Comparison of the shear bond strength between new and recycled brackets: An in vitro study

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Abstract

Aim: There are currently many patients who need orthodontic treatment. Given the high expense of orthodontic therapy and the fact that orthodontic brackets are recyclable elements, this study was carried out to compare the shear bond strength of new and recycled brackets in vitro.

Materials and Method: Thirty healthy extracted first premolars without cracks or decay were selected. The teeth were randomly assigned to two groups and etched by 37% phosphoric acid for 30 seconds. An icy surface was obtained and brackets (018 standard, Dentaurum) were assigned equally to two groups of 15 new and recycled brackets each. After 500 round thermo-cycling in temperatures between 5 $^{\circ}C$ and 55 $^{\circ}C$, Shear bond strength was obtained by dividing the force by bracket cross-sector. The Adhesive Remnant Index (ARI) and the Enamel detachment index (EDI) were evaluated.

Results: Average shear bond strengths for the new and recycled brackets were 17.5717±7.3929 Mpa and 16.6811±5.3899 Mpa, respectively. There were no significant differences in shear bond strength between the twobrackets.Furthermore, no significant difference was observed in EDI and ARI ratios.

Conclusion: With respect to shear bond strength, recycled brackets may be a viable option for fixed orthodontic treatment in clinical practice.

Key words: Recycled brackets, shear bond strength, fixed orthodontic.

The primary purpose of recycling brackets is to complete the process of removing adherent materials from the bracket without damaging or weakening the matrix behind the bracket or causing dimensional deformities in the bracket's groove. The recycling process for orthodontic brackets involves a heat or chemical method [1]

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as well as includes electropolishing of recycled brackets to reduce any roughness or coarseness on the surface.[2] This is done not only for the patient's convenience but is also essential for reducing corrosion in the next bracket usage. Electropolishing should be used with low current intensity and for a short period of time.[3] During electropolishing, the bracket's groove shape is not affected considerably.[4] The effects of recycling are dependent on the recycling method, the type of steel used in bracket-making and the type of bracket pad (mesh or non-mesh). The recycling process may affect the bracket by changing its physical, chemical and dimensional properties. In Eliades[5] research on recycled brackets' properties, it was determined that no considerable change in mass and surface of the bracket was made after recycling. According to Martina and Tarvare [6, 7], on shear bond strength in recycled and new brackets showed that the

bond strength of the recycled bracket was more appropriate for clinical usage. In a study comparing shear bond strength in various types of new after recycling brackets, Mascia 8 removed bonding material from the enamel the second time by scaling with manual tools and pumice powder. They noticed that an increase in the repetition of recycling had no effect on shear bond strength. Regan 9 reported that an increased number of recycling cycles was an effective factor in reducing tensioning bond, however; this reduction was not significant. He reported that new brackets, in comparison with recycling used brackets, through any method, resulted in little difference (i.e., the change was not statistically significant) in tensioning bond strength. Bishara [10] has examined the effect of bracket bond renewal on one tooth three times and reported that the highest shear bond strength occurs during the first bonding. In a clinical 12-month study, Cacciafesta [3] compared bond breaking in new and recycled orthodontic brackets. Cacciafesta reported that the ratio of breaking in recycled brackets between the anterior and posterior teeth, as well as the mandibular and maxillary teeth was not significantly different with new brackets. The analysis of the breakage position showed that in two groups of patients, the brackets had separated at the connection point of the enamel with the adhering material and that most of the adhering material was adherent to the bracket; no enamel damage was observed clinically[5]. A study by Tavares[7] showed that there was no statistically significant difference between the control brackets, the brackets recycled by aluminum oxide blasting and the new brackets attached to previously bonded teeth. Tavares concluded that bracket recycling using 90-microm aluminum oxide particle air-abrasion was efficient, technically simple and might result in a cost reduction for both orthodontists and patients.

Materials and Methods

In a lab experimental study, 30 healthy premolars that were without cracks or decay and that were pulled out in an orthodontic period were chosen. To prevent dehydration, they were preserved in physiologic serum until all samples were obtained; they were also washed every day. Before connection strength testing, fixation of the teeth was required. For this purpose, an empty metal frame, of 25 mm height and 21 mm internal diameter, was made through turnery. The samples were etched by 37% phosphoric acid within 30 seconds. After washing with water and drying by air flow, an icy surface was obtained. The samples were grouped into new and recycled (chemical method) brackets. After etching, the brackets were first bonded to the tooth by self-curing Alphadent composite in such a way that its furrow was perpendicular to the longitudinal axis of the tooth; then, a 17× 25 mil steel wire was placed in the slot of bracket, and it was fixed by ligature wire. The teeth were transferred into the cylinder with a 17× 25 mil wire in such a way that this wire was tangent to the cylinder edge, which was parallel with the horizon; all of the teeth were fixed by semi-liquid acryl injection into the cylinder in acrylic blocks, parallel to the perpendicular. Samples were conserved in serum.

After one day, all of the samples were thermocycled between 50C and 550C at 500 rpm (30 seconds in a warm bath followed by 30 seconds in a cool bath at 20-second intervals). The bond strength of the bracket was measured using an Instron at 0.5mm/min; the cross-sector surface of each bracket was 10.87 mm (the cross-sector surface of the bracket was confirmed by e-mail correspondence with the Dentarum Company). The shear bond strength (Mega Pascal) was obtained by dividing the force for separating the brackets from the tooth surface (Newton) by the bracket's cross-sector surface (2mm). The sample, the tooth and bracket separated from its surface were studied by light microscope at a magnitude of 10X. Thus, ARI was recorded, in accordance to Bishara's suggested index (Scale 1: all composite remained on the tooth; Scale 2: more than 90% of the composite remained on the tooth; Scale 3: more than 10%, but less than 90% remained on the tooth; Scale 4: less than

10% remained on the tooth; Scale 5: No composite remained on the tooth); EDI (Enamel Detachment index) and were also studied .[11] Using SPSS software (version 10.5), the shear bond strength was calculated; and Student's t-test was performed to determine differences between the groups with respect to shear bond strength.

Results

In this study, the average strength needed for separating the bracket from the tooth in the recycled brackets group was 16.6811 ± 5/3899 Mpa, while it was 17/5717+3929 Mpa in the new bracket group; this difference is not statistically significant. Other indicators with respect to the two groups are shown in Table 1.

Table 1: Mean, variance, standard deviation, minimum, maximum and range of exerted strength in the studied groups.

Group	Mean SBS(MPa)	Standard Deviation	Minimum SBS (MPa)	Maximum SBS (MPa)	Range
New bracket	17.5717	1.9077	6.72	37.78	31.7
Recycled bracket	16.6811	1.3917	8.82	27.71	18.89

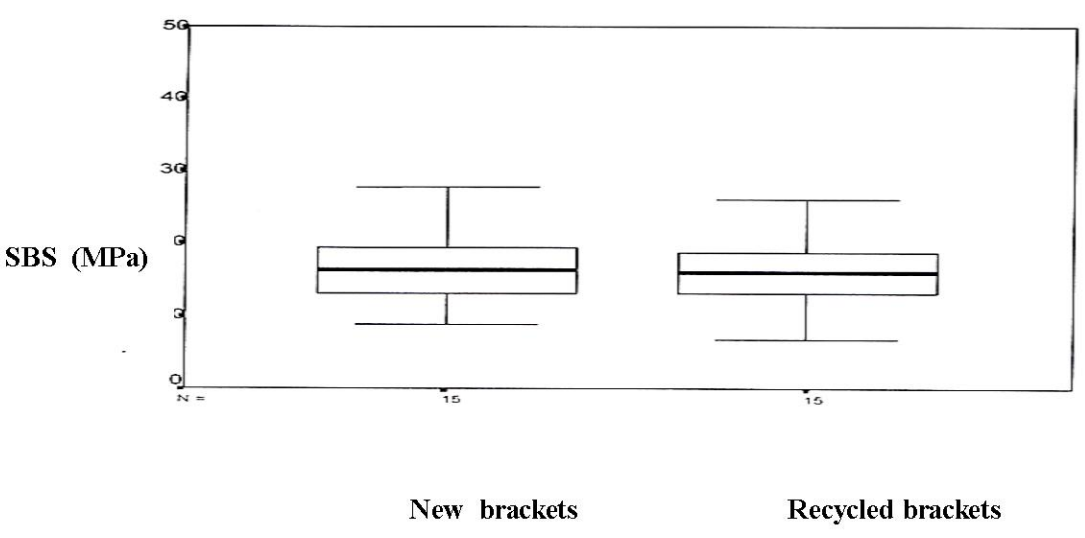

Figure 1: Comparison of sheer bond strength (Mpa) in new and recycled brackets

In this investigation, there was no difference between the average shear bond strength among the two groups (p=0.7091). Sharma-sayal also compared the shear bond strength of new brackets and used brackets recycled via sand blasting; after accounting for the time factor, energy used for cleaning and the possibility of damage to the base of the bracket, there were no differences between these two groups.12 The possible physical changes that occur during the recycling process may affect bond strength. Martina's research showed that there was no significant difference between the shear bond strength of new and recycled brackets and concluded that recycled brackets were appropriate for chemical use6, which is in accordance with this investigation. Moreover, in Eliades' research on the properties of recycled brackets, it was determined that no considerable change was made in bracket mass and surface before and after recycling5.

In every respect, it seems that there are no considerable physical changes made to the bracket during the recycling process and that recycled brackets can be used again in the clinic. Regarding the separating amount from the Caccifests' study, no significant difference was observed after separating the new and recycled brackets from anterior and posterior teeth and also from mandibular and maxillary teeth 11, which are in agreement with our investigation.

It seems that the crucial factor is preparing the enamel surface gain; otherwise, recycling will not have a significant effect on bond strength. However; in reconnecting brackets (whether new or recycled) to the surface of a tooth whose previous bracket was accidentally separated, special care in the renewed preparation of the enamel surface is needed. If the preparation is done properly, there will be no concern about bond strength, and using recycled brackets has economic and ecological advantages. In the present study, there was no statistically significant difference in shear bond strength between recycled and new metal brackets. In the future, research on shear bond strength between new and recycled ceramic brackets should be conducted.

Conclusion

Based on the results of our investigation, the bonding potential of recycled brackets is good and, as such, recycled brackets may be a suitable option for clinical use.

Acknowledgment

We would like to thank Mr. Farhad Sattar Dabaghi and the Shafagh Laboratory.

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