A Comparative Study between Bond Strength of Rebonded and Recycled Orthodontic Brackets

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ABSTRACT

Introduction: A large number of orthodontists prefer to rebond the failed bonded brackets or use recycled brackets in some instances. The aim of this study was to compare the shear bond strength of rebonding with using recycled brackets on enamel surface.

Methods: Bonding of brackets on the surface of extracted first bicuspids was tested in five different groups to compare their shear bond strength (SBS): Group N, new bracket on enamel surface of newly extracted teeth as a control group; Group R, recycled bracket on newly extracted teeth; Group NR, new bracket on the cleaned enamel surface of previously bonded teeth with Tungsten Carbide bur; Group RE, reused bracket on cleaned surface of previous teeth; and RR group, with brackets undergone two times of recycling on the newly extracted bicuspids. Adhesive Remnant Index was specified for each group.

Results: The highest SBS was related to control group (group N) which rated as 12.00 Mpa, and the next scores were related to groups NR, RE, RR, and R with 11.85, 10.80, 10.00 and 9.94 Mpa, respectively. The differences between groups N and NR with groups R and RR were significant.

Discussion: Rebonding had no significant effect on reduction of SBS. Tungsten Carbide burs are suitable for removing of remaining composite from brackets and enamel surface and finally, chemically recycled brackets had a clinically acceptable SBS.

Key words: bracket, chemical recycling, shear bond strength

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Introduction

In 1968 zinc polyacrylates were introduced for attachment of brackets to dental surface by Smith[1]. Then, diacrylate resins were used as sealants and adhesive materials[2]. Finally, Bowen resin or bis GMA was introduced as a basic part of modern composite materials with high strength and large cross linking for attachment of brackets to enamel surface[3]. Despite the significant improvement in quality of adhesive masterials, more than 5-7% of brackets attachment failure is seen clinically[4], which need to be rebonded. In some instances, it is required to replace the brackets. Clinicians can choose new or recycled brackets or reuse the detached ones.

In 1980 Perry found that by appropriate preparing of enamel surface, etching, and placing a new bracket, there is a similar bond strength comparable with first time bonding[5].

Chen and Mascia launched a study on 20 upper central incisors, and found that there is no difference in retentive strength after four times of rebonding [6].

Bonding system and method of removal of residual composite have no significant effect on bonding strength after rebonding [7].

Reduction of bonding strength after rebonding with the use of new brackets has been reported from 20% to 40% in different studies, based on the different methods of bonding [7, 8, 9, 10].

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Sonis found that, with the use of air abrasion bond strength after rebonding may remain the same as the first time bonding [11]. Using Tungsten Curbide burs for cleaning off the brackets before rebonding, produce a favourable shear bond strength and pattern of failure[12].

Bracket recycling can change the slot dimension and may reduce shear bond strength of them. Depending on bracket design, manufacturing process, and thermal or chemical recycling, up to 35% of reduction has been reported in shear bond strength [6].

Wheeler and Ackerman in 1983, launched a study on recycling of brackets and found that thermal recycling might result in reduction of mesh thickness of brackets down to 7%, but it had no direct effect on shear bond strength of these brackets [13].

Powers and Wright reported a 25% to 65% reduction in shear bond strength following recycling of brackets through reduction of mesh diameter[9].

The aim of this study was to compare the shear bond strengths of new brackets with rebonded and recycled ones.

Materials and Methods

Sixty recently extracted first maxillary bicuspids with no caries and no structural defects, which had been stored in fresh water, were used in this experimental study.

Standard Edgewise metal brackets with foil meshed base (Dentarum Corp. Germany) and No-mix composite (Dentarum Corp. Germany) were used. At first, buccal surface, of 40 teeth were cleaned with fluoride free pumice and rinsed, and then were etched for 30 seconds with 37% phosphoric acid gel (Dentarum Corp. Germany). Next, they were sprayed with distilled water for 15 seconds and dried by hair dryer. These 40 teeth were divided into two groups of "N" and "R". In group "N", new brackets were directly bonded to enamel surfaces and in group "R" chemically recycled brackets were bonded on the conditioned enamel surfaces.

Bonded samples were mounted vertically in acrylic blocks by means of a specific designed axis made of a wire welded vertically to the jig (figure 1), and stored in incubator in 37°c water for 48 hours and then debonded using a universal testing machine (8500 Instron Engineering co. Canton, Mass.) at a cross head speed of 5mm/min (figure 2). Shear bond strength (SBS) was recorded in Newton and then calculated in mPa. The debonded surfaces were examined under a stereo microscope and scored by Adhesive Remnant Index (ARI) into four groups:

Group 0: no remained composite on the enamel surface,

Group 1: less than half of composite remained on the enamel surface,

Group 2: half of composite remained on the enamel surface, and

Group 3: all of composite remained on the teeth.

After debonding, remnants of composite were removed by TC burs from the enamel surfaces and bracket bases and after conditioning of enamel surfaces, 20 new and 20 reused brackets were bonded on the surface of previous teeth which were cleaned by TC bur and etched for 30 minutes (groups NR and RE, respectively) in the same way of the 2 earlier groups. 20 recycled brackets were sent for another recycling and then bonded on 20 newly extracted teeth in the same manner (RR group).

Statistical analysis was done using SPSS soft ware (ANOVA and Duncan tests).

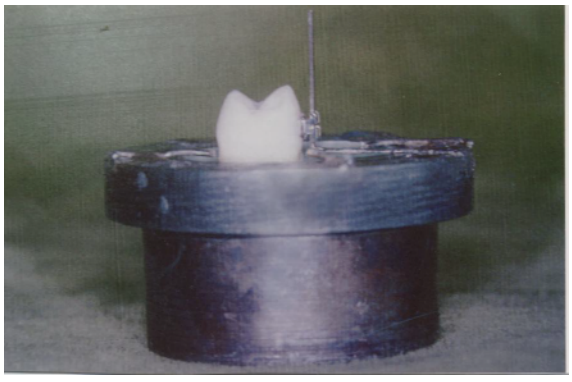

Figure 1: Stabilizing axis for mounting the samples vertically in the cylinder

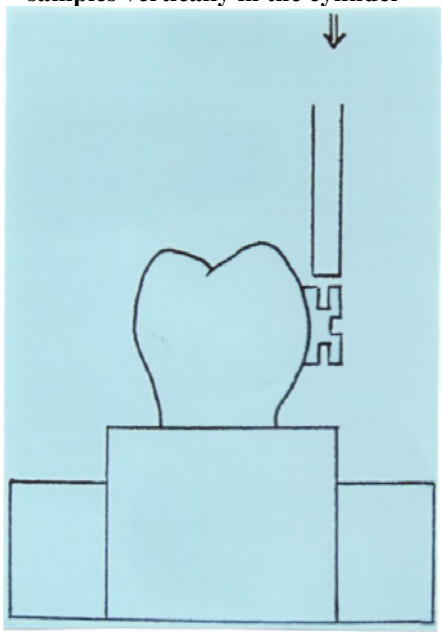

Figure 2: Debonding of brackets with vertically cross-head vertically

Results

Means, Standard deviation and standard errors for SBS in different groups are shown it table 1.The highest score is for the group N as a control.

There was significant differences in SBS between group R and both groups N and NR, as well as significant differences between group RR and both groups N and NR ($P<0.05$).

ARI scoring in different groups is shown in table 2. Pearson analysis showed a significant difference in ARI scoring between R and NR groups with others, so that the highest amount of remained composite on the enamel surface was in group R and on the contrast, the least amount of remained composite on the enamel surface after debracketing in group NR was seen (Table 3).

Table 1: MeaN. SD and SE in experimented groups

Group	N	Mean	Standard Deviation	Standard Error	CI 95%		min	Max
					Min	Max		
N	20	12.0015	2.4756	.5536	10.8429	13.1601	8.81	18.04
NR	20	11.8550	2.4973	.5584	10.6862	13.0238	7.55	17.21
R	20	9.9440	1.9179	.4289	9.0464	10.8416	6.71	13.01
RR	20	10.0070	1.8194	.4068	9.1555	10.8585	6.71	13.85
RE	20	10.8045	1.8436	.4122	9.9417	11.6673	7.96	14.27
Total	100	10.9224	2.2678	.2268	10.4724	11.3724	6.71	18.04

Group N, new bracket on enamel surface of newly extracted teeth as a control group; Group R, recycled bracket on newly extracted teeth; Group NR, new bracket on the cleaned enamel surface of previously bonded teeth with Tungsten Carbide bur; Group RE, reused bracket on cleaned surface of previous teeth; and RR group, with brackets undergone two times of recycling on the newly extracted bicuspids.

Table 2: ARI scores for experimental groups

ARI score	N	NR	R	RR	RE
0	0	1	0	0	0
1	8	13	3	8	7
2	11	6	14	11	13
3	1	0	3	1	0

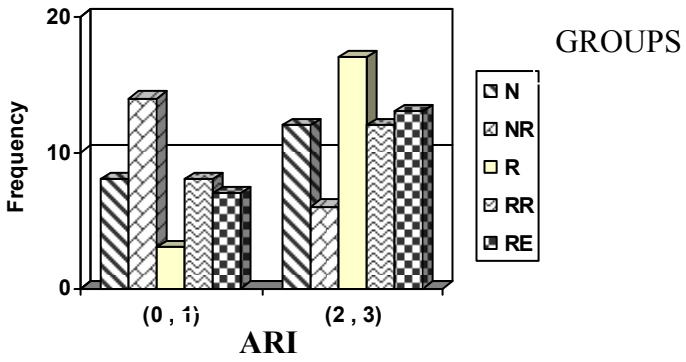

Table 3: Diagram of frequency of low and high ARI score in experimental group

Discussion

In our study, the mean value of SBS was 12.00 mPa for new brackets at the first time of bonding for No-mix composite which is a clinically acceptable value.

Rebonding of a new bracket on the enamel surface had no significant effect on its SBS as has been shown previously in other studies [5, 6, 8, 12, 14]. Using TC burs for removing of remained composite on the base of brackets produces a rough surface without any other traces in contrast with what stones or sand blasters do[12]. No significant difference was observed in SBS between reused and new brackets, which is contrary to some previous researsches in which removing of composits has been done by greenstone or sand blasting [7, 9, 10].

In recycled brackets there was a statistically significant but clinically not important reduction in SBS, which was lower than what are in most of other studies [6, 8, 15] due to excluding of electropolishing during the process of recycling. Electropolishing can distort [8, 15] and reduce the size of bracket mesh [8]. Reyclying the brackets for the second time had no effect on their SBS.

Despite the clinically non-significant reduction in SBS after recycling, clinicians ought to pay close attention to slot size, reduction in corrosion resistance, and sterility of them. ARI in groups NR and R were approximately 0 and 3, respectively. This difference was significant ($P<0.05$). In case of recycled brackets, increase in ARI might be due to changes in bracket meshes.

Conclusions

1- Rebonding of a new bracket had no significant effect on SBS.
2- Removing of the composite remaining on the bottom of the bracket by TC bur can minimize the reduction in SBS.
3- Chemical recycling of brackets without electropolishing for one or two times can maintain the SBS in a clinically accepted limit.
4- After debonding of recycled brackets, remained composite was mainly on the enamel surface which is in contrast with new brackets.

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