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Research Article

BRACKET RECYCLING EFFICACY AMONGST CONVENTIONAL SANDBLASTER AND AIR PROPHY UNIT AN IN-VITRO STUDY

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ABSTRACT

Objective: To evaluate bracket recycling efficacy amongst Conventional and Air prophy sandblaster at different particle sizes of aluminium oxide.
Design: Experimental study
Setting: The study was conducted in Department of Orthodontics and Dentofacial Orthopedics, Subharti Dental College & Hospital Meerut, Uttar Pradesh, India.
Method: Total 150 maxillary first premolars were embedded in metal block with the help of self-cure acrylic. The 150 samples were divided into 3 groups. Group 1 (control), Group 2 (conventional sandblasting), Group 3 (Air prophy unit). Group 2 and 3 were further divided into 30 samples each on the basis of two different partical size of aluminium oxide i.e. A1 (50 µm) and A2 (110 µm) which will be used for sand blasting. Descriptive statistics and ANOVA was performed to find the difference in mean among the groups.
Results: The shear bond strength of recycled bracket was seen highest in small particle size (50µm) of aluminium oxide in both the groups [(group 2 subgroup A1 (15.43 ± 2.74 MPa), group 3 subgroup A1 (15.14 ± 2.10 MPa)], where as when larger particle size (110 µm) of aluminium oxide was used the SBS was found to be low in group 3 subgroup A2 (11.37 ± 1.39 Mpa) and least in group 3 subgroup A2 (9.66 ± 1.64 Mpa).
Conclusion: Air prophy unit is similar to that of Conventional sand blaster for bracket recycling when small partical size (50 µm) of aluminium oxide were used.

INTRODUCTION

Recycling orthodontic brackets is one of the options available to practitioners, either on an individual basis where brackets need to be rebonded back onto a tooth or as part of a wider practice philosophy. The availability of various in-office techniques have been developed for recycling debonded brackets and the commonest methods practiced are sandblasting and direct flaming. Both these methods consume time since they cannot be performed on the chairside hence, an alternative method has to be employed to overcome these drawbacks.

Air-powder polishing has been shown to be an efficient and effective method for the removal of stains and plaque. Air abrasion is essentially a pseudo mechanical, non-rotary method of cutting dental hard tissues using the kinetic energy of a stream of desiccated abrasive particles to bombard the tooth surface at high velocity. The abrasive employed for cutting tooth structure is aluminum oxide (Al_2O_3: α-alumina).

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Hence, the present study was conducted to evaluate bracket recycling efficacy amongst Conventional sandblaster and Air prophy unit with various particle size and compare the shear bond strength of recycled brackets.

MATERIALS AND METHODOLOGY

Total 150 maxillary first premolars extracted for orthodontic purposes with no caries, cracks, or restorations were collected and cleaned from soft tissue residues with the help of a gauge piece or cotton. Teeth were then stored individually in distilled water at room temperature in plastic containers.

Inclusion Criteria

1. First premolars extracted within the past 3 months and stored in normal saline at room temperature.
2. Teeth with intact buccal enamel, with no enamel fractures or minor racks.
3. Teeth with no previous treatment with any chemical agent, and no hypo calcification.
4. Teeth free from dental caries and restorations.

Exclusion Criteria

1. Extracted teeth that were stored in various chemical agents such as hydrogen peroxide (H2O2).
2. Brackets of varied dimensions and types.
3. Different types of composites.
4. The light source of varying wavelengths.
5. Different curing times.

The tooth was embedded in the metal block so that they do not move while applying force with the help of self-cure acrylic. The enamel surface of each tooth was polished with fluoride-free pumice and rubber cup for 10 seconds, sprayed with water, and dried with the compressed oil-free stream. The enamel surface was etched with 37% phosphoric acid (3M) for 30 seconds, after that, they were thoroughly rinsed with water and air-dried. A thin layer of primer (3M) was applied occluso-gingivally and light-cured. Composite (Transbond XT) was applied to the bracket base and the bracket was then positioned at the center of the buccal surface between mesiodistally and occluso-gingivally on the tooth using the reverse side of the tweezer. The pressure of 2 ounces was applied using a digital pressure meter (Medicare Products Inc.). (Figure1) The excessive adhesive was removed using an explorer and the bracket was light-cured with a Cordless LED light cure unit (Woodpecker mini S) for 10 sec from occlusal, gingival, mesial, and distal sides, delivering a light intensity of 1200 mW/cm2, 450 nm wavelength. The same procedure was followed later on in the study.

Figure 1 Pressure of 2 ounces by using digital pressure meter

The 150 samples were divided into 3 groups: -
Group 1: - 30 teeth (control)
Group 2: - 60 teeth (conventional sandblasting)
Group 3: - 60 teeth (Air prophy unit)

Group 2 and 3 were further divided into two subgroups- A1 and A2 with 30 samples in each group based on two different aluminum oxide particle sizes used for sandblasting i.e. A1 (with a particle size of 50 µm) and A2 (with a particle size of 110 µm). Each sampled group was color-coded i.e., group 2 subgroup A1 was color-coded green, group 2 subgroup A2 was yellow, group 3 subgroup A1 was blue, group 3 subgroup A2 as pink and lastly group 1 was marked as colorless (Figure 2).

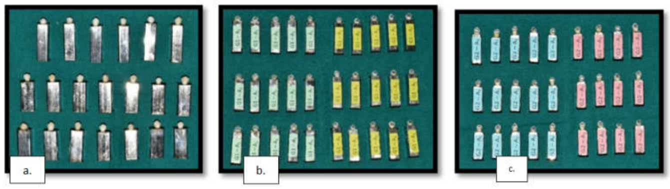

Figure 2 Extracted 1st premolar mounted in metal block:-
a. Group 1 (colorless)
b. Group 2 subgroup A1(green) &Group 2 subgroup A2(yellow)
c. Group 3 subgroup A1(blue) &Group 3 subgroup A2(pink)

Group 2 and 3 samples were debonded with the help of a straight debonding plier. The sharp edges of the plier were placed mesially and distally to the bracket base. Carbide finishing bur (L169) was used to remove the residual adhesive with a micromotor speed of 15,000 rpm.

The two debonded bracket group was recycled with two different particle size of aluminum oxide. While recycling the brackets are kept at a distance of 10 mm from the tip of the nozzle and blasting was done for 60 seconds for each bracket for both methods in the view box. The recycled brackets of groups 2 and 3 and their subgroups were again rebonded as above mentioned method.

The final debonding was carried out using an Instron Universal testing machine for groups 1, 2, and 3, and the shear bond strength values were recorded and put for statistical evaluation. (Figure 3)

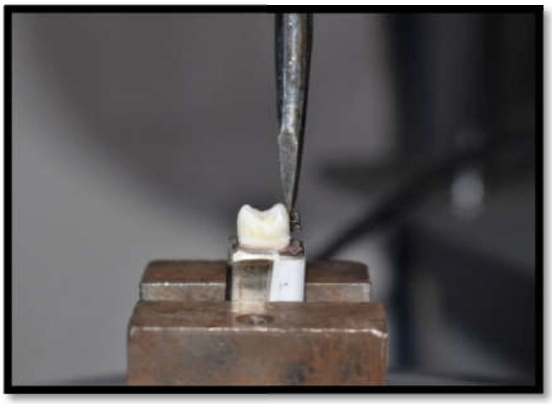

Figure 3 Recording of shear bond strength

Statistical Analysis

Statistical analysis was performed using SPSS v23 software. The level of significance was kept at 5%. The overall difference in SBS among all the groups was analyzed using one way ANOVA test. Intergroup comparison of SBS was done using an independent t-test.

RESULTS

Group 1 has shown the highest shear bond strength i.e., 16.25 ± 1.83 MPa, whereas group 3 subgroup A2 recorded the least SBS i.e. 9.66 ± 1.64 MPa, followed by group 3 subgroup A1 (15.14 ± 2.10 MPa), group 2 subgroup A2 (11.37 ± 1.39 Mpa) and group 2 subgroup A1 (15.43 ± 2.74 MPa) respectively. Table 1 showing a comparison of groups 2 and 3 with group 1. On comparing group 2 subgroup A1 and group 3 subgroup A1 with group 1 showed a statistically non-significant difference. The difference between these groups and group 1 was found to be only 0.82 MPa and 0.91 MPa. Whereas on comparison of group 2 subgroup A2 and group 3 subgroup A2 with group 1, a statistically significant difference were found. The difference in shear bond strength of group 1 with group 2 subgroup A2 & group 3 subgroup A2 was found to be 4.88 MPa & 6.59 MPa.

Table 2 showing a comparison, a statistically significant difference was observed between group 2 subgroup A1 and group 2 subgroup A2 with a difference of 4.06 MPa. Group 3 also showed a statistically significant difference between group 3 subgroup A1 and group 3 subgroup A2 with a difference of 5.68 MPa.

Table 1 Comparison of SBS of group 1 with subgroups of group 2 and 3

Groups	SBS (MPa)	Difference (MPa)	t value	p value
Group 1	16.25 ± 1.83	0.82	1.366	0.177 (NS)
Group 2 Subgroup A1	15.43 ± 2.74			
Group 1	16.25 ± 1.83	4.88	11.651	0.001*
Group 2 Subgroup A2	11.37 ± 1.39			
Group 1	16.25 ± 1.83	0.91	1.857	0.068 (NS)
Group 3 Subgroup A1	15.34 ± 1.99			
Group 1	16.25 ± 1.83	6.59	14.711	0.001*
Group 3 Subgroup A2	9.66 ± 1.64			

Independent t test; * indicates significant difference at $p \leq 0.05$; NS: Non-significant

Table 3 shows the comparison between groups 2 & 3 with different particle sizes. In comparison, a statistically non-significant difference was observed between group 2 subgroup A1 and group 3 subgroup A1 difference of 0.09 Mpa. Whereas a statistically significant difference was observed on comparison of group 2 subgroup A2 and group 3 subgroup A2 with a difference of 1.71 MPa.

Table 2 Comparison of shear bond strength within group 2 and 3

Groups	Subgroup A1	Subgroup A2	Difference	t value	p value
Group 2	15.43 ± 2.74 (MPa)	11.37 ± 1.39 (MPa)	4.06 (MPa)	7.237	0.001*
Group 3	15.34 ± 1.99 (MPa)	9.66 ± 1.64 (MPa)	5.68 (MPa)	12.055	0.001*

Independent t test; * indicates significant difference at $p \leq 0.05$

Table 3 Comparison of SBS between group 2and 3with different particle sizes

Subgroup	Group 2	Group 3	Difference	t value	p value
A1	15.43 ± 2.74 (MPa)	15.34 ± 1.99(MPa)	0.09 (MPa)	0.154	0.879 (NS)
A2	11.37 ± 1.39 (MPa)	9.66 ± 1.64 (MPa)	1.71 (MPa)	4.365	0.001*

Independent t test; * indicates significant difference at $p \leq 0.05$; NS: Non-significant

DISCUSSIONS

Sandblasting technique was introduced in the 20th century as a method of recycling orthodontic brackets. The air prophy unit has proved to be one of the most effective chairside air-polishing units for the removal of resin material from the base of the brackets. Thus in the present study, the air prophy unit has been used for sandblasting the brackets but with aluminum oxide as an abrasive unit instead of recommended sodium bicarbonate routinely used for reconditioning of the brackets.

Reynolds *et al* (1975) found clinically acceptable bond strength to range from 5.9 to 7.8 MPa However, Mizrahi and Smith (1971) concluded that bond strength in the range of 2.8 to 10 Mpa is sufficient for clinical purposes. It was observed that all groups in the present exhibited mean SBS higher than the recommended SBS required for successful orthodontic bonding. The probable reason for high SBS in the present study could be the difference in force application. Among the groups, group 1 showed the highest SBS i.e. 16.25 ± 1.83 MPa, followed by group 2 subgroup A1 (15.43 ± 2.74 MPa), group 3 subgroup A1 (15.14 ± 2.10 MPa), group 2 subgroup A2 (11.37 ± 1.39 Mpa) and least SBS observed in group 3 subgroup A2 i.e. (9.66 ± 1.64 Mpa). The probable reason for less SBS observed in the experimental group as compared to the control group may be due to incomplete adhesive removal, or direct loss of material from the bracket surface during recycling, thereby affecting the bond strength of the bracket.

In table 1 of the present study, the groups (group 2 subgroup A1 and group 3 subgroup A1) which were sandblasted with 50 µm diameter aluminum oxide showed no significant difference in bond strength. It was in accordance with the study conducted by Sonis (1996) and Grabouski *et al* (1998) who also reported that there is a statistically non-significant difference in bond strength between new and sandblasted rebonded brackets. In another study by Aksu and Kocadereli (2013), it was observed that a non-significant bond strength was found between new brackets & recycled brackets. On the other hand group 2 subgroup A2 and group 3 subgroup A2 groups in which 110 µmaluminum oxide was used, the SBS was found to be less as compared to the smaller size particle used before. It is in accordance with the study by Montero MM *et al* (2015).

In Tables 2 and 3, the comparison of SBS within the test groups based on aluminum oxide particle size i.e., 50 µm and the 110 µm was done. It was observed that when debonded brackets were reconditioned with a smaller particle size of aluminum oxide i.e., 50 µm the SBS was found to be 15.43 ± 2.74 MPa by Conventional sandblaster and 15.34 ± 1.99 MPa by Air prophy unit, similar results were reported by Basudan and Al-Emran (2014).

It was also observed with the increase in the size of the particle the shear bond strength reduced this was in accordance to Montero MM *et al* (2015). Thus, the present study indicated that the air prophy unit can be used for bracket recycling with less particle size of alumina as it is equally effective as a conventional sandblaster with the same size of alumina. This study also suggests that using the higher size of alumina in the Air prophy unit leads to a decrease in shear bond strength as it causes blockage of unit nozzle resulting in prolonged time required to clean the bracket base.

CONCLUSION

- Aluminum oxide of smaller particle size (50 µm) showed a mean shear bond strength of 15.43 ± 2.74 MPa by conventional sandblaster (group 2 subgroup A1) and 15.14 ± 2.10 MPa by Air prophy unit (group 3 subgroup A1).
- Aluminum oxide of larger particle size (110 µm) showed a mean shear bond strength of 11.37 ± 1.39 MPa by conventional sandblaster (group 2 subgroup

A2) and 9.66 ± 1.64 MPa by Air prophy unit (group 3 subgroup A2).

- Hence Air prophy unit with 50 µm of aluminum oxide particle size under 4 bar pressure can be used for recycling brackets at the chairside.

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