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Quantitative and Qualitative Estimation of Enamel Loss after Debonding

Dr. Siju B Padayattil, Dr.Anil Malik, Dr Kevin Joseph Nirayath, Dr.Nidhi, Dr.Shafees Koya

[1,4]*PG Student, Yenepoya Dental College, Mangalore, Karnataka*
[2,5]*Reader, Yenepoya Dental College, Mangalore, Karnataka*
[3]*Senior Lecturer, Yenepoya Dental College, Mangalore, Karnataka*

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ABSTRACT:
This investigation analyzes the quantitative and qualitative effects of debonding on the enamel surface. The present study aimed to evaluate three different methods used for debonding, i.e., using anterior band removing plier, 12 fluted spiral tungsten carbide bur, and sharp tip ultrasonic scaler. The effects of these methods on the enamel surface were studied using the SEM. The depth of enamel lost during these procedures was measured using a metroscope. Forty-five extracted premolars were bonded with T.P. Begg brackets using no mix type of composite resin and were divided into three groups, and each group was debonded using one of the mechanical methods. It was observed that some amount of enamel was lost, and the enamel surface had become rough during debonding in all three methods. Anterior band removing plier and ultrasonic scaler failed to remove the composite resin completely, whereas twelve fluted tungsten carbide burs removed the composite resins. The ultrasonic scaler caused less enamel loss than twelve fluted tungsten carbide bur, statistically there was no significant difference between these two methods.
It is clearly conclusive that a significant amount of enamel loss is associated with all three mechanical debonding techniques. However, tungsten carbide bur proved to be the most efficient debonding method. Continual improvements in the future on acid etching and debonding techniques are required to reduce enamel loss during bonding and debonding procedures.

KEYWORDS: Debonding methods, Enamel loss, Residual Resin, Debonding plier, Burs.

I. INTRODUCTION

The direct application of an orthodontic attachment to the tooth surface evolved in 1955 when Buonocore published his description, "Simple method of increasing the adhesion of acrylicfilling materials to enamel surface," by introducing the acid etch technique using phosphoric acid. The other methodsare sandblasting etching and using nitric acid, citric acid, maleic acid, and polyacrylic acid.

Bonding is based on the mechanical interlocking of an adhesive to irregularities in the tooth's enamel surface. Hence, mechanical locks are formed on the base of the orthodontic attachments and enamel surface.Several clinical research studies have been done on the effect of acid etching on the enamel surface and its disadvantages. In contrast, few studies have discussed debonding procedures and their effects on enamel.

II. METHODOLOGY

The present study aims to investigate the enamel surface quantitatively and qualitatively after three mechanical debonding procedures. Forty-five freshly extracted premolar teeth for orthodontic treatment were collected from the oral surgery department of Yenepoya Dental College, Mangalore. Instruction was given to extract the teeth carefully without causing any enamel damage. All the teeth selected were without discoloration, caries, or anomalies and were preserved in normal saline. Forty-five teeth were divided into three different groups of fifteen teeth each. For etching the enamel surface, 30% Orthophosphoric Acid supplied by TP Laboratories and the adhesive kit were used.

The Bonding agent T.P.(Right on) consists of a composite base paste and a primer. The composite resin is chemically cured and has no mixed bonding system.
T.P. Begg brackets of 020-inch slot size, with mini mesh and a base of 0.125 x 0.122 inch, were used.

The following instruments were used for this study.

1. Bracket holding forceps to position the bracket for bonding onto the enamel surface.

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2. Pin and ligature cutter removed the bracket from the tooth surface.
3. Anterior band removing pliers were used to remove the residual adhesives.
4. 12 fluted spiral tungsten carbide burs removed the remaining bonding material from the tooth surface.
5. Sharp tip ultrasonic scaler was used.

The teeth were mounted on a jig which was a 3-inchaluminum cubic; on one side, there was a slot 1cm wide, 1.5 cmdeep, and 3 inches long, with the other side a flat surface. The mounting was done inthe jig vertically along the slot using plasterof Paris$(CaS04_4)_2.H20$. Then it was kept only for fifteen minutes for the initial setting of plaster of Paris and to prevent any dehydration of dentinal tubules.

III. TESTING PROCEDURE (11 BOLD)

The jig is kept on a metroscope. It is fixed on a movable object table using a clamp between two knobs of the metroscope. A thin pointer was attached to the metroscope knob. The two knobs can be moved, which will come in contact, with the labial surface ofthe tooth and on the aluminium jig. The tooth surface to be studied 0.125x 0.122-inch area is further divided into 4 small blocks. Four points were located with specific distance between the two in each small block. Each point was measured four times through the microscopic attached to it and average of it was taken asthe correct reading. This is to avoid any error in the reading.

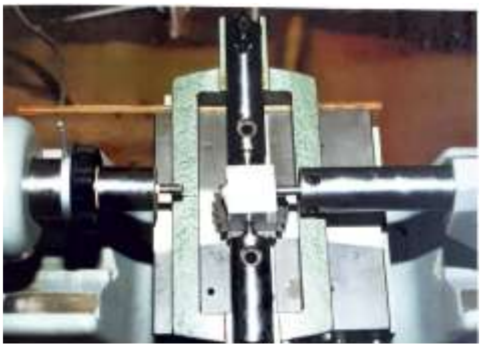

Fig1. Jig kept on Metroscope for measurement

0.122-inch (breadth) x 0.125 inch (length)

BLK1	BLK2
BLK3	BLK4

Diagram showing division on the tooth surface as four blocks.

All the teeth, which were mounted on the jig were transferred on to the metroscope and the readings were taken as explained above, before the acid etching was done.

After the initial reading, teeth were subjected for etching using etching solution of 30% orthophosphoric acid. Teeth were rinsed thoroughly with distilled water using syringe, isolated and dried using chip blower air. Few drops of acid were placed onto the work. Using cotton forceps and one disposable foam pellet, etchant is dabbed on to teeth, without any rubbing. Etching was done for forty-five seconds. It is necessary to etch an area slightly larger than the actual bonding site. After forty-five minutes teeth were washed using distilled water and dried using chip blower until a chalky white surface appears. The teeth were transferred on the metroscope and readings were taken as mentioned earlier.

Bonding of brackets on the etched surface was done by direct bonding method. Few drops of bonding agent were taken on to a work pad. A thin coat of adhesive activator is applied on to the etched surface using a disposable brush provided by the manufacturer. A thin coat of it is applied on to the bracket base to prevent pooling of bonding agent in the curved surface. Bonding paste was applied on the bracket surface, and the bracket was placed on the tooth surface. Gentle pressure is applied so that excess material flushes out. Thick adhesive layers are avoided because of the weak bond strength. Too much pressure also makes the bracket base come in direct contact with the tooth surface which again cause week bonding. Thus, the teeth with bonded brackets were allowed to cure for 24 hours so that they attain the maximum strength by complete cure. The sampleswere kept in normal saline.

Using a pin and ligature cutter the brackets of all the groups were debonded and residual resins from the tooth surface were moved by one of the three mechanical methods in each group separately.

Group I: Anterior band removing plier was used to remove residual composite using a sharp beak of the plier.
Group II: 12 bladed Spiral fluted tungsten carbide bur was used.
Group III: Using a sharp tipped ultrasonic scaler, residual resins were removed.

Fig.2 Anterior band removing plier, 12 fluted tungsten carbide bur

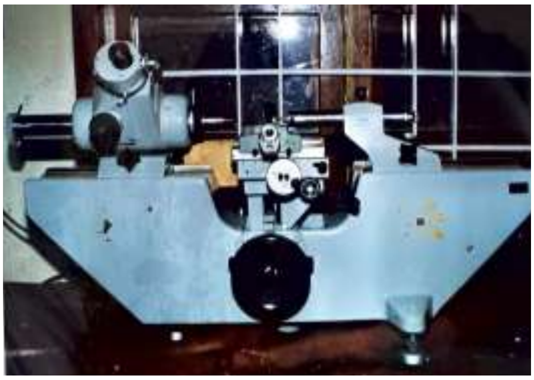

Fig 3.Metroscope

The debonded tooth surface of 3 different groups were again polished using fine pumice and polishing brush to simulate in vivo condition, since it is necessary to polish the teeth after debonding inpatient's mouth. The specimen is transferred to a metroscope, the bonded area was examined and depth of the debonded area is taken four times in the similar manner as done in pre etching procedure.

The findings were tabulated according to the grouping. (Table 1)

Scanning under electron microscope: To see the surface structure of enamel, the specimen was transferred onto a SEM. The entire crown could not be fitted onto the SEM. Hence the crown was cut gingivally and proximally, away from the debonded surface. The size was reduced in order to fit into the SEM. The specimen was mounted onto studs. The platforms with the mounted six specimens were then placed in the ion sputtering machine and gold dust was coated on the specimens. The specimens once coated completely with the gold dustwere removed from the sputtering machine and then placed inside thechamber of the scanning electron microscope. Six vacuum specimens were placed at a time. An accelerating voltage of 20KVand a current of 3 ampere was used and observed at 50x, 100x, 500x and 1000x magnifications and photographs were taken at 500x magnification. The photomicrographs taken were analysed qualitatively for the defects on enamel surface and any residual bonding material.

IV. RESULTS

This particular study evaluated the enamel surface, both qualitatively and quantitatively atter three mechanical methods of debonding. Forty-five extracted teeth were selected for the purpose of this study.

The enamel surfaces of all the teeth prior to bonding procedures were etched with 30% orthophosphoric acid. When etched for a period of forty-five seconds all specimens had a mean enamel loss of 8.2u (SD 1.58) when tested in a metroscope. The enamel surfaces had uniform microporosities when viewed though the SEM.

Fig4. Enamel Surface after acid etching

Fig5. Enamel Surface after Debracketing

On quantitative assessment it was found that using the anterior band removing plier for debonding resulted in a maximum amount of enamel loss of 23.06u (SD 3.78). Ultrasonic scaler caused a minimum amount of enamel loss 21.6u (SD 6.22). Removal of residual resins using tungsten carbide bur showed a mean enamel loss of 2 1.86u (SD 2.83). (Table II)

Statistical analysis of difference between each corresponding groups were done by using the students unpaired ‘t’ test for significance between the means. The result obtained through the 't' test showed statistically very high significance between group 1 & 2, 1&3. It was not significant between 2 & 3 (Table III)

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When the specimens were viewed through SEM, all the had grooves on the enamel surface. Specimens debonded using hand scaler showed deep grooves and some amount of residual composites on the enamel surface. Specimens debonded using twelve fluted tungsten carbide bur showed parallel shallow grooves and a clean enamel surface without any trace of composite resin.

The specimens debonded with ultrasonic scaler showed shallow grooves but there was residual composite resin on the enamel surface.

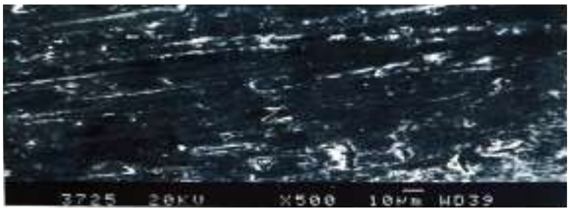

Fig6. Enamel Surface after debonding using band removing plier

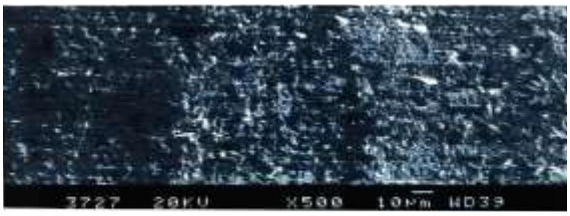

Fig7. Enamel Surface after debonding using 12 Fluted tungsten carbide bur

Fig8. Tooth surface after debonding with ultrasonic scaler

TABLE II: MEAN VALUE OF ENAMEL LOSS AFTER 3 MECHANICAL METHODS OF DEBONDING

	MEAN	S.D
Group I	23.36	2.15
Group II	21.86	1.55
Group III	21.64	1.98

TABLE III: COMPARISON OF THREE GROUPS

	Group I	Group II	Group III
Group I		t= 2.07 p=0 .047	t=2.22 p= .035
Group II			t=0.38 p>0.05
Group III			

Group I= Debonding using Pliers
Group II=Debonding using tungsten carbide bur
Group III=Debonding using ultrasonic scaler

V. DISCUSSION

It is common practice to etch the enamel in order to bond the brackets on to the tooth surface. There are various methods tried invitro such as acid etching with orthophosphoric acid, nitric acid, citric acid, crystal growth with polyacrylic acid, laser etching, sand blasting etc.

Only one procedure is clinically accepted, that is etching with orthophosphoric acid. It is known that etching is decalcification of surface enamel which results in enamel loss.

Varying degree of enamel is lost depending upon the concentration of acid used, time taken for etching, type of bonding material and method of debonding procedure. This loss of enamel could be so severe that it may cause more enamel loss to produce deep ditches onthe enamel surface. Hence it is necessary to know the amount of enamel lost during this process. This study of enamel loss is based on standard procedure of bonding using 30% orthophosphoric acid, forty-five seconds of etching time and bonding of brackets using nonmix adhesives which is in common practice today.

After bracket removal, there were various amount of residual composite resin remaining on the tooth surface. These compositesresins were removed using three mechanical methods. Using anterior band removing plier, ultrasonic scaler and 12 fluted tungsten carbide finishing bur.

Enamel surface after debonding should be compared to the adjacent natural enamel surface. Examination of dry appearance is important; some reflection and refraction phenomena associated with a wet surface could mask irregularities." The scarring of enamel following the removal of bonded brackets is inevitable.

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Acid etching is done in order to make a rough enamel surface to facilitate mechanical interlocking of the bonding material on to the tooth surface. This means surface decalcification of enamel. This results in some enamel loss which was common for all the three groups in this study. Hence before bonding, the enamel loss due to etching was measured in order to eliminate any bias that could be caused by etching. The amount of enamel loss was 8.3u with a standard deviation of 1.5p.

Fitzpatric and Way in their study reported that average enamel loss in etching as 9.9 microns while Thompson and Way"" reported a loss of 5 to 9 microns of enamel. These results are in agreement with the enamel loss of the present study. Caspersen' had reported the depth of etching from 10 to 50 microns. This present study is in close agreement to Caspersen's study.

The 12 fluted tungsten carbide bur used to debond, proved to be the most efficient in residual resin removal because the enamel was found to be free from resin when viewed through SEM, however they produced parallel grooves on the enamel surface. The amount of enamel loss was 21.8 microns of which 8.2 microns were lost by acid etching.

Zachrisson and Arthuns suggested that Tungsten carbide bur when used carefully with painting movements, the amount of enamel lost may be in the range of 5 to 10 microns, which gives an acceptable enamel surface after debonding. The present study is in agreement with Zachrisson and Arthun’s statement. Oliver reported that tungsten carbide bur caused the least enamel damage after debonding, thus supporting the result obtained in this study.

Bertrand and Marshall in their study stated that, adhesive removal using 12 fluted tungsten carbide bur was effective in resin removal but left fine scratches and facets on the enamel surface.

Clinical and SEM studies by Zachrisson on tooth surface following the removal of brackets, demonstrated normal surfaces appearance when plain Cut tungsten carbide bur rotated at low speed was used to remove remnants on the tooth surface. Camphell used 30 fluted tungsten carbide bur at high speed and found to be most efficient in removing residual resin. D.N. Kapoor reported a mean enamel loss of 14.64 u, and parallel grooves on enamel surface while debonding using 12 bladed tungsten carbide bur. The present study supports Dr. Kapoor's findings.

In contrast to the present study Y.H. Hong and Leu" reported. Remnants of composite resins on the tooth surface after the removal of residual composite resins using jet high speed tungsten carbide. In a study by Retief and Denys stated that the tungsten bur. carbide bur should be used only to remove the bulk of the composite resin, not to remove complete residual resins since it produces parallel grooves on the enamel surface. Gwinnett and Gorelick suggested that debonding using tungsten carbide bur was unnecessarily damaging the enamel surface. Zarrina and Kehoe' in their findings indicated that all rotating instruments that are efficient in removing residual resins introduce some amount of abrasion to the enamel surface. They suggested that 12 fluted tungsten carbide bur should be used only to remove the bulk of composite.

On the other hand, ultrasonic scaler, inspite of producing less enamel loss during debonding could not clean residual resinCompletely from the enamel surface. The total enamel loss by debonding using ultrasonic scaler was 21.64u out of which 8.24 u islost by acid etching. Burapavong stated that by using ultrasonic scaler there will be an average enamel loss of 10-20um, and therebe some amount of residual resins retained on the enamel surface. The present study has similar findings. Caspersen also reported the same in his research study. Keith V. Krilhad showed a loss of 16.23 um of enamel using ultrasonic scaler, and also statedthere were various amount of residual resins remaining on thetooth surface which again supports the present study.

V. CONCLUSION

Following orthodontic treatment with fixed appliances, bonded brackets may be removed by different methods, which leave varying amount of composite resin on the enamel surface. The composite resin removal is necessary to eliminate potential plaque traps and restore the aesthetic appearance of the enamel surface. A variety of methods have been designed to achieve satisfactory resin removal with minimal iatrogenic damage to the enamel surface.

Some enamel scarring following the removal of bonded brackets is inevitable, regardless of the competence of the clinician or the instrumentation used. Some scarring will always occur in every debonded enamel surface.

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