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ORIGINAL ARTICLE

COMPARING TWO ORTHODONTIC BRACKETS BOND TO FLUOROSED AND NON-FLUOROSED ENAMEL- AN IN VITRO STUDY

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ABSTRACT:
Background: Orthodontic attachments must be able to bond to a wide range of tooth and prosthetic surfaces. Despite the high prevalence of fluorosis in many parts of India, only limited information is available on the integrity of the bond between orthodontic brackets and fluorosed teeth. **Study design:** The objective of this study was to measure and compare Shear Bond Strengths (SBSs) of metal and ceramic orthodontic brackets on fluorosed and non-fluorosed teeth. One hundred and twenty (60 fluorosed and 60 non-fluorosed) extracted premolar teeth were divided into four groups A to D, consisting of 30 teeth in each group.3M Espe Single Bond was used as an orthodontic adhesive to bond brackets on the buccal surface of each tooth. The experimental groups consisted of Group A, in which metal brackets were used and Group B, in which ceramic brackets were bonded to fluorosed teeth. Group C and D consisted of metal brackets and ceramic respectively, bonded to non-fluorosed teeth. An Instron testing device was used to debond and measure the SBSs. SBSs werecompared using ANOVA with posthoc analysis done using Dunnett's C test forpairwise comparisons. Significance was set at $P<0.05$. **Results:** Study results showed that SBS of Group B>Group C>Group D>Group A. Ceramic brackets bonded to fluorosed teeth had the highest SBS with a mean of 15.78 (SD=9.07) Megapascals (MPa), while metal brackets bonded to fluorosed teeth produced the lowest SBS of 8.41 (SD=4.68) MPa. The SBSs of ceramic brackets bonded to fluorosed teeth was significantly higher than that of SBS of metal brackets bonded to fluorosed teeth, but not significantly different from SBSs obtained from either brackets bonded to non-flurosed teeth. The adhesive if used to bond ceramic brackets to fluorosed teeth can produce adequate SBS for clinical use. **Conclusion:** Ceramic brackets can be used efficiently to bond to fluorosed teeth. A follow up study should be carried out to assess the nature of enamel damage caused during debonding of flourosed teeth. This is an in vitro study and thus the clinical application should be interpreted with caution.
Key words: Orthodontic bonding, Shear bond Strength, Fluorosis, Ceramic brackets, Metal brackets.

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INTRODUCTION:

Successful orthodontic treatment greatly depends on patient compliance and the ability of orthodontic attachments to withstand orthodontic and occlusal forces over the duration of treatment. Orthodontic attachments must be able to bond to a wide range of tooth and prosthetic surfaces. Successful bonding of orthodontic brackets depends on the nature of the enamel surface, enamel conditioning procedure, type of adhesive used and the shape and design of the bracket base. (1) Orthodontic bonding is based on the mechanical locking of an adhesive to irregularities in the enamel surface of the tooth and mechanical locks formed in the base of the orthodontic attachment. The recommended amount of shear bond strength (SBS) the orthodontic attachment should withstand has been estimated to be between 5.9 MPa and 7.8 Mpa during clinical use Enamel damage has been reported during debonding in cases where the tensile bond strength was above 14.5Mpa. (2) Ceramic brackets are made of high-purity aluminum oxide, and the brackets are available in both polycrystalline and mono crystalline forms. It is important to note that the SBS of polycrystalline ceramic brackets has been reported to be higher than that of stainless steel metal brackets. (3) Though aesthetic ceramic brackets have an advantage of being more cosmetic and have increased bond strength, they also come with some clinical shortfalls. They mayresult in increased enamel wear and enamel fracture during the debonding process.

The brackets are structurally harder and stronger than enamel. Dental fluorosis, prevalence is a condition caused by excessive ingestion of fluoride of more than 1-2 ppm during tooth development. (4) There are marked differences in the enamel structure between non-fluorosed and different degrees of fluorosed teeth. Fluorosed enamel may pose a huge challenge for orthodontists working in endemic fluorosed regions. (5) Many studies tested SBS on fluorosed teeth using metal bracket but the literature indicated that no study has tested for SBS using ceramic brackets. The aim of this in vitro study was therefore to evaluate and to compare the effects of fluorosis on the SBS achieved by directly bonding orthodontic ceramic and metal brackets to fluorosed teeth.

METHODOLOGY:

One hundred and twenty extracted human teeth were equally divided into fourGroups (A to D) and stored in distilled water. Teeth used in this study were classifiedaccording to the Thylstrup-Fejerskov Index (TFI).TFI has been shown to be more sensitive with regards to the lower degrees of fluorosis. The teeth for all the groups were mainly collected from dental colleges and clinics. Groups A and B together comprised of 60 fluorosed teeth selected according to the TFI and only fluorosed teeth classified as TF4-6 were used. Groups C and D constituted the control samples of 30 non-fluorosed teeth each. The teeth were embedded in acrylic blocks with only the crowns exposed (Figure 1). Each tooth was oriented with the Instron Material Testing Device, (Figure 2) shearing blade as a guide, so that it's labial surface is parallel to the force during the shear strength testing. In Groups A and C, metal orthodontic brackets having a mesh base, and in Groups B and D, ceramic monocrystalline brackets, were bonded to the teeth using the conventional bonding protocol (polish, etch, prime and bond). The bonding agent was polymerized with a conventional LED curing light for 15 seconds for ceramic brackets and 20 seconds for metal brackets. Bonded teeth were stored in distilled water for 24 hours before determination of the SBS and subsequent debonding. All the equipments and materials for bracket bonding are shown in figure 3. An Instron Material Testing Device was used for the debonding of brackets and for measuring the SBS. The shearing blade was set to move at a speed of 1mm/min during debonding. The shearing debonding force was directed occluso-gingivally and recorded in Mpa. Data on SBS of both fluorosed and non-fluorosed teeth were collected. Bond strengths were compared by an analysis of variance (ANOVA), which allowed comparison of the data associated with the metal and ceramic brackets together with that associated with the fluorosed and non-fluorosed teeth.

RESULTS:

The results as seen in Table 1 and Figure 4 show SBS in order of increasingstrength as: fluorosed teeth to metal (8.41 MPa) < non fluorosed teeth to ceramicbrackets (11.24 MPa) < Non Fluorosed teeth to metal (13.56 MPa) <fluorosed teethto ceramic brackets (15.78 MPa).Group A displayed significantly lower shear bond strength when compared with the group B. Group C displayed a significantly higher bond strength when compared with group A.

Figure 1: Teeth mounted in acrylic blocks

Figure 2: Instron material testing device with blade to see the parellism

Figure 3: Instruments and equipments for study

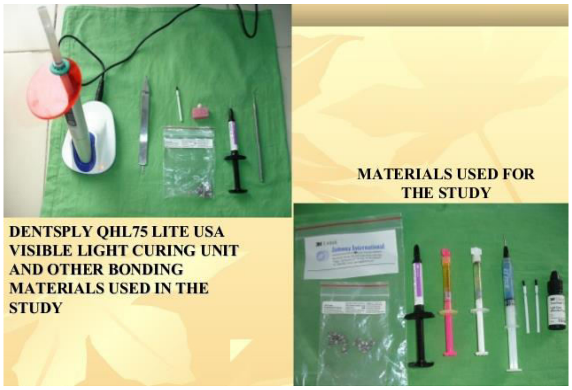

Figure 4: Mean Shear bond strength

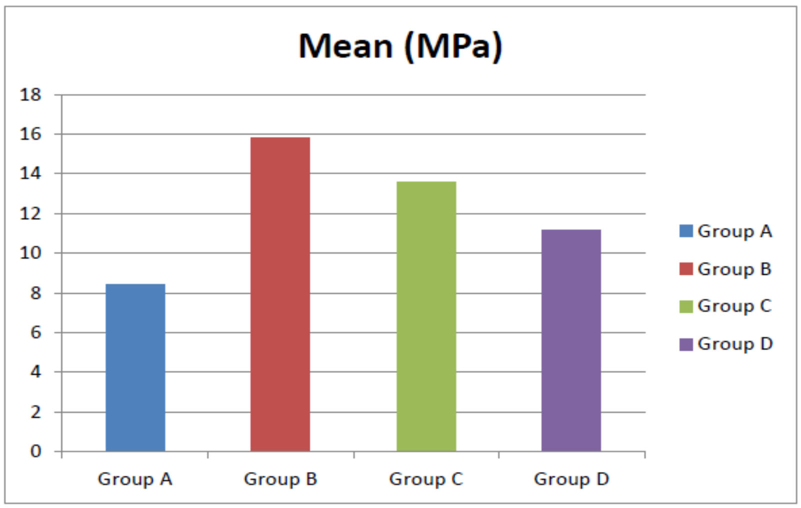

Table 1: Shear Bond strengths by group

Group	n(sample size)	Minimum	Maximum	Mean(Mpa)	Std. deviation
A	30	1.78	25.63	8.41	4.38
B	30	1.04	36.67	15.78	9.17
C	30	2.46	23.20	13.56	5.67
D	30	3.69	33.32	11.24	5.94

DISCUSSION:

Orthodontic bonding is based on the mechanical locking of an adhesive to irregularities in the enamel surface of the tooth and mechanical locks formed in the base of the orthodontic attachment. Ceramic brackets are made of high-purity aluminum oxide, and the brackets are available in both polycrystalline and monocrystalline forms. It is important to note that the SBS of polycrystalline ceramic brackets has been reported to be higher than that of stainless steel metal brackets Monocrystalline brackets have been reported to have higher bond strength than polycrystalline brackets. The occurrence of the enamel fractures previously reported during debonding is due to the high bond strength of ceramic brackets. Though aesthetic ceramic brackets have an advantage of being more cosmetic and have increased bond strength, they also come with some clinical shortfalls. They may result in increased enamel wear and enamel fracture during the debonding process. The brackets are structurally harder and stronger than enamel. (6) The morphology of the metal bracket base comprises of a metal mesh, yields adequate adhesive bond strength values to enamel. The enormously increased active surface area of the base resulted in much greater mechanical interlocking. Metal brackets rely on mechanical retention for bonding and a mesh base is the conventional method of providing this retention unlike ceramic brackets which may rely on chemical or mechanical factors or a combination of the two. (7) Debonding techniques are also mechanical and ideally create a fracture within the resin bonding material or between the bracket and resin with little or no damage to the enamel surface. Increasing the strength of bonding adhesives becomes a potential problem in debonding when the enamel surface may tear as the bracket base is pulled away from it. Ceramic brackets are more likely than metal brackets to be associated with enamel damage during debonding.(8) In this study, the mean SBS value ranges between 8.4 MPa and 15.7 MPa. These SBS were consistent with the ranges previously reported in a studies(7) In the later study, the SBS value ranges were found to be between 3.9 MPa and 18.6 MPa. Most of the adhesives available in the literature found bond strength between 5.9 MPa to 11.3 MPa (7,9)and few studies have reported SBS as high as 29.4 MPa (10,11). The minimum bond strength of between 5.9 MPa and 7.8 MPa has been established to be adequate for most clinical orthodontic needs.(12) The SBS obtained in this study for the two types of brackets irrespective ofthe tooth surface structure are therefore adequate for use in orthodontics. However, in the present study, when the teeth bonded to metal brackets were compared, it was found that the shear bond strength to fluorosed teeth was significantly lower (8.41 MPa) than that to non-fluorosed teeth (13.56 MPa). These observations were in agreement with the findings of studies by (13,14) However, in contrast to our findings other studies showed that there was no significant difference between the fluorosed and non fluorosed groups with regard to SBS (15,16). A review of the literature showed no previous studies comparing the SBS of ceramic orthodontic brackets between fluorosed and non-fluorosed teeth. In this study the orthodontic bonding of ceramic brackets to fluorosed teeth showed higher shear bond strength when compared to non-fluorosed teeth. However, the difference noted in these two groups was statistically insignificant. This observation therefore suggests that ceramic brackets would be adequate for clinical use on fluorosed teeth. The SBS of ceramic brackets have been found in previous studies to be higher than that of stainless steel brackets (2,6,10) It was therefore no surprise that our study also demonstrated (Pietersen K 2005) a significantly higher SBS when comparing fluorosed teeth bonded with ceramic brackets (15.7MPa) with those bonded to metal brackets (8.4 MPa). However, with regards to non-fluorosed teeth, this study found a statistically significant difference in SBSs between ceramic brackets (11.13MPa) and metal brackets (13.56 MPa); even though the SBS of ceramic brackets tended to be lower that of metal brackets. It is clear from studies reported in the literature that the bond strengths of orthodontic attachments to enamel vary greatly depending on the material used, the conditioning agent, the adhesive, enamel morphology, preparation of enamel surface, and the test conditions. Differences in testing equipment, crosshead speed, load cell application, storage media, thermocycling, test method (tensile shear) and variations in the site of force application, make comparisons between different studies difficult or even impossible.(17)This study has also few limitations. First, this was an in vitro study, therefore the performance of these materials under clinical conditions in vivo still needs to be established. Furthermore, considering the relatively high SBS obtained for ceramic brackets bonded into fluorosed teeth, there is a need for further examination of the nature of debonding to eliminate possibility for enamel fractures that may preclude the clinical use of these brackets, especially given that the metal brackets, which are alternatives for fluorosed teeth, also produced acceptable levels of SBS.

CONCLUSION:

Metal Brackets bonded to fluorosed teeth have the lowest SBS and ceramic brackets bonded to fluorosed teeth have the highest SBS. Metal brackets bonded to fluorosed teeth showed a significantly lower SBS when compared with the metal brackets bonded to non fluorosed teeth. Ceramic brackets bonded to fluorosed teeth showed higher, but no significantly different SBS when compared to ceramic brackets bonded to non-fluorosed teeth. This study thus concludes that both metal and ceramic brackets bonded to fluorosed teeth can be efficiently used in orthodontics.

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