Bond strength of orthodontic brackets to temporary crown

[1]Dr. Prashanth R, [2]Dr. Divya Swarup, [3]Dr. Deepak Singh, [4]Dr. Shanahaz K Saidalavi, [5]Dr. Farzzana Mehraj, [6]Dr. Shivani Arora

[1]Associate Professor, Department of Orthodontics, GDC& RI, VIMS Campus, Cantonment Ballari, India (**Corresponding author**)
[2,3]Professor, Orthodontics & Dentofacial Orthopedics, Awadh Dental College & Hospital, Jamshedpur, Jharkhand, India
[4]Reader, Orthodontics, Malabar Dental College and research center, Malappuram, Kerala, India
[5]Department of Orthodontic and Dentofacial Orthopedic, Post graduate student, Dental College, Azamgarh, India
[6]Senior Lecturer, Department of Prosthodontics, Desh Bhagat Dental College and Hospital, Mandi Gobindgarh, India

Abstract:

Background: This study was conducted to assess the Bond strength of orthodontic brackets to temporary crown. **Material and methods**: A bisacrylic composite was utilized to fabricate a total of seventy five discs, which were subsequently divided into five groups (n = 20) based on the type of surface treatment applied. The surface treatments included the use of black, blue, as well as green diamond burs, as well as sandblasting. Additionally, a control group was included in the study. The process of bonding metal orthodontic brackets to discs was carried out in a standardized conventional manner. The specimens underwent thermocycling, wherein they were exposed to five thousand cycles of alternate water baths at temperatures of five degrees Celsius and fifty five degrees Celsius. The shear bond strength test was conducted with a universal testing equipment. The surface treatment impact and features of debonded surfaces were analyzed using a scanning electron microscope (SEM). The analysis and classification of the remaining composite resin on the surfaces of the specimens were conducted using the adhesive remnant index. A one-way analysis of variance (ANOVA) was conducted with a significance level (α) of 0.05. **Results**: The average shear bond strength seen in the control group was documented as 10.63 ± 5.45 MPa, indicating a relatively higher value compared to the mean shear bond strength of 8.47 ± 4.11 MPa observed in the blue bur group. However, this difference was not statistically significant. However, the reported values were lower than the respective means seen in the green bur, black bur, and sandblasting. The results of the one-way analysis of variance (ANOVA) indicated a statistically significant difference in means throughout the five groups. However, when comparing the control and blue groups, a significant difference in shear bond strength was observed solely in relation to the sandblasting technique. **Conclusion**: The application of thermocycling conditions has been found to enhance the bond strength of orthodontic brackets through the process of sandblasting provisional crowns.

Keywords: Bond strength, brackets, crown, temporary.

Introduction:

The search for orthodontic treatments by adults is currently increasing, not only because of esthetics, but also because of frequently being an intermediate stage on oral rehabilitation.[1] Facing this new scenario, orthodontists often need to bond brackets to restorations and temporary crowns, since adult dentition is usually characterized by restorative treatments.[2] An issue regarding this procedure relies on the fact that bonding brackets to restorative materials is claimed to be more difficult than to natural teeth.[2,3] Although not many studies have been performed on provisional restorations, some showed less than the minimum bonding necessary to be able to perform tooth movement in the orthodontic treatment.[4-8]

Factors including physical, mechanical, handling properties and biocompatibility might influence the choice of a material for provisional restorations, which should work as protection of the pulpal tissues, and present esthetics and oral functions.[9]

Many materials are available on the market for provisional crown fabrication, such as polymethylemethacrylate (PMMA) resin and bisacryl composite resin. The best recommended PCM is bisacryl composite resin, as it showed low exothermic reaction during setting, better strength, color stability, and adequate marginal adaptation when compared to PMMA.[10] Orthodontic tooth movement requires different amounts of force to achieve clinical orthodontic movement. The ranges of force needed for translatory and extrusive movements are 70–120 g and 35–60 g, respectively. According to Reynolds, the minimum suggested tensile bond strength between orthodontic brackets and teeth is 6–8 MPa, which is required for clinical orthodontic tooth movement.[11]

Hence, this study was conducted to assess the Bond strength of orthodontic brackets to temporary crown.

Material and methods:

The power analysis for this investigation was conducted with a significance level (α) of 0.05 and a power (1-β) of 0.80. The largest disparity in mean share bond strength in MPa (9.33, 7.42) with a standard deviation of 1.73 was selected as the primary distinction between the two means for the success CD group utilizing Fuji Ortho LC brackets.

A set of 100 cylindrical specimens, each with a diameter of 10 mm and a height of 15 mm, were fabricated using bisacrylic composite material. This material is commonly used as a cold curing temporary crown material and was obtained from the manufacturer Success CD in Neumünster, Germany. The specimens were made following the instructions provided by the manufacturer. The bisacrylic material was provided in automix cartridges and injected into a standardized silicon mold measuring 10 mm by 15 mm. Subsequently, a glass slab was used to apply pressure and remove any excess material. The specimens were subjected to light curing using the Acteon Satelec tiny LED light cure device. The light cure was set to operate at a rapid mode intensity of 1250 mW/cm2. The end of the optical guide of the light cure was positioned directly onto the specimen for a duration of 30 seconds for each sample. Subsequently, all the specimens were preserved under ambient conditions in distilled water at a temperature of 3°C for a duration of 24 hours. The 100 specimens were allocated into 5 groups (n = 20) using a randomization process based on surface treatment.

The data analysis was conducted using SPSS-20.0, a software package developed by IBM, headquartered in Chicago, USA. The numerical data obtained from shear bond strength measurements were categorized into different groups, namely control, blue, green, black, as well as sandblasting. The mean and standard deviation were calculated for each group. To assess the normality of the data within each group, the Kolmogorov-Smirnov test was employed. The results of the test indicated that the data in each group followed a normal distribution. A one-way analysis of variance (ANOVA) was used to assess the differences in shear bond strength across the various groups. A p-value less than or equal to 0.05 was deemed statistically significant.

Results:

The average shear bond strength seen in the control group was documented as 10.63 ± 5.45 MPa, indicating a relatively higher value compared to the mean shear bond strength of 8.47 ± 4.11 MPa observed in the blue bur group. However, this difference was not statistically significant. However, the reported values were lower than the respective means seen in the green bur, black bur, and sandblasting. The results of the one-way analysis of variance (ANOVA) indicated a statistically significant difference in means throughout the five groups. However, when comparing the control and blue groups, a significant difference in shear bond strength was observed solely in relation to the sandblasting technique.

Table 1: Scores for the adhesive remnant index of all groups (n = 20) according to optical microscope (16x) analysis.

Groups	Score 0	Score 1	Score 2	Score 3
Control	12	03	04	01
Blue	08	05	06	01
Green	00	04	05	11
Black	00	04	03	13
Sandblasting	00	03	06	11

Score 0, no adhesive left on the crown surface. Score 1, less than half of the adhesive left. Score 2, more than half of the adhesive left. Score 3, all adhesive left on the crown surface, with a distinct impression of the bracket mesh.

Discussion:

Adequate retention of orthodontic fixed appliances throughout the full course of treatment plays a major role in the success of rendering orthodontics, rather than having a course of treatment that involves multiple bracket debonding incidences.[12] This study was conducted to evaluate and to compare the shear bond strength between orthodontic brackets and provisional crown material using common mechanical surface treatment protocols. The bisacrylic composite is recommended for provisional crowns over other provisional materials in cases that require combined prosthetic and orthodontic treatment for the long-term because of their superior mechanical properties and strength.[13] Hence, this material was used in this research. The bond strength between orthodontic brackets and provisional crown material should be strong enough to tolerate orthodontic forces without debonding; however, at the end of the orthodontic treatment, the brackets should be easily removed.[14] The magnitude of bracket bond strength needed to withstand orthodontic forces throughout the treatment is hard to determine in various oral conditions.

Hence, this study was conducted to assess the Bond strength of orthodontic brackets to temporary crown.

In this study, the average shear bond strength seen in the control group was documented as 10.63 ± 5.45 MPa, indicating a relatively higher value compared to the mean shear bond strength of 8.47 ± 4.11 MPa observed in the blue bur group. However, this difference was not statistically significant. However, the reported values were lower than the respective means seen in the green bur, black bur, and sandblasting. The results of the one-way analysis of variance (ANOVA) indicated a statistically significant difference in means throughout the five groups. However, when comparing the control and blue groups, a significant difference in shear bond strength was observed solely in relation to the sandblasting technique.

Fotovat F et al[15]determined and compared the shear bond strength of orthodontic brackets on temporary crowns made by three different methods.In this experimental study, disc form samples (N=54) were made in dimensions 8×1mm, according to the manufacturer's instructions. In this study, we had three groups (N=18) based on manufacturing methods (3D printing, conventional, and CAD/CAM). Following surface preparation of the samples, the brackets were bonded in the centre of the discs. Before the shear bond strength test, the samples were subjected to the thermocycling process. The shear bond strength of brackets was measured by Universal Testing Machine. Data were analysed by one-way ANOVA and LSD post hoc test.The findings indicated that the mean shear bond strength of orthodontic stainless-steel brackets on temporary crowns varied between CAD/CAM and 3D printing methods ($P<0.001$) and also between CAD/CAM and conventional methods ($P<0.001$). The mean shear bond strength of orthodontic stainless steel brackets on temporary crowns was not different between 3D printing and conventional methods (P=0.7).The shear bond strength of orthodontic stainless-steel brackets bonded to temporary crowns fabricated by conventional and 3D printing methods was similar, and the shear bond strength in the samples fabricated by CAD/CAM method was lower than other specimens.

Rambhia S et al[16]tested the hypothesis that there is no difference in the shear bond strength of brackets bonded to provisional crown materials (PCMs) using two adhesive agents.Four PCMs were tested: Integrity, Jet, Protemp, and Snap. Forty cylindrical specimens of 10 mm diameter x 5 mm were prepared for each PCM. Ten specimens from each group were bonded to one of the two brackets, Clarity or Victory, using one of the two adhesives, Fuji Ortho LC or Ortho Bracket Adhesive. The brackets were debonded in shear at a cross-head speed of 5 mm/min, and the shear bond strength (SBS) was calculated. The type of failure was visually determined. The numeric data were analyzed using three-way analysis of variance and Tukey multiple range test at alpha = .05.The mean SBSs ranged from 2.81 MPa to 9.65 MPa. There was a significant difference between Snap and the other three materials (P < .0001). There was no significant difference between the two brackets or the two adhesives (P > .05). The bond failure for all the specimens was of the adhesive type between the PCM and the adhesive resin.The PCM Snap yielded a significantly lower mean SBS value compared to the other three materials. No significant differences were found between the brackets or the adhesives. The bond failure was of the adhesive type.

Conclusion:

The application of thermocycling conditions has been found to enhance the bond strength of orthodontic brackets when used in conjunction with sandblasted provisional crowns.

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