-

Debonding was carried out using Instron Universal testing machine (50 KN Hounsfield Tensometer, U.K) was used and the shear bond strength values were recorded. This machine consists of two cross heads, upper and lower (fig 4). The upper crosshead is movable, while the lower crosshead is stationary. The crossheads of the Instron are mounted on a hydraulic framework connected to a frame recording unit. Progressive debonding force was applied to the brackets. The force required to debond the brackets from the enamel surface was recorded. The acrylic blocks were positioned in the lower crosshead with the crown position of the teeth facing upwards. The long axis of the tooth and the bracket base were parallel to the direction of the debonding force applied. A loop made of 0.8mm stainless wire was portion was engaged below the gingival tie wing of the bracket. A load cell was a range of 0-50 kg was used. The crosshead of the Instron moved at a uniform speed of 3mm/minute. The load was progressively increased till the bracket deboned from the tooth surface.

(Fig 4)

The debonding force was measured in terms of Newton's. This was repeated for all the samples in the same order as they were bonded. The bond strength values obtained in terms of Newton's were converted into megapascals using surface area of the bracket. The surface area of the bracket was determined by measuring the height and width of the bracket base applying the formulae of a trapezium which is ½ heights X and the surface area of the bracket was obtained as 10.5 mm^2.

After debonding, the percentage of the surface of the bracket base covered by adhesive was determined using Stereomicroscope (Lawrence and Mao) with eye piece of 10X magnification. (Fig 5)

(Fig 5)

The percentage area still covered by adhesive on the tooth after debonding was obtained by subtracting the area of adhesive covering the bracket base from 100%. Later each tooth was assigned an adhesive remnant index (ART) value according to Artun and Bergland.[10]

Score 0: No adhesive left on the tooth surface
Score 1: Less than ½ of adhesive left on the tooth surface
Score 2: More than ½ of adhesive left on the tooth surface
Score 3: All adhesive left on the tooth surface.

Results:-

The results of the DESCRIPTIVE statistics and one way ANOVA analysis comparing the shear bond strength of orthodontic brackets bonded to teeth with or without fluoride varnish at different time periods (day 1, 8 and 15). The analysis revealed that the mean value shear bond strength of clear Shield group was significantly high. The mean value shear bond strength of Duraphat group comes to day 8 and day 15 (table I & II) had revealed significantly high. In comparison at different time intervals there is no significant difference between all groups (sig of 0.379, 0.048, and 0.225). The ANOVA analysis (table III) for ARI described that there is no significant difference between the scores of all groups at different time periods.

Table1:-descriptive analysis

	Mean	Minimum	Maximum
Varnish 3M	8.8908	6.79	11.21
Duraphat™	9.6693	5.98	12.33
Clearshield™	9.9382	5.99	12.29
Control	10.3365	6.78	12.87
Varnish 3M	9.7087	5.98	12.87
Duraphat™	9.2640	6.91	12.81
Clearshield™	10.9044	8.98	12.84
Control	11.0986	9.01	12.94
Varnish 3M	9.7484	6.13	13.72
Duraphat™	10.2539	6.13	13.72
Clearshield™	9.2516	5.98	11.86

Table2:- anova

	Sum of Squares	df	F	Sig.
Between Groups	11.173	3	1.057	.379
Within Groups	126.879	36		
Total	138.052	39		
Between Groups	23.721	3	2.898	.048
Within Groups	98.213	36		
Total	121.934	39		
Between Groups	24.780	3	1.523	.225
Within Groups	195.292	36		
Total	220.072	39		

Table3:- anova

	Sum of Squares	df	F	Sig.
Between Groups	6.200	3	2.638	.064
Within Groups	28.200	36		
Total	34.400	39		
Between Groups	.675	3	.260	.853
Within Groups	31.100	36		
Total	31.775	39		
Between Groups	3.675	3	1.569	.214
Within Groups	28.100	36		
Total	31.775	39		

Discussion:-

The main goal of evaluating shear bond strength with fluoride varnish was to know the either fluoride varnish has any effect on shear bond strength of orthodontic bracket. There are numerous studies showing conflicting results regarding the effect of topical fluoride application on the bond strength of orthodontic attachment. There is a high

risk of developing dental caries during orthodontic treatment, especially when the oral hygiene instructions are not followed properly.[17] So as to prevent dental caries these varnishes were introduced to increase the attachment time of fluoride ions which encourages the formation of fluoroapatite crystal which increases the micro-hardness of enamel and reduces the solubility in oral environment. With the recent advances of single –dose in the fluoride varnish system, an unanswered question was whether this system would affect the bond strength. The optimal shear bond strength required in clinical use is yet unknown. Ideally, there shouldn't be any kind of bond failures and they should be easy to debond at the end of the treatment with enamel damage.[10] But according to Reynolds in 1975 the optimal range of bond strength required clinically is 5.9 MPa to 7.8 MPa.[11] The hypothesis that fluoride varnish treatment to the teeth prior to bonding orthodontic attachment would exhibit reduction in the shear bond strength. Our present study suggested that various varnishes used prior to bonding did not have any negative effect on bond strength. The mean bond strength was found to be much better than which was ranging from minimum 6 to 9Mpa (table I).

According to a study, pretreatment with fluoride application has reduced the etching action of phosphoric acid. The sodium fluoride treated enamel surface was occluded with globular reaction products. Deep channels covered with precipitates were visible, indicating liability in attachment between the precipitates & the underlying enamel, which possibly results in smaller bonding areas.[12]

However, it was observed that no difference was reported in bond strength of orthodontic brackets to enamel treated with or without fluoride varnish, with self etching primer or a conventional adhesive.[13] Similarly no significant reduction in resin tag formation into normal enamel and enamel pretreated with Duraphat varnish both the groups etched for 15 seconds with 50% phosphoric acid.[14]

According to Kimura T, Dunn WJ, Taloumis U, the relationship between the shear bond htgnerts of orthodontic brackets to enamel, with or without fluoride varnish, by using either conventional or self-etching primer systems. Forty-eight extracted teeth were divided into 4 groups of 12 teeth each: group 1, fluoride varnish, conventional adhesive; group 2, fluoride varnish, self-etching primer system; group 3, no fluoride varnish, conventional adhesive; and group 4, no fluoride varnish, self-etching primer system. Precoated adhesive orthodontic brackets were light-cured to the facial surfaces of the teeth and stored in whole human saliva at 37°C for 24 hours. The specimens were subjected to a shear force in a testing machine until failure. The adhesive remnant index was used to score the teeth. The results showed that the application of fluoride varnish does not affect the bond strength of orthodontic brackets to enamel with conventional or self-etching primer systems. Similarly adhesive remnant index scores were not statistically different.[15]

Dalia El Bokle, Hala Munir, in their study they compared the effect on the shear bond strength of orthodontic brackets on application of a fluoride releasing light-cure varnish to the enamel surface either before or after the application of sealant. In this study specimens were randomly divided into 3 equal groups. In group 1 and 2 a fluoride-releasing light-cure varnish, was applied to the enamel surface before or after, respectively, the sealant provided with the adhesive, while group 3 (control) was bonded regularly using only the sealant supplied with the adhesive. All teeth were mounted in metal jigs compatible with universal testing machine, to determine the shear bond strength. The residual adhesive on the enamel surface was evaluated after debonding with the adhesive remnant index. The results indicated that application of fluoride-releasing light-cure varnish before or after the sealant did not reduce the mean shear bond strength of orthodontic brackets. Evaluation of the residual adhesive on enamel surfaces showed no significant differences between all groups.[16]

However, within the limitations of this in vitro study, it can be anticipated that enamel surface treated with different preventive agents before or after acid-etching in orthodontic bonding would be beneficial in poorly compliant patients to prevent the initiation of carious lesion without disturbing bonding strength. The uses of different fluoride varnishes may help in prevent and provided the good shear bond strengths. The use of this agent probably reduces the incidence of initial caries lesion as reported by many investigators[18, 19.] Further clinical studies to investigate the clinical effectiveness of preventive agents before orthodontic bracket bonding would be required to prove these in vitro results.

Conclusions:-

In the present in vitro study, treating the tooth surface with fluoride varnishes like Duraphat varnish
Varnish 3M group, ClearShield^{TM} can be considered as an effective method to prevent or reduce demineralization. The results of this study indicated that there is no effect on the shear bond strength of orthodontic bracket and enamel, when treated with or without the different types of fluoride varnishes, irrespective of time intervals between the fluoride treatment and bonding. In Adhesive Remnant Index (ARI) test there was no significant difference between the scores of all groups.

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