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Original Research

Comparison of bond strength of metal and ceramic brackets bonded with conventional and High-Power LED light curing units

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ABSTRACT:

Background: To compare bond strength of metal and ceramic brackets bonded with conventional and high power LED light curing units. **Materials & methods:** A total of 40 teeth were enrolled. Group A were metal brackets bonded with Transbond XT, Group B- ceramic brackets with high power light cured, group C- metal brackets with adhesive light cured conventionally and Group D- ceramic brackets with adhesive light cured. The SBS was measured. The results were analysed using SPSS software. **Results:** A total of 40 teeth were enrolled. The mean SBS of samples in groups A, B, C and D was 22.08, 11.6, 25.26 and 11.63MPa, respectively **Conclusion:** The obtained SBS is the same for both bracket types by use of high-power and conventional LED light curing units.

Keywords: Bond strength, Ceramic brackets, Metal brackets.

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INTRODUCTION

Orthodontic treatment is widely used in both children and adults. The number of adult orthodontic cases has increased dramatically over the past few years. [1] According to the American Association of Orthodontists, the number of adults opting for orthodontic treatment in the US and Canada increased by 16% between 2012 and 2014. [2] The increasing demand for orthodontic treatment keeps orthodontists chasing the optimal bonding strategy considering different brackets and surfaces. [3,4] Since most adult patients have dental restorations and/or prostheses, the bond strength of brackets to enamel and restorative material is a major concern during orthodontic treatment and later at the bracket removal. [5] Another concern is that the removal of the bracket may result in irreversible damage to the restorative and enamel surfaces. [5,6] Currently, all-ceramic restorations are widely used to restore missing or damaged enamel, and therefore several types of ceramics have been developed during recent years. The most common ceramic-based materials for veneering prosthetic structures include feldspar and leucite-based porcelain. [7,8]

The light-cure adhesives were widely accepted due to their advantages in comparison with other chemical-cure adhesives. These advantages include high primary bond strength, better physical characteristics because of air inhibition phenomenon, user friendly application, extended working time for precise bracket placement and better removal of adhesive excess; but they have three major disadvantages namely being time-consuming, hindering light transmission and polymerization shrinkage. [9,10] Since then, several new methods using different composites and light-curing units have been introduced for this purpose. The halogen lamp, also known as quartz halogen and tungsten halogen lamp, has been used as light-curing unit for many years, [11] and is the most common source of visible blue light for dental applications. This lamp contains a blue filter to produce light of 400–500 nm wavelength. [12] The wide spectrum of action, easy use and low-cost maintenance are the most favorable characteristics of halogen light curing systems. [11] Despite their popularity, halogen light curing units have several disadvantages. For example, their light power output is 1% of the total electric energy consumed. [13] Moreover, the lamp, reflector and filter wear out gradually. [14] Halogen bulbs have a restricted useful lifetime of about 40–100 hours. [15] Hence, this study was conducted to compare bond strength of metal and ceramic brackets bonded with conventional and high power LED light curing units.

Materials & methods

A total of 40 teeth were enrolled. The maxillary central incisors were used for the study. The teeth were divided into four groups (n=10). Group A were metal brackets bonded with Transbond XT, Group B- ceramic brackets with high power light cured, group C- metal brackets with adhesive light cured conventionally and Group D- ceramic brackets with adhesive light cured. Teeth surfaces were etched with 37% phosphoric acid for 20 seconds. After applying a uniform layer of adhesive primer on the etched enamel, composite was placed on the base of brackets. The samples were light cured according to the manufacturer's instructions and thermocycled. The SBS was measured. The results were analysed using SPSS software.

Results

A total of 40 teeth were enrolled. The mean SBS of samples in groups A, B, C and D was 22.08, 11.6, 25.26 and 11.63MPa, respectively. Two-way ANOVA revealed a statistically significant difference in SBS among the groups (P=0.004).

Table 1: The shear bond strength (SBS) values (in megapascals) of metal and ceramic brackets to tooth surfaces using high-power and conventional LED light curing units

Group	Curing time (s)	Mean
A	4	22.08
B	3	11.6
C	20	25.26
D	20	11.63

Discussion

The new LED curing units were launched simultaneously with the advancement of technology. First, these curing units generated light with an intensity of approximately 800–1000YmW/cm 2 , reducing the required light exposure time to 10 seconds. [16,17] Currently, some high-power LED curing units are able to emit light radiation with intensity of 1600–2000YmW/cm 2 , allowing shorter exposure times of six seconds for metal brackets. [18] Hence, this study was conducted to compare bond strength of metal and ceramic brackets bonded with conventional and high power LED light curing units.

In the present study, a total of 40 teeth were enrolled. The mean SBS of samples in groups A, B, C and D was 22.08, 11.6, 25.26 and 11.63MPa, respectively. A study by Chalipa J et al, the mean SBS of samples in groups A (high-power LED, metal bracket), B (high-power LED, ceramic bracket), C (conventional LED, metal bracket) and D (conventional LED, ceramic bracket) was 23.1±3.69, 10.7±2.06, 24.92±6.37 and 10.74±3.18MPa, respectively. The interaction effect of type of LED unit (high-power/conventional) and bracket type on SBS was not statistically significant (P=0.483). In general, type of LED unit did not affect SBS. Type of bracket significantly affected SBS ($P<0.001$). The ARI score was not significantly influenced by the interaction between the type of LED unit and bracket. [19]

In the present study, two-way ANOVA revealed a statistically significant difference in SBS among the groups (P=0.004). Another study by Pinho M et al, the two-way ANOVA full factorial design was used to compare TBS, SBS, and ARI on the surface and bracket type ($\alpha = 0.05$). There were significant differences in TBS, SBS, and ARI values per surface ($p < 0.001$ and $p = 0.009$) and type of bracket ($p = 0.025$ and $p = 0.001$). The highest mean SBS values were recorded for a ceramic bracket bonded to an acrylic surface (8.4 ± 2.3 MPa). For TBS, a ceramic bracket bonded to acrylic showed the worst performance (5.2 ± 1.8 MPa) and the highest values were found on a metallic bracket bonded to enamel. [20] Arash V et al, the mean shear bond strength values (MPa ± SD) were group HM=12.59, group SM=11.15, group HC=7.7, and group SC=7.41. Bond strength differences between groups HM and SM (p=0.063) and between HC and SC (p=0.091) were not statistically significant. There were significant differences between HM and HC and between SM and SC groups ($p < 0.05$). Insignificant differences were found in ARI among all groups. [21] The bond strength at the bracket–adhesive–substrate interface must withstand forces during orthodontic treatment, although it should also allow the removal of the brackets without fractures of those substrates, namely restorative materials or tooth enamel. [22] In fact, novel developments have been seeking an efficient and safe method for debonding brackets by using a wide variety of tools and procedures. [23,24] The detachment must occur at the bracket–adhesive interface to prevent any damage of dental surfaces. [23,25] The bond strength of the bracket to the tooth surface depends on many factors. The most important are study design, the material from which the bracket was made, the type of surface, the type of adhesive polymerization, and the etching procedure. [26-28] The bond strength between the bracket and tooth enamel is an extremely important issue in the context of the treatment of malocclusion. Re-fixing the brackets after they have become detached is a difficult and unpleasant task, involving mechanical trauma to the adjacent soft tissues of the oral cavity, as well as causing delay in obtaining the expected therapeutic effect. [29,30] Swanson et al. [31] showed that 40 seconds of curing by LED units results in a stronger bond, but 20 seconds of curing time also creates a bond strength higher than the required amount (>8MPa). In this study, 20 seconds of radiation was considered for the conventional unit for both bracket types and four seconds of curing for metal brackets and three seconds for ceramic brackets by high-power LED unit were considered. The mean bond strength for ceramic brackets was in the required range for both LED units; while the bond strength of metal brackets was higher than required. The lower bond strength of ceramic brackets could be due to the type of ceramic brackets used in this study. These types of brackets have no base design for micromechanical retention and also to reduce chemical bond strength; thus, chemical bond would only take place at the center of bracket base and this theorem was well observed when ARI scores were evaluated.

Conclusion

The obtained SBS is the same for both bracket types by use of high-power and conventional LED light curing units

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