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Clinical Evaluation of Shear Bond Strength of Orthodontic Brackets Bonded to Zirconium Crowns: An Observational Study

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ABSTRACT

Background: Zirconia is used as a framework, and, as it presents relative opacity, it is covered with porcelain containing optical properties similar to those of natural teeth. We planned the present study to clinically evaluate the shear bond strength of orthodontic brackets bonded to Zirconium Crowns.

Materials & methods: The present study included evaluation and comparison of shear bond strength of orthodontic brackets bonded to Zirconium Crowns. Thirty samples of all-zirconium ceramic, on which orthodontic brackets were bonded, 15 metallic and 15 ceramic polycrystalline brackets were made. Simplified method of bonding of the orthodontic brackets to the crown surface was used for avoiding the effect of base surface design. Same operator bonded the orthodontic brackets following the same protocols. Universal force testing machine was used for assessing the shear bond strength.

Results: Mean shear bond strength of the specimens bonded with metallic bracket was 8.02 MPa, while mean shear bond strength of the specimens bonded with ceramic bracket was 5.13 MPa respectively. Significant results were obtained while comparing the mean shear bond strength of the subjects of the metallic bracket group and ceramic bracket group.

Conclusion: In comparison to the ceramic brackets, metallic brackets bonds more strongly to the all zirconium crowns because of their better retentive properties.

Keywords: Bond strength, orthodontic bracket, Zirconium.

INTRODUCTION

Metal ceramic fixed partial dentures (FPDs) are considered the gold standard, as reliable materials. However, the request for esthetic dentistry as well as the rising question regarding biocompatibility of dental alloys, support the commercialization of new products. Nowadays, all-ceramic prostheses are replacing, more and more, metal-based restorations.[1-3] A variety of ceramic systems are developed for single crowns or fixed dental prostheses (FDPs) with an excellent esthetic outcome. Zirconia is used as a framework, and, as it presents relative opacity, it is covered with porcelain containing optical properties similar to those of natural teeth. However, this type of restoration has residual stress generated by thermal issues and hence is susceptible to fracture.[4-6] Various mechanical or chemical methods other than etching protocol on the enamel are recommended in different types of ceramics, as well as in zirconium, in order to avoid difficulties in treating adults with fixed orthodontic appliances.[6] Hence; we planned the present study to clinically evaluate the shear bond strength of orthodontic brackets bonded to Zirconium Crowns.

MATERIALS & METHODS

The present study was conducted in the department of orthodontics and prosthodontics of JNIMS Dental

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College, Imphal. and it included evaluation and comparison of shear bond strength of orthodontic brackets bonded to Zirconium Crowns. Ethical approval was obtained from institutional ethical committee in written before the starting of the study. Thirty samples of all-zirconium ceramic, on which orthodontic brackets were bonded, 15 metallic and 15 ceramic polycrystalline brackets were made. Simplified method of bonding of the orthodontic brackets to the crown surface was used for avoiding the effect of base surface design. Same operator bonded the orthodontic brackets following the same protocols. Universal force testing machine was used for assessing the shear bond strength. All the results were recorded in Microsoft excel sheet and were analyzed by SPSS software. Chi- square test was used for assessment of level of significance. P- value of less than 0.05 was taken as significant.

RESULTS

A total of 30 specimens were analyzed and were broadly divided into two study groups based on the type of bracket used. Mean shear bond strength of the specimens bonded with metallic bracket was 8.02 MPa, while mean shear bond strength of the specimens bonded with ceramic bracket was 5.13 MPa respectively. Significant results were obtained while comparing the mean shear bond strength of the subjects of the metallic bracket group and ceramic bracket group.

DISCUSSION

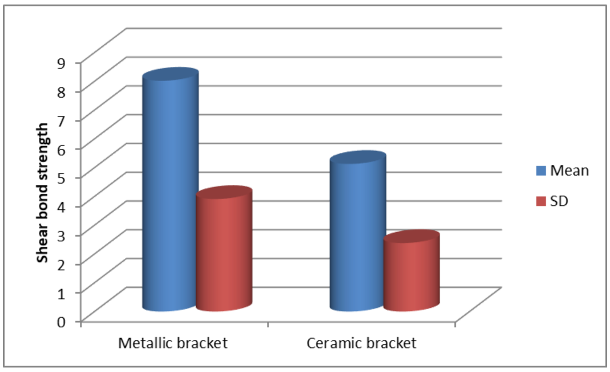
The mechanical properties of zirconia allowed them to be used in posterior FPDs and permit substantial reduction in core thickness. Composition, grain size, shape of the zirconia particles, type and amount of the stabilizing oxides, interaction of zirconia with other phases and processing are also factors that have impact on the metastability of the transformation.[7, 8]

A total of 30 specimens were analyzed and were broadly divided into two study groups based on the type of bracket used. Mean shear bond strength of the specimens bonded with metallic bracket was 8.02 MPa, while mean shear bond strength of the specimens bonded with ceramic bracket was 5.13 MPa respectively. Blakey R et al tested the effect of different surface treatments on the shear bond strength of metal and ceramic orthodontic brackets bonded to temporary polycarbonate crowns. Eighty polycarbonate crowns for the maxillary right central incisor were evenly divided into 4 groups, and the facial surfaces were subjected to one of the following conditions: group A (control): no treatment; group B: the surface was sandblasted with 50 mum aluminum oxide particles; group C: the glazed surface was removed with a diamond bur; and group D: the surface was etched with 9.6% hydrofluoric acid. Precoated Victory metal brackets (3M Unitek, Monrovia, Calif) were bonded to the facial surface of half (n = 10) of the polycarbonate crowns in each group, and precoated Clarity ceramic brackets (3M Unitek) were bonded to the facial surface of the other half (n = 10). Each was debonded with a shear load in a universal testing machine at a crosshead speed of 0.254 mm per minute, and the adhesive remnant index (ARI) was used to analyze the sites of bond failure. There was a significant difference between group B (sandblasting) and all other ceramic and metal groups. In the metal groups, there was a slight difference between group C (diamond bur) and

Table 1: Mean Shear bond strength of both the types of brackets.

Shear bond strength	Metallic bracket	Ceramic bracket
Number of specimen	15	15
Mean	8.02	5.13
SD	3.91	2.38
p- value	0.02 (significant)	

Graph 1: Mean Shear bond strength of both the types of brackets.



group A (control). According to the ARI, sandblasting was the only surface treatment to significantly affect the adhesion of metal and ceramic brackets to polycarbonate crowns. There was no statistically significant difference between the metal and ceramic brackets in group B (sandblasting). There was a statistically significant difference between metal and ceramic brackets in each group, with the exception of group C (diamond bur), which was just below statistical significance. Metal and ceramic orthodontic brackets bonded to temporary polycarbonate crowns will most likely not withstand the forces of orthodontic biomechanics.[9]

In the present study, significant results were obtained while comparing the mean shear bond strength of the subjects of the metallic bracket group and ceramic bracket group. Bishara SE et al compared the shear bond strength of the new collapsible bracket with a traditional ceramic bracket. Sixty-one Clarity collapsible ceramic brackets, 41 Transcend 6000 brackets, and 21 Victory Series metal brackets were bonded to the teeth with the same bonding system. The Zwick Universal Test Machine was used to determine the shear bond strength of 21 teeth bonded with the new bracket and 20 teeth bonded with the Transcend brackets. The same testing device was used to determine the compression force levels needed to debond 20 collapsible brackets and 21 metal brackets. Pliers were used to debond both the new ceramic brackets and Transcend brackets to determine the mode of bond failure. After debonding, all teeth and brackets were examined under 10x magnification. Any adhesive remaining after bracket removal was assessed according to the Adhesive Remnant Index (ARI). The findings indicated that the shear bond strength of the new Clarity ceramic bracket was comparable to that of a conventional ceramic bracket. Similarly, there were no significant differences in the results of the compression tests comparing the magnitude of forces needed to deform and debond both the new ceramic and metal brackets. The ARI scores for both the shear and compression tests indicated a similar bond failure pattern when the new collapsible brackets were compared with either the conventional ceramic or metal brackets. On the other hand, the chi-square test results indicated that, when debonding pliers were used, there was a significantly greater incidence of an ARI score of 1 with the collapsible brackets. This indicated that, when debonding the new brackets with the Weingart pliers, there was a greater tendency for most of the adhesive to remain on the enamel surface. In conclusion, the main advantage of the Clarity ceramic brackets is that they can be debonded in the same manner as metal brackets. When the new ceramic brackets are debonded with the Weingart pliers, most of the residual adhesive remained on the enamel surface, a pattern that is similar to the one observed with metal brackets. The failure at the bracket-adhesive interface decreased the probability of enamel damage but necessitated the removal of more residual adhesive after debonding.[10] Mehmeti B et al performed a comparative analysis of the shear bond strength (SBS) of metallic and ceramic orthodontic brackets bonded to all-zirconium ceramic surfaces used for prosthetic restorations. Twenty samples/semi-crowns of all-zirconium ceramic, on which orthodontic brackets were bonded, 10 metallic and 10 ceramic polycrystalline brackets, were prepared for this research. SBS has been testedby Universal Testing Machine, with a load applied using a knife edged rod moving at a fixed rate of 1 mm/min, until failure occurred. The force required to debond the brackets was recorded in Newton, then SBS was calculated to MPa. In addition, the samples were analyzed using a digital camera magnifier to determine Adhesive Remnant Index (ARI). Higher shear bond strength values were observed in metallic brackets bonded to zirconium crowns compared tothoseof ceramic brackets, with a significant difference. During the test, two of the ceramic brackets were partially or totally damaged. Metallic brackets, compared to ceramic polycrystalline brackets, seemed tocreate stronger adhesion with all-zirconium surfaces due to their better retention mode.[11]

CONCLUSION

From the above results, the authors conclude that in comparison to the ceramic brackets, metallic brackets bonds more strongly to the all zirconium crowns because of their better retentive properties. However; further studies are recommended.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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