Case Report

A COMPARATIVE EVALUATION OF ENAMEL SURFACE ROUGHNESS OF TWO DIFFERENT BONDING ADHESIVES AFTER DEBONDING WITH ATOMIC FORCE MICROSCOPY

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Abstract:

Introduction: The goal of this research was to evaluate the pain felt by patients after veneers were debonded and gum remnants were removed using a tungsten carbide (TC) brush from two different cement frameworks: light fix composite and glass ionomer concrete glues. So long as we assume the null hypothesis is true, the two adhesive solutions do not vary in their ability to smooth out imperfections on the enamel surface.

Materials and Methods: Based on the consideration and prohibition models, this in vitro study examined sixty newly removed human premolar teeth (n = 60) to assess orthodontic plans. Light fix cement (Trans bond XT, 3M Unitek, Monrovia, CA) was used to strengthen the metal portions in Group I (n = 30), whereas light glass ionomer concrete (GC Fuji Ortho LC, Tokyo, Japan) was used to accomplish the same in Group II (n = 30). The dried residues of the concrete glue were removed using a TC brush and a slow-speed handpiece. Maximum roughness (Rmax), root mean square roughness (Rq), and roughness (Ra) were all determined at time zero (before holding). and their attributes were compared to those at time two (after debonding and completion).

Results: The two groups had very different experiences with the roughness of the polished surface when held. The composite resin and glass ionomer cement groups had statistically significant (p0.001) differences in surface roughness.

Conclusion: After debonding the sections and finishing with a TC brush, the surface roughness of the veneer significantly increased with both the light fix and the glass ionomer strong concrete structures. The enamel surface roughness of the light cure group was worse than that of the glass ionomer cement group.

Key-words: *Tungsten, Surface Roughness, Orthodontic, Light Cure, GIC, Enamel, Debonding, Composite, Brackets, Adhesive*.

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1. Introduction:

After orthodontic treatment is finished, a process called debonding is performed to remove any remaining adhesives from the tooth's surface as well as any orthodontic attachments. In order to avoid iatrogenic harm and preserve as much of the original enamel structure as possible, orthodontists should strive to restore the enamel surface to as near to its natural state as feasible. [1].

Micro-roughness values for natural enamel surface structure fall between 0.59 and 0.66 m. [2]. Surface etching, priming, and adhesive are all required for bonding brackets to enamel.

The enamel surface and its original morphology are vulnerable to damage at each of these stages. Debonding and enamel surface polishing are the two main components of enamel restoration after orthodontic treatment. Evidence from the past suggests that there is a correlation between enamel discolouration and an increase in surface roughness [3], which may have an aesthetic impact. [4]. The goal of the subsequent operations and protocols should be to return the enamel to its state before treatment. Various methods of polishing and finishing were tried out to see how they would affect the sheen of the enamel. Finishing using a diamond finishing bur or tungsten carbide (TC) bur is a very efficient (and time-efficient) method of surface cleaning. To test the effects of different adhesive systems, we utilized a TC bur to scrape off orthodontic bracket glue and an AFM to evaluate the roughness of the enamel surface. After being finished with a tungsten bur, it has been hypothesized that the two adhesive methods leave no discernible differences in the enamel's surface qualities.

Method:

The protocol for the in vitro research was given the go light by the institution's ethics board.The study population comprises of sixty natural human premolars that were recently removed for orthodontic treatment. Periodontal disease, hypoplastic abnormalities, carious lesions, cracked or shattered teeth, and other morphological anomalies were not considered indications for tooth extraction. Creating Acrylic Cubes After the teeth's roots were trimmed using a metallic disc bur, they were stored in distilled water until the self-curing acrylic was used to attach the crowns to the teeth's labial surfaces. Water, oil-free compressed air, and non-fluoridated pumice were used to clean the teeth. polished, and ready for use.

All 60 teeth were divided evenly between the two groups by a lot drawing process to ensure statistically valid results. Each experimental group had a different colored acrylic foundation. Teeth in Group-I (n=30) were color-coded blue because they were bonded with light cure composite, while those in Group-II (n=30) were color-coded pink because they were bonded with RMGIC. Samples were collected and tests were run in batches. To avoid any confusion before sending the blocks to the lab for analysis, they were each given a unique color.

For 10 seconds, the buccal surface of each crown (n=30) was scrubbed with pumice that did not contain fluoride. After being carefully cleaned with water and dried with oil and moisture free compressed air, the crown labial surface was carved for 20 seconds with gel containing 37% phosphoric corrosive. When the bond improver has been spread thinly, we waited twenty seconds for it to cure using an Indian product called Orthosolo. A stainless steel bracket was held in place while the composite glue (Enlight light cure adhesive) was applied. The bracket was then placed on the tooth's mid-buccal surface along the FACC, with the adhesive facing the tooth's FA. Extra composite was removed from around the bracket. After that, all of the surfaces were exposed to light for 40 seconds to cure. It took 24 hours of room temperature storage in water for all the samples.

Group II bonding techniques The tooth was given a thorough rinsing with water after prophylaxis and allowed to dry naturally. In this subset, acid etching was not performed. For 20 seconds, 10% polyacrylic acid was used to treat the buccal enamel surface. The RMGIC bonding cement made by GC Fuji Ortho Lc (Japan) is used in accordance with the directions provided by the company. The compound used to apply the stainless steel bracket (straight wire, MBT prescription, 0.22 slot) was noticeably thicker. All surfaces were exposed to light curing for 40 seconds, curing the RMGIC glue. As was the case with Group-I, the bracket was positioned on the tooth's labial surface. It took 24 hours of room temperature storage in water for all the samples. Methods of debonding and adhesive residual index analysis Traditional debonding pliers were used on all of the brackets in both sets. Plier tips were situated anterior to the gingival and occlusal wings and posterior to the bracket's base. The bracket was removed by squeezing the pliers' handles together

until the angled ends met, and then rotating the instrument in the direction of the bracket's occlusal edge. Next, we looked at the surface of a debonded tooth using a scanning electron microscope (SEM) at a 60x magnification using a Carl ZEISS EVO MA SEM. Bishara's adhesive remnant index (ARI) was used to calculate the amount of adhesive still present on the tooth surface after debonding. 15].

The rating was arrived at by tallying the number of replicated network measurements in a miniature image of debonded finish, which is a reflection of the amount of sap material on the tooth surface. Methods of Cleansing To remove any remaining paste, a 12-fluted carbide cement expulsion tool attached to a slow-speed handpiece was used in each instance. Using a dental operating light, the study's principal investigator (SD) and senior researcher (SGS) made sure there was no glue left. Both groups keep tabs on how long it takes to clean each individual tooth. The last level of roughness is T2. At the end of the cleaning processes (T2), Rmax, Rq, and Ra were measured using AFM to get an idea of how rough the surface was overall.

Calculus analytic All collected data was entered into an Excel spreadsheet, and then SPSS Statistics v.25 (developed by IBM) was used for the analysis. The means of the two groups were compared using the paired t-test, and statistical significance was determined using the student's independent t-test. All of the tests had p-values of less than 0.05, the threshold for statistical significance when comparing two groups.

Results:

In Table 1 we can see how the enamel surfaces of the different groups compare before and after bonding, and in Table 2 we can see how the roughness values change after finishing. The data demonstrate that at the T1 stage, the groups are statistically indistinguishable, suggesting that the sample is distributed normally. "However, there is a statistical difference between the groups at T2 ($p < 0.001$).

Table 1: Comparison of enamel surface roughness between the groups before bonding (T1) - independent Student's t-test

Parameters	Group n=30	Mean±SD	p-Value
Ra(nm)	Group-I	45.05±1.21	0.745
	Group-II	44.10±1.13	
Rq(nm)	Group-I	49.09±1.20	0.891
	Group-II	48.99±1.01	
Rmax(nm)	Group-I	410.15±10.01	0.475
	Group-II	415.08±1.02	

Table 2: Comparison of enamel surface roughness between the groups after debonding and polishing (T2) - independent Student's t-test

Parameters	Groupn=30	Mean±SD	p-Value
Ra(nm)	Group-I	85.05±0.88	0.001
	Group-II	60.56±1.12	
Rq(nm)	Group-I	126.18±1.01	0.001
	Group-II	79.10±1.10	
Rmax(nm)	Group-I	642.18±1.16	0.001
	Group-II	425.27±1.50"	

Discussion:

Appropriate bonding and debonding procedures are crucial in orthodontics. Bracket

debonding equipment, bonding glue, and finishing and polishing techniques utilized to remove adhesive resin are the most significant variables that might effect these procedures. There are many more variables that might affect them[5]. Shear bond strengths, bracket failures, and bond strengths for RMGIC-bonded stainless steel orthodontic brackets were all within the expected range for successful clinical bonding, similar to that of composite-based adhesives[6]. Although the RMGIC adhesive has a lesser binding strength than composite resin, the benefits of glass ionomer, such as fluoride release, more than make up for this. In addition, it works equally well on both conditioned and unconditioned enamel. [7]. Studies like this suggest that GIC cement, which is less damaging to tooth enamel, may have a bond strength that is on par with or even better than composite resin when it comes to placing orthodontic brackets. It's got a lot going for it: decent adhesive qualities, low solubility, great hardness, and the ability to release fluoride.

Few research have been done to evaluate the surface quality of RMGIC adhesives despite their numerous benefits. Shear bond strengths, bracket failures, and bond strengths for RMGIC-bonded stainless steel orthodontic brackets were all within the expected range for successful clinical bonding, similar to that of composite-based adhesives[6]. Although the RMGIC adhesive has a lesser binding strength than composite resin, the benefits of glass ionomer, such as fluoride release, more than make up for this. Due to the reduced risk of enamel fracture, this contact is appropriate for most patients. [8]. When looking at the statistical analysis of bond failure during debonding, there was no discernible difference between the groups. There is less risk of enamel injury with lower scores since less enamel has to be removed. When the link between the adhesive and the enamel fails, however, the enamel surface may be damaged. On the other hand, reports on whether or not low ARI scores are desired vary widely and may be rather confusing. One surprising result of this research was that Group-I was able to achieve a pretty smooth finish despite having higher ARI ratings than Group-II.

Recent research has shown that using a TC bur to remove composite takes about the same amount of time whether you're using loupes or not (about 33–34 seconds; [9]). To test whether or not adhesive type and ARI scores significantly influenced the amount of time needed to clear up adhesive, a two-way ANOVA was carried out. The ARI score did not show any statistically significant relationship with adhesive type.

The roughness of enamel surfaces is measured using atomic force microscopy in this research. The AFM can detect enamel surfaces and gather data using a scanning probe microscope. The enamel surface was analyzed in terms of three factors: The geometric mean of the heights and widths of valleys and peaks along a mean line is the value of average roughness, or Ra; the height distribution with respect to the mean line is the root mean square roughness, or Rq. Rmax is the greatest roughness depth value and indicates isolated profile characteristics. Similarly, at T1, there is no statistically significant difference between the groups in terms of Rq or Rmax, suggesting that the sample is representative of the population as a whole due to its random selection.In comparison to the GIC group, where the mean difference between T1 and T2 is Rq and Rmax, the composite adhesive group shows a statistically significant (p 0.001) improvement. They may have seen less alterations to the enamel's depth and surface area since the acid etching stage was skipped while using RMGIC. In other words, choose RMGIC versus composite undoubtedly contributes to a rougher enamel surface. This also suggests that further polishing and finishing procedures to restore the enamel that was there before treatment be explored. In contrast to SEM investigations, the AFM technique utilized here offers the benefit of assessing both the qualitative and quantitative changes to the surface.

Another AFM study by Mohebi [10] revealed that using a 12-fluted TC resulted in no statistically significant difference between using loupes and not using them, and that the resulting marginal change in mean surface values (Ra) was around 20-40 nm. However, there are no studies in the literature that directly compare the outcomes of the AFM

approach when RMGIC is included as a variable. This research's findings contradict those of a previous clinical trial that found that patients' preferences in either composite or RMGIC materials had no effect on the roughness of their enamel. As an example, they looked at the central incisor teeth, and they utilized aluminum disks to polish the teeth as a variable. It was determined from this research that there is a substantial variation in the surface attributes after completion between the groups examined and between the pre-bond and post-debond durations within each group, thereby rejecting the null hypothesis.

Limitations:

Due to the in vitro nature of the research, the findings must be taken to clinical practice with caution.

Conclusion:

This research suggests that after removing glue using TC burs, further finishing and polishing equipment should be used. When compared to traditional light cure composite, the RMGIC adhesive causes less surface modification of the enamel. In some clinical scenarios when other factors allow and RMGIC is warranted, it may be suggested to utilize RMGIC instead of composite for orthodontic bonding.

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