Original Study

EFFECT OF ALGINATE IMPRESSION TAKING ON SHEAR BOND STRENGTH OF ORTHODONTIC BRACKETS

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ABSTRACT

Aim: The most commonly used impression material in orthodontics for preparation of study casts is alginate. The purpose of this study was to evaluate the effect of alginate impression taking on the shear bond strength (SBS) of orthodontic brackets bonded with conventional acid etching and priming system.

Materials & Method: In this study four groups of non-fluoridated flowable composite (Grandio Flow, Voco) containing 0, 1, 2 and 3% w/w arginine (Merck), and four groups of fluoridated flowable composites (Wave, SDI) with the same weight percent's of arginine was prepared and antimicrobial properties of them were examined. Sixty human premolar teeth recently extracted for orthodontic purposes were selected and mounted in acrylic locks. The teeth were stored in 1% thymol solution for prevention of bacterial growth and dehydration and randomly allocated into three groups (N=20). Group1: the bracket bond to tooth surface without alginate impression taking (control). Group 2: bracket bond to tooth surface after taking alginate impression. Group 3: bracket bond to tooth surface two days after taking the alginate impression. SBS was measured by a universal testing machine with a speed of 1mm/min.

Results: The results showed that mean values for the SBS of group 1, 2, 3 were: 19.57(±2.03), 21(±2.01), 20.57(±2.3) respectively. Statistical analysis using ANOVA shows there was no statistically significant difference among the groups (p=0.542).

Conclusion: In this study alginate impression taking did not effect on the shear bond strength of the orthodontic brackets.

Key words: Alginate impression, Orthodontic brackets, Shear bond strength.

Introduction

As the name implies, use of fixed orthodontic appliances relies on bonding them to tooth structures.[1,2] Brackets are one of the most important components involved in orthodontic treatment.[2] These components were initially used by being attached to bands and fixed orthodontic treatment was carried out in the form of full band.[3] The introduction of the system in which brackets are directly bonded to tooth structures is considered a great breakthrough in orthodontic treatment.[4]

Various materials are used to bond brackets to tooth structures, including acrylic resins, stabilized resins, hybrid ionomers and composite resins.[4-7]

Bonocore, as a pioneer in adhesive dentistry, showed that bonding of acrylic restorative materials improves significantly after acid etching of enamel surfaces. Acid etching creates porosities on the enamel surface that measure 5–50 μm in depth (micro- and macro-tags) by dissolving enamel prisms and crystals. Micro- and macro-tags form a basis for micromechanical adhesion on the enamel surface.[8-11]

Commonly used systems for bonding of brackets to tooth surfaces are enamel conditioners, primers and adhesive resins (the 4th and 5th generation bonding agents); usually 35–37% phosphoric acid is used as an enamel conditioner.[9,10] Adhesion of resin to tooth structure depends on four principles:

1. Mechanical adhesion;
2. Surface adsorption;
3. Diffusion adhesion; and
4. A combination of the above three.[6,11,12]

Despite great attempts to improve the etching, primer and adhesive techniques, bonding failures have been reported at a rate of 0.5–16% of the cases [4,13,14] bonding failure occurs at three surfaces:

1. Cohesive failures in the bonding substrate (enamel);
2. Cohesive failure in the bonding agent; and
3. Failure at enamel–bonding agent interface.

Various factors affect the bond between the bracket and enamel, including the type of the adhesive, the curing technique, the time and concentration of the acid etch, the structure of the bracket, the placement technique and the oral cavity. The cleanliness and wettability of the bonded surfaces are some of the prerequisites for proper bonding.[4,6,9] Zachrison reported that contamination is one of the most important reasons for the failure of the bond.[15,16]

One of the first steps during initial orthodontic examinations is to prepare diagnostic records. Of all these records, study casts are one of the best tools for diagnosis and registration of data.[17] The most commonly used impression material in orthodontics for preparation of study casts is alginate. The general formula of the reaction between alginate and water is as follows:

$$\text{sodium and potassium alginate} + H_2O\ CaSO_4$$
$$H_2O + \text{calcium alginate} + Na + SO_4$$

Based on the above formula, sodium and sulphate precipitate on tooth surfaces.[7]

No studies to date have evaluated the possible effect of impression taking with alginate on the shear bond strength

of orthodontic brackets. The present study was undertaken to evaluate whether deposition of sodium and sulphate on tooth surface can increase the bond strength of brackets or on the contrary whether such deposition contaminates the enamel surface, decreasing the bracket bond strength. In addition, attempts were made to determine the appropriate time for bonding brackets after initial impression taking with alginate.

Materials & Methods

Sixty maxillary first premolars, extracted for orthodontic purposes, were selected. All the teeth were sound, with no restorations, caries or hypoplastic lesions. The teeth were mounted in acrylic resin blocks (Acropars, Tehran, Iran) with the crown and 2 mm of the roots out of the block, and then were randomly divided into 3 groups (n=20):

- *Group 1*: No impression taking procedure was carried out before bonding of the brackets to tooth surfaces. All the samples were cleaned with pumice powder (Pishro, Tehran, Iran) and prophylactic rubber cups for 10 seconds, followed by acid etching of the buccal surfaces of the teeth with 38% orthophosphoric acid (Palpdent, Watertown, USA) for 15 seconds. Light Bond (Resilience, Itaska, USA) (a 5th generation bonding agent) was applied on the buccal surfaces of the teeth and cured for 20 seconds with the use of a light-curing unit (Bonart, Copenhagen, Denmark) in order to bond an 18-slot standard premolar bracket (American, Sheboygan, USA) with composite resin (Resilience, Itaska, USA) to the buccal surface of each tooth sample. Curing was carried out for 40 seconds.
- *Group 2*: First the teeth were separately immersed in alginate paste (Zhermack, Italy) and after the alginate paste turned into alginate gel (a setting time of 5 minutes) the teeth were removed, followed by cleaning with pumice powder and rubber cups and bonding procedures of standard brackets of premolar teeth as described for group 1.
- *Group 3*: The teeth were immersed in alginate paste as described for group 2 and then immersed in 5% normal saline solution for two days. Then the cleaning and bonding procedures were carried out in a manner similar to that in group 1.

Then all the samples were subjected to an l000-round thermocycling procedure in a thermocycling unit (Naft Machine, Tehran, Iran). Each cycle consisted of 30 seconds in water at 5°C, followed by 30 seconds in water at 55°C.

Then the brackets were deboned in a universal testing machine (Zwick/Roell ZO50, Berlin, Germany) at a strain rate of 1 mm/min and the shear bond strength values were measured. The sharing force was applied to the bracket–tooth surface interface parallel to the tooth long axis and the maximum force at failure was determined in Newton. In order to convert Newton to MPa, the forces in Newton were divided by the bracket base surface area (9.8 mm^2).

Data were analysed wit SPSS, using ANOVA.

Results

The results in groups 1 to 3 are presented in Tables 1 to 3.

Sample	Newton	Mpa
1	248	25.30
2	243.5	24.84
3	234.8	23.95
4	234.7	2394
5	234	23.87
6	213.2	21.75
7	212.9	21.72
8	211.4	21.57
9	209.9	21.40
10	206.9	21.11
11	194.5	19.84
12	192.5	19.64
13	188.8	19.26
14	184.2	18.80
15	183.8	18.75
16	164.3	16.76
17	138.6	14.14
18	119.9	12.23
19	112.3	11.45
20	111.5	11.37
Mean	191.98	19.58

Table 1: Bond strength without taking impression (N, MPa).

Sample	Newton	Mpa
1	252.6	25.77
2	244.2	24.91
3	241.8	24.67
4	239.5	24.43
5	238.8	24.36
6	238.3	24.31
7	238.2	24.20
8	237.7	24.25
9	237.4	24.22
10	228.7	23.33
11	213	21.73
12	196.6	20.06
13	196.2	20.02
14	195.4	19.93
15	178.6	18.22
16	176.2	17.97
17	167.4	17.08
18	141.9	14.47
19	134.8	13.75
20	121.1	12.35
Mean	205.92	21

Table 2: Bond strength immediately after impression taking (N, MPa).

Sample	Newton	Mpa
1	246.4	25.14
2	246.3	25.13
3	241.5	24.64
4	240.3	24.52
5	236	24.08
6	235	23.97
7	233.1	23.78
8	232.2	23.69
9	231.4	23.61
10	221.5	22.60
11	202.9	20.70
12	185.3	18.90
13	182.1	18.58
14	174.2	17.77
15	171.2	17.46
16	169.7	17.31
17	156.8	16.00
18	154.4	15.75
19	148.9	15.19
20	124.2	12.67
Mean	201.67	20.57

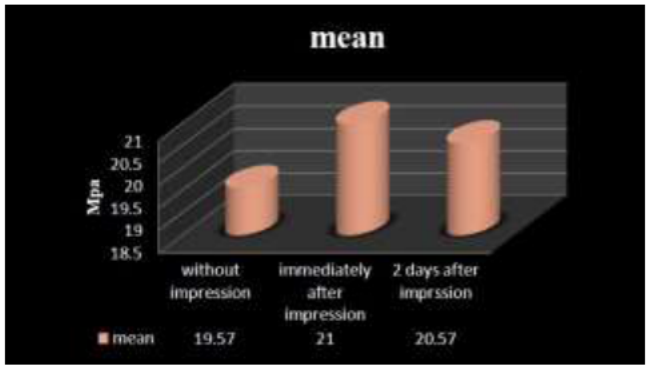
Table 3: Bond strength 2 days after impression taking (N, MPa)

Table 4 presents the minimums maximums, means and standard deviations.

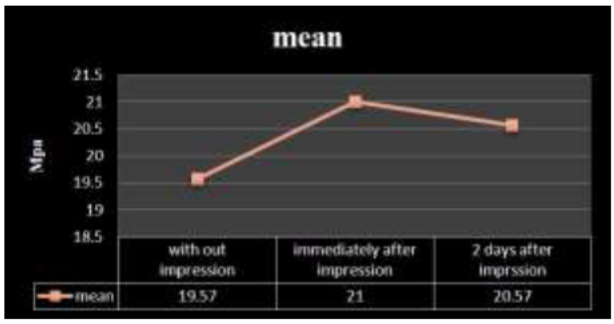
Impression Condition	Sample Numbers	Min.	Max.	Mean	Standard Deviation
Without Impression	20	11.37	25.30	19.57± 2.03	4.2
Immediately After Impression	20	12.35	25.77	21 ± 2.01	4.03
Two Days After Impression	20	12.67	25.14	20.57 ± 2.3	3.9

Table 4: Shear Bond strength of brackets comparison in different impression conditions.

Graphs 1 and 2 show the results of comparisons made between the shear bond strength values of brackets in the three study groups.



Graph 1: Shear bond strength of brackets comparison between 3 groups.



Graph 2: Shear bond strength of brackets comparison between 3 groups.

Discussion

In the present study, no significant differences were detected in the mean shear bond strengths of orthodontic brackets between the groups without impression taking, immediately after impression taking and with a delay after impression taking. To explain these results it might be advisable to briefly review the mechanism of the effect of phosphoric acid on enamel.

Acid etching dissolves the enamel prisms and crystals with different mechanisms and produces a rough surface by creating micro- and macro-tags for micro-mechanical bonding of resin to enamel.

It is probable that 38% phosphoric acid gel applied to tooth surfaces before bonding procedures removes 10 µm from the enamel surface, completely removing the pellicles and the possible sodium and sulphate deposits due to the reaction between the alginate powder and water.[4,6,12]

Given the lack of a study on the effect of impression taking with alginate on the shear bond strength of brackets and the absence of exact similarity between previous studies and the present study, it is not possible to make a comparison between this study and previous studies. Some previous studies have evaluated the effect of fluoride, chlorhexidine and bleaching agents on the shear bond strength of brackets.

Al-Kawari *et al* evacuated the effect of CPP-ACPF and CPP-ACP before acid etching and concluded that they had no significant effect on the shear bond strength of brackets. They explained that these two materials rapidly evaporate after being applied to tooth surfaces, leaving a very thin layer that cannot disrupt the etching process.[13] Frey *et al* reported that 1% chlorhexidine gel and 0.7% chlorhexidine mouthwash had no significant effect on the shear bond strength of brackets, which was attributed to the very low thickness and viscosity of these materials, with no interferences with the etching process.[18] Oztas *et al* and Bishara *et al* reported, respectively, that use of 20% carbamide peroxide and 10% carbamide peroxide, whether 1 day or two weeks after bleaching, had no significant effect on the shear bond strength of brackets, which was explained by the fact that water irrigation of the samples and drying with air current for 30 seconds after etching

might have neutralized the effect of the bleaching agents.[19,20]

In the present study, the samples were cleaned with pumice powder and prophylactic rubber cups after impression taking with alginate and before acid etching, followed by rinsing with water and drying with a current of air. It is possible that the residual alginate particles are removed after these procedures so that they do not interfere with acid etching of the enamel surface. Therefore, the etching of enamel, which has the greatest role in micromechanical retention, is carried out properly.[6,13,19-22]

Conclusion

Based on the results of the present study, impression taking with alginate has no significant effect on the shear bond strength brackets.

Recommendations

It is suggested that the effect of impression taking with alginate be evaluated with newer bonding agents, i.e. the sixth and seventh generation bonding agents. It is also suggested that an in vivo study be undertaken to evaluate the effect of impression taking with alginate on the shear bond strength of brackets under clinical conditions.

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