International Journal of Applied Research

ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 5.2
IJAR 2018; 4(6): 60-62
www.allresearchjournal.com
Received: 14-04-2018
Accepted: 15-05-2018

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Comperative evaluation of shear bond strength of different type of brackets: An *in vitro* study

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Abstract
Ceramic brackets provide better esthetics for orthodontic treatment, but main concern of orthodontic treatment is bond strength and bond strength of ceramic brackets needs to be evaluated. Forty human premolars recently extracted for orthodontic purposes were used in this research divided into two groups. Group I consisting of teeth bonded with metallic brackets and group II consisted of teeth bonded with ceramic brackets. Group I showed a mean shear bond strength of 25.1 Mpa, with standard deviation of ± 6.3 while Group II had a mean shear bond strength of 35.9 Mpa, with standard deviation of ± 12.3.All bond strength values of the brackets used in this study were greater than this minimum requirement and within clinically acceptable ranges. The difference between group I and group II was statically significant. Ceramic brackets showed more bond strength than metallic brackets.

Keywords: Shear bond strength, ceramic brackets, study

Introduction

Ceramic brackets were introduced because of increasing aesthetic demands from orthodontic patients [1]. Since their introduction, product design and clinical performance has greatly improved and the superior aesthetics of ceramic brackets and the resistance to discolouration are well accepted. Aesthetic brackets in adult patients have been in demand in recent years. There are three types of ceramic brackets currently available in the market, polycrystalline and mono crystalline (single-crystal) aluminas [2, 3]. Ceramic brackets are also quite strong; they are more difficult to deform and have a higher tensile strength than the stainless steel brackets[4]. With metallic brackets, the critical question for the clinician is whether the bond is too weak to withstand the forces applied during orthodontic treatment. With ceramic brackets, the concern is whether the bond is too strong for safe debonding. The aim of this *in vitro* study was to evaluate the SBS of different metallic and ceramic bracket bonding combinations using conventional primer. For the purpose of this study, the null hypothesis assumed that there were statistically significant differences between SBS values and the site of bond failure of metallic and ceramic brackets bonded to enamel.

Methodology

Forty human premolars recently extracted for orthodontic purposes were used in this research. The criteria for tooth selection included no caries or cracks, no pre-treatment with a chemical agent such as alcohol, formalin, or hydrogen peroxide, or any other form of bleaching. Their buccal surfaces were intact, and they had not been subjected to any type of treatment. All the collected teeth were cleaned of blood and saliva and they were stored in a buffered saline solution at room temperature. The teeth were placed vertically in a self-cure acrylic and the crowns were exposed avoiding contact between the resin and tooth. The buccal surfaces were pumiced, washed with a spray, and dried with compressed air before enamel preparation. They were divided into 2 groups of 20 teeth each.

All the extracted teeth were cleaned with a scaler and then with a fine pumice on a slow speed conventional hand piece. A 37% phosphoric acid solution was applied to each enamel surface with a disposable foam pellet, for 30 seconds. The teeth were then rinsed for 20 seconds and air dried.

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After surface preparation, in group I primer was applied to the etched surface and left uncured. Standard edgewise premolar metallic brackets with a base surface area of 12 mm were bonded to the teeth using light cure adhesive whereas group II was treated the same as group 1, except that ceramic brackets were bonded to the teeth. The average surface of the orthodontic bracket base of 14 mm.
An Instron Universal Testing Machine was used to record the bond strength in the shear mode. The experiments were conducted at a room temperature of 25 ^{0}C. The prepared acrylic blocks were positioned in the Instron Universal Testing Machine with the long axis parallel to the direction of the load application. A load side density of 0-50 Kgs was set in the Instron Universal Testing Machine and the cross head speed was adjusted for 1 mm per minute. A progressive load was applied till the bracket was debonded from the tooth surface. The load at which the bracket debonded was recorded in Newtons and subsequently calculated in Mega Pascals using the formula.

$$\text{Shear bond strength (Mpa)} = \frac{\text{F (Debonding force in Newtons)}}{\text{D X L mm}^2\text{ (bracket base area)}}$$

Where D = Width of the bracket base and
L = Height of the bracket base

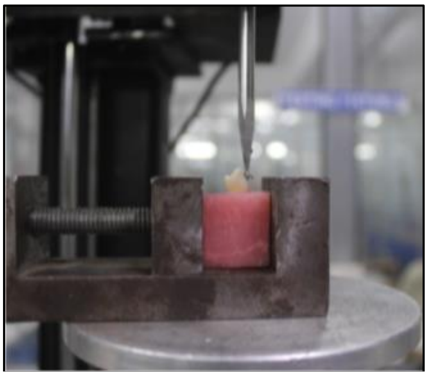

Fig 1: Showing bracket Debonding

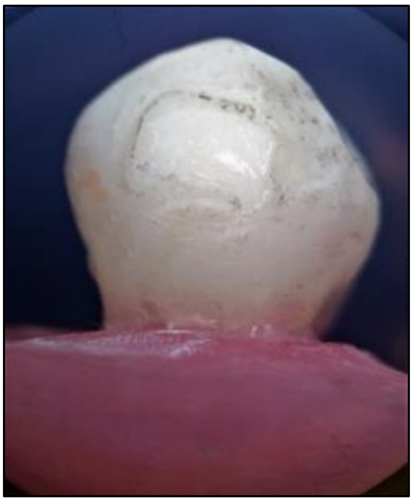

Fig 2: Showing Debonded sample

Results

The recorded data was compiled and entered in a spreadsheet (Microsoft Excel) and then exported to data editor of SPSS Version 20.0 (SPSS Inc., Chicago, Illinois, USA). Analysis of variance (ANOVA) Tukey–honestly significant difference procedure was employed for comparing sheer bond strength. Graphically the data was presented by bar diagrams. A P-value of less than 0.05 was considered statistically significant. The results of this study evaluating the Shear bond strength of metal and ceramic brackets at a speed of 1mm/min of the cross head of the instron machine (recorded in Newtons and Mpa) were tabulated in Table 1. Group I consisting of metal brackets showed a mean shear bond strength of 25.1 Mpa, with standard deviation of ± 6.3 while Group II consisting of ceramic bracket had a mean shear bond strength of 35.9 Mpa, with standard deviation of ± 12.3.

Table 1: Showing shear bond strength among various groups

Group	N	Mean	SD
I	20	25.1	6.3
I	20	35.9	12.3

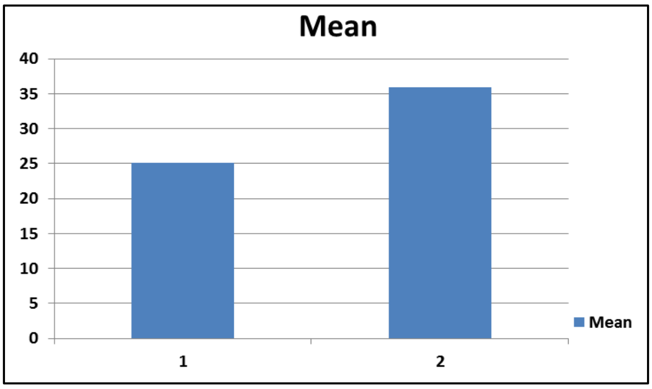

Fig 3: Comparison Graph Between two groups (Mean)

Table 2: Comparison between two groups

S. No.	Comparison between groups	Calculative p-value	Result
	Group I vs Group II	$p < 0.05$	Significant

Discussion

Recently adult patients demand orthodontic treatment with ceramic brackets, but some clinicians remain concerned about their bond strength. Metal brackets, though they are aesthetically inferior to ceramic brackets, can be deformed considerably without fracturing, even in the presence of impurities and at sharp intersections [5]. Metal brackets are available at relatively lower cost as compared to ceramic brackets. Ceramic brackets bond to the tooth surface by forming both mechanical and chemical bonds. Silanisation of the bracket because of the silane coupling agent is responsible for the chemical bond and it improves the bond strength. Because of a significant increase in the bond strength, the stress of debonding can also be shifted from the bracket – adhesive interface to the adhesive-enamel interface, which is likely to damage the enamel surfaceduring the debonding procedure [6].
The mean SBS of the group I, teeth bonded with metal brackets (25.1 ±6.3MPa) was more than group II with ceramic brackets (mean SBS = 35.9 ± 12.3MPa). Reynolds (1975) suggested that a minimum bond strength of 5.9–7.8 MPa is adequate for routine clinical use. All bond strength values of the brackets used in this study were greater than this minimum requirement and within clinically acceptable ranges. The difference between group I and group II was statically significant. These findings were similar to previous studies [8, 9].

Varying SBS values for ceramic brackets have been reported in the literature. Earlier studies indicated that ceramic brackets with a silane-treated chemical base had significantly higher mean bond strengths than metallic brackets that ranged between 18.8 and 28.3 MPa (Joseph and Rossouw, 1990). Mundstock *et al.*

Conclusion

The ceramic brackets showed higher bond strength as compared to metallic brackets under dry conditions.

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