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Comparative evaluation of the effect of recycling on shear bond strength of stainless steel bracket

Tanusha Mahobia[1,*], Yogesh Kumar Mahobia[2]

[1]MDS Student, [2]Reader, Dept. of Orthodontics & Dentofacial Orthopedics, [1]Maitri College of Dentistry and Research Centre Durg CG, [2]New horizon dental college and research center, Bilaspur CG

***Corresponding Author:**
Email: tanushamahobia@gmail.com

Abstract

Aim: In clinical practice, Orthodontist is in dilemma while encountering used brackets. Recycling the brackets is one of the solutions. This recycling process deals with removing bonding agent remnants from the bracket base, thus allowing the brackets to be reused in the procedure.

Method- For the present study, eighty non-carious human premolar, extracted for orthodontic reasons, was collected. They were randomly allocated to 4 groups: One control group (group A) and three experimental groups (group B, group C and group D). Step by step bonding procedure was performed. The bracket of all 3 experimental groups was debonded within 30 minutes after bonding to simulate the clinical condition at which a newly bonded bracket was tied to the arch wire. One way Anova was used with post hoc for comparison. Level of statistical significance set at 0.05.

Result: Control group in which no debonding and rebonding procedure was performed has highest shear bond strength followed by experimental group D, in which bracket base was cleaned with aluminum oxide sandblasting and experimental group C, in which bracket base was cleaned with ultrasonic scalar while the last experimental group B in which bracket base was cleaned with slow speed round carbide bur have least shear bond strength.

Conclusion: The recycling of debonded bracket with aluminum oxide sandblaster has given out better results over the other two techniques. The bracket recycling by this technique had a better bond strength. Hence from this study sandblasting technique proved to be more efficient and satisfactory to the clinician with respect to bond strength.

Keywords: Sandblasting, Orthodontic brackets, Shear bond strength, Rebonding.

Introduction

In orthodontics as well as in other dental field there is a trend to simplify the technical procedure to reduced operative time and treatment cost. Accidental dislodgement of an orthodontic bracket, due to occlusal trauma or intentional removal of a bracket in order to reposition it to achieve ideal occlusal goals, are common occurrences in orthodontic treatment. The orthodontist are faced with the decision of what to do with used brackets, in order to reduced the waste and cost, for both the orthodontist and the patients.

One solution is to recycle the brackets. The recycling process basically consists in removing bonding agent remnants from the bracket base, thus allowing the brackets to be reused.

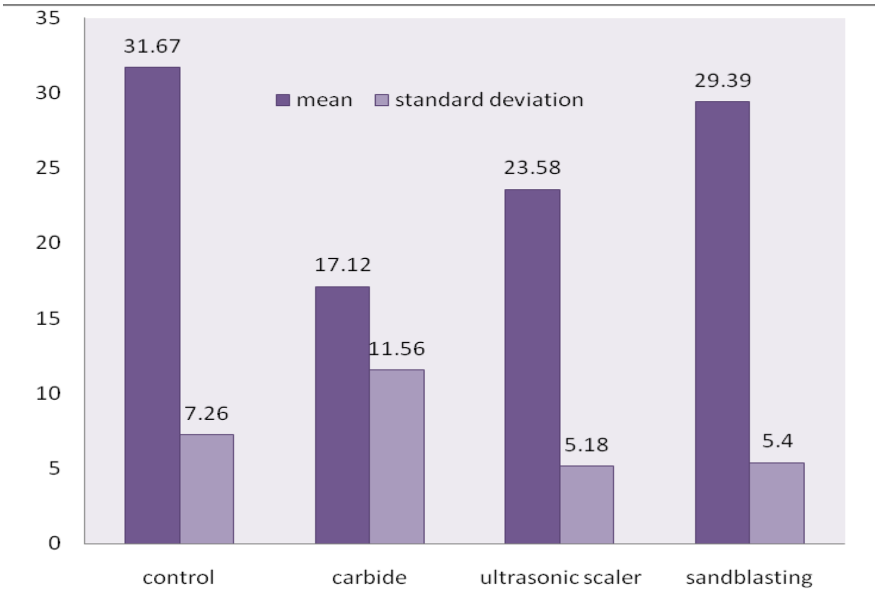
Method

Eighty non-carious human premolar, extracted for orthodontic reasons, was collected from department of Oral-surgery and private dental clinic in Durg. Rinsed in tap water, scraped with a LeCron spatula to remove periodontal tissue remnants and stored in saline at 4^{o} c up to 6 month until use. Teeth were embedded in chemically activated acrylic resin, leaving only the crown exposed. 80 samples were divided into 4 Groups each group contain 20 sample. One control group (group A) and three experimental groups (group B, group C and group D). Step by step bonding procedure was performed. The bracket of all 3 experimental groups was debonded within 30 minutes after bonding to simulate the clinical condition at which a newly bonded bracket was tied to the arch wire. In group A (control group) the bonded brackets was remain attached to tooth surface until shear testing i.e, no debonding/ rebonding procedure was performed. Following bracket debonding, three different recycling method was performed on experimental groups to remove the resin layer from the bracket base prior to rebonding. Group B: Bracket base cleaned with slow speed round carbide bur. Group C: Bracket base cleaned with ultrasonic scalar. Group D: Bracket base cleaned with aluminum oxide sand blaster. Rebonding of recycled bracket was being performed. The specimen was then stored in distil water for 24 hours until shear bond test. After 24 hours bond strength testing was carried out on a computer control electromechanical universal testing machine at the solid material testing laboratory. An occluso-gingival load at 0.5 mm/minute crosshead speed was applied at the bracket adhesive innterface and shear/peel stress was recorded in Mpa.

Descriptive statistics

Table 1: Comparison of bond strength among various experimental groups

Experimental group	No of samples	Mean	Standard deviation
Control (group A)	20	31.6745	7.26854
Carbide bur (group B)	20	17.1215	11.56954
Ultrasonic scaler (group C)	20	23.5820	5.12496
Sandblasting (group D)	20	29.3985	5.40917



Graph 1: Mean bond strength in Mpa, of various groups

All groups contain 20 samples, group A (control group) have mean value of 31.6 Mpa while the experimental groups that is group B (bracket base cleaned with slow speed round carbide bur) have mean value 23.5 Mpa, group C (bracket base cleaned with ultrasonic scalar) have mean value 17.1 Mpa and the group D (bracket base cleaned with aluminum oxide sandblasting) have mean value 29.3Mpa.

This table shows that control group in which no debonding and rebonding procedure was performed has highest shear bond strength followed by experimental group D, in which bracket base was cleaned with aluminum oxide sandblasting and experimental group C, in which bracket base was cleaned with ultrasonic scalar while the last experimental group B in which bracket base was cleaned with slow speed round carbide bur have least shear bond strength.

Table 1

ANOVA					
bond strength	**Sum of Squares**	**df**	**Mean Square**	**F**	**p value**
Between experimental Groups	2543.765	3	847.922	14.003	.001*
Within Groups	4601.995	76	60.553		
Total	7145.760	79			

*p value ≤ 0.05 was considered statistically significant

Inter group comparison by applying one way Anova between all experimental groups that is group B, group C and group D showed statistically significant difference between all experimental groups having p value 0.001 (p > 0.05).

Post Hoc Tests

Multiple Comparisons

Dependent Variable: bond strength

Tukey

Table 2

(I) group	(J) group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Control	carbide	14.55300*	2.46074	.000*	7.8867	21.2193
Control	scaler	8.09250*	2.46074	.009*	1.4262	14.7588
control	sandblasting	2.27600	2.46074	1.000	-4.3903	8.9423
Carbide	scaler	-6.46050	2.46074	.063	-13.1268	.2058
Carbide	sandblasting	-12.27700*	2.46074	.000*	-18.9433	-5.6107
Scaler	carbide	6.46050	2.46074	.063	-.2058	13.1268
Scaler	sandblasting	-5.81650	2.46074	.124	-12.4828	.8498

*p value ≤ 0.05 was considered statistically significant

Discussion

Shear bond strength of new and recycled brackets has been a subject of great interest in orthodontic research. Several techniques have been used for recycling of orthodontic brackets i.e. removal of resin remnants and reuse of debonded brackets, including the removal of resin by ultrasonic scalar, by slow speed round carbide bur or by aluminum oxide sand blasting machine. But to determine which one of the recycling procedure proven to be more clinically efficient and has a superior bond strength was the aim of this study.

Aluminum oxide sandblasting has been proved a good option for bracket recycling by offering a simple, easy-of-handle technique. Sandblasting can be performed in the dental office, which reduces the costs and working time.

The results of this study showed no statistically significant difference among the control brackets and aluminum oxide sand blasted brackets. The good mechanical retention between the enamel surface and the sandblasted recycled brackets is probably due to the fact that this method creates an effective micro roughened surface on the bracket base, which increases the area available for composite bonding in comparison to the control brackets. This finding agrees with the findings of other authors.[1] Another study used GAC brackets (9.9 mm2) and light-cured resin showed no statistically significant difference between aluminum oxide air-abraded recycled brackets and new brackets regarding their retention.[6] However, sandblasting efficiency also depends on bracket type.[7]

Another two groups, group B (bracket base cleaned with slow speed round carbide bur) and group C (bracket base cleaned with ultrasonic scalar) showed significant reduction in the shear bond strength. Recycling procedure reduces the effectiveness of the retentive elements of the base as well as incomplete removal of composite resin thereby affecting the bond strength of bracket. The reduction in shear bond strength of the experimental group in this study seems to confirm the finding of various other studies.[10,11] However the value of this study does not correlate with that of other studies reported in the literature in which brackets were bonded with Concise Orthodontic chemically cured composite resin system[1] and also the variation in the standardization of procedures. In this study shear bond test was carried out on computer controlled electromechanical universal testing machine while the other similar studies used 4411 model Instron machine,[1] Instron universal testing machine model 3366.[5] and technically it is proven that computer controlled UTM gives more accurate results that manual UTM. Bracket recycled by slow speed round carbide bur had the smallest shear bond strength of all groups; it may be assumed that this method is the least indicated for direct bracket recycling. The use of 50µm aluminum oxide particle stream has been recommended for bracket recycling to increase retention by creating a roughened surface. The outcome of this study demonstrated that bracket recycling using 50µm aluminum oxide sandblasting was efficient and technically simple and might provide cost reduction alike and the time taken to sandblast is shorter than other method.

Conclusion

There are many techniques to recycle the debonded brackets, but to determine which one of the recycling procedure proven to be more clinically efficient, and has superior bond strength been the aim of this study.

The recycling of debonded bracket with aluminum oxide sandblaster has given out better results over the other two techniques. The bracket recycling by this technique had a better bond strength. Hence from this study sandblasting technique proved to be more efficient and satisfactory to the clinician with respect to bond strength.

Sand blasting technique was the most superior method for recycling followed by ultrasonic scalar method and lastly the carbide bur method.

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