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Original Research

A Clinical Comparison of Failure Rates of Metallic and Ceramic Brackets

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ABSTRACT:
Background: To compare clinical failure rates of metallic and ceramic brackets. **Materials & methods:** A total of 20 subjects with diagnosed malocclusion that required two-arch fixed appliance treatment were enrolled. The results were analysed using SPSS software. P- value is statistically significant as less than 0.05. **Results:** A total of 384 brackets were bonded, 200 of which were metallic brackets and 184 were ceramic ones. In the 12-month observation period, there were 10 metal (5%) and 2 ceramic bracket (1.1%) failures. The overall failure rate was 3.2% (n = 12). **Conclusion:** Metal brackets exhibited significantly higher failure rates than ceramic brackets for both 6- and 12-month observation periods ($p < 0.05$).
Keywords: ceramic brackets, metal brackets, failure.

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INTRODUCTION

Esthetics has always been an important factor in orthodontic treatment. The manufacturers of metal brackets tried to improve esthetics by decreasing the stainless steel bracket dimensions and minimizing the metal part. [1] Ceramic brackets were later introduced to obviate the esthetic needs of orthodontic patients. [2,3] At present, ceramic brackets are made of aluminum oxide. [4] These brackets have advantages such as biocompatibility, optimal esthetics, resistance to chemical and thermal changes, and adequate bond strength. [5] The mechanism of bonding of ceramic brackets can be mechanical or chemical. Evidence shows that the bond strength of composite to ceramic brackets with chemical bonding mechanism is higher than that with the mechanical bonding mechanism and is almost as high as the bond strength to the enamel. This increases the risk of enamel cracks and fracture. [6,7] Thus, ceramic brackets with mechanical bonding mechanism are preferred to ceramic brackets with chemical bonding mechanism. Bonding is an integral part of orthodontic treatment. It involves etching as primary procedure. Acid etching technique was first introduced by Bounocore for an improved bonding to the tooth structure in 1955. [8] Since then, there has been magnificent progress in direct bonding of orthodontic brackets. Orthodontic bonding has evolved significantly since it was first introduced by Buonocore in the 1950s. [9] Primer may be used as part of the bonding process and with light-cured composite; it is usually unfilled resin. Its primary purpose is enamel

surface penetration to improve the effectiveness of the final bond. [10] Nonetheless, there is controversy in the literature regarding the use of primers because differences in the adhesion of orthodontic brackets to enamel with or without previous priming of the enamel surface have not been substantiated. [9]

Bracket failure occurs at one of the three locations within the enamel-adhesive-bracket complex: between the tooth enamel and the adhesive, within the adhesive, or at the adhesive-bracket interface. The adhesive-enamel interface has been well tested as evidenced by numerous articles dedicated to both in vivo and in vitro tests. These surveys mostly assessed the application of self-etching primer which is still controversial. [11-13] The evaluation of identical adhesive systems and two different orthodontic brackets makes it possible to compare the bond strength between the adhesive and the bracket. However, there are few inconsistent results of in vitro tests that compare the bond strength of metal and ceramic brackets with the enamel. Some authors do not observe statistically significant differences between metal and ceramic brackets subjected to shear or tension bond strength testing. [14,15] Hence, this study was conducted to compare clinical failure rates of metallic and ceramic brackets.

Materials & methods

A total of 20 subjects with diagnosed malocclusion that required two-arch fixed appliance treatment were enrolled. They were divided into 2 groups as 10 subjects in each. Group 1 was metallic brackets; group 2 was ceramic brackets. In a year time period, all bracket failures were recorded. The received data were processed statistically. The results were analysed using SPSS software. P- value is statistically significant as less than 0.05.

Results

A total of 384 brackets were bonded, 200 of which were metallic brackets and 184 were ceramic ones. In the 12-month observation period, there were 10 metal (5%) and 2 ceramic bracket (1.1%) failures. The overall failure rate was 3.2% (n = 12).

Table 1: number and percentage of bracket failure

Bracket type	Bonded N	Failures after 1 year, N	Failures after 1 year, %
Metallic	200	10	5
Ceramic	184	2	1.1
Total	384	12	3.2

After 6- and 12-month observation periods showed that metal brackets have a greater risk of failure than ceramic ones ($p < 0.05$).

Table 2: significance after 1year

Types and duration	P –value
Ceramic brackets (6 months)	0.02
Metal brackets (6 months)	
Ceramic brackets (12 months)	0.01
Metal brackets (12 months)	

Discussion

This study investigated the detachment rates of the ceramic and metallic brackets. The failure rate of the ceramic brackets in our study was 1.1%. To date, no data have been reported in relation to the failure rates of the ceramic brackets bonded with composite adhesive and self-etching primer. Hitmi et al. [16] reported a similar failure rate of 0.7% for the ceramic brackets bonded with Fuji Ortho LC, light-cured glass-ionomer resin-modified adhesive. Higher values were obtained by Årtun, [17] who compared the failure rates of the ceramic brackets with mechanical or chemical retention and found 1.7% and 3.2%, respectively. Recently, Stasinopoulos et al., [18] in retrospective study, reported a detachment rate of the ceramic brackets of 20%. Hence, this study was conducted to compare clinical failure rates of metallic and ceramic brackets.

In the present study, a total of 384 brackets were bonded, 200 of which were metallic brackets and 184 were ceramic ones. In the 12-month observation period, there were 10 metal (5%) and 2 ceramic bracket (1.1%) failures. The overall failure rate was 3.2% (n = 12). A study by Oginski T et al, a total of 381 brackets were bonded, 195 of which were metallic brackets and 186 were ceramic ones. In the 12-month observation period, there were 14 metal (7.2%) and 2 ceramic bracket (1.1%) failures. The overall failure rate was 4.2% (n = 16). The majority of failures (14 brackets; 87.5%) occurred during the first 6 months of the experiment, 12 (83%) of which were metal brackets and 2 (100%) were ceramic brackets. The statistical analysis revealed significant differences between the groups ($p < 0.05$). [19]

In the present study, after 6- and 12-month observation periods showed that metal brackets have a greater risk of failure than ceramic ones ($p < 0.05$). Another study by Sharma, Shreya et al, a total of 100 extracted human premolar teeth were divided into 2 main groups A and B which were further subdivided into: Group A1 – metallic brackets bonded with primer; Group A2 – ceramic brackets bonded with primer; Group B1 – metallic brackets bonded without primer; group B2 – ceramic brackets bonded without primer. The SBS of these brackets was measured. The SBS of group A2 was significantly higher than the other groups, group A1 was the second highest, group B3 was the third highest and group B4 was the least significant. The adhesive remnant index was lowest on failure of ceramic brackets bonded with primer. [20] Bond strength of orthodontic brackets to the enamel should be high enough to maintain the brackets in place during the treatment period. It must be high enough to resist occlusal loads as well. On the other hand, very high bond strength is not favorable since it increases the risk of enamel fracture and subsequent pulp injury after

debonding. According to Reynolds, [21] bond strength as high as 5.9–7.8 MPa can resist masticatory forces. It is clinically favorable and minimizes enamel fracture. Bond strength higher than 14 MPa can cause enamel cracks on the tooth surface. [21] Shear bond strength (SBS) depends on several factors, including the size and design of bracket base, thickness and type of adhesive, bonding technique, type of bracket, and experience of the clinician. [22] A direct comparison of the study results is difficult due to the different experiment protocols concerning brackets, adhesive systems, tooth enamel preparation, curing time, curing power, number of operators, length of the study, and the age of the patients. In this study, the failure rate of the metal brackets was seven-times higher than that of the ceramic brackets and this difference was statistically significant ($p < 0.05$). These results are in agreement with the study by Hitmi et al., [23] who compared the detachment rates of the metal, plastic, and ceramic brackets bonded with resin-modified glass-ionomer adhesive and, similarly to our study, discovered a statistically larger percentage of failures of metal brackets than ceramic ones. The difference in the failure rates between the metallic and ceramic brackets found in our study is hard to explain. In the laboratory study, Benkli et al. [24] showed that shear bond strength of the Radiance bracket bonded to human enamel is twice as high as that of the metallic ones. On the other hand, Oginski at al. [25] did not find statistical differences between the bond strength of Radiance brackets and metallic brackets bonded with the self-priming system and colour changing Grengloo adhesive to bovine enamel. Despite the conflicting results of the in vitro investigations, the difference in the failure rates may be contributed to the different degree of cure of the orthodontic adhesive under brackets made from different materials. Eliades et al. [26] investigated the degree of cure of the adhesive under brackets under the irradiation modes used in our study. They found a significantly higher degree of cure of directly irradiated orthodontic light-cured adhesive under monocrystalline brackets in comparison with the indirectly irradiated adhesive under stainless steel attachments. Moreover, monocrystalline brackets had a diffuse visible light transmittance of 80% at 468 nm compared to almost no light transmittance of metallic brackets.

Conclusion

Metal brackets exhibited significantly higher failure rates than ceramic brackets for both 6- and 12-month observation periods ($p < 0.05$).

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