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Comparing Two Orthodontic Brackets Bond to Fluorosed and Non-Fluorosed Enamel- An In Vitro Study

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ABSTRACT

Background: Patient compliance and the ability of orthodontic attachments to withstand orthodontic and occlusal forces over the duration of treatment is the key to successful orthodontic treatment. An orthodontic attachments should possess a good ability to bond with the wide range of tooth and prosthetic surfaces. Nature of the enamel surface, enamel conditioning procedure, type of adhesive used and the shape and design of the bracket base should be in a good condition for the successful bonding of the orthodontic brackets. **Methods:** One hundred extracted human maxillary premolar teeth were equally divided into four Groups (1 to 4) and stored in distilled water. TFI (Thylstrup-Fejerskov Index (TFI)) has been shown to be more sensitive with regards to the lower degrees of fluorosis that's why teeth used in this study were classified according to this index. Teeth having mild to moderate (TFI= 3-4) were included in this study. Groups 1 and 2 comprised of 25 fluorosed teeth Groups 3 and 4 constituted the control samples of 25 non-fluorosed teeth each. The teeth were embedded in acrylic blocks with exposed crowns. **Results:** The results in our study show Shear bond strength (SBS) in order of increasing strength as: fluorosed teeth to metal (8.40 MPa) < non fluorosed teeth to ceramic brackets (11.21 MPa) < Non Fluorosed teeth to metal (13.44 MPa) < fluorosed teeth to ceramic brackets (15.72 MPa). Group 1 displayed significantly lower shear bond strength when compared with the group 2. Group 3 displayed a significantly higher shear bond strength when compared with group1. **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.

Keywords: Orthodontic brackets, Enamel, Fluorosis.

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INTRODUCTION

Patient compliance and the ability of orthodontic attachments to withstand orthodontic and occlusal forces over the duration of treatment is the key to successful orthodontic treatment. An orthodontic attachments should possess a good ability to bond with the wide range of tooth and prosthetic surfaces. Nature of the enamel surface, enamel conditioning procedure, type of adhesive used and the shape and design of the bracket base should be in a good condition for the successful bonding of the orthodontic brackets.[1] Orthodontic bonding depends onto the theory of 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. Aluminium oxide is used for the fabrication of ceramic brackets which are available in both polycrystalline and mono crystalline forms. Estimated Shear bond strength (SBS) of polycrystalline ceramic brackets has been reported to be higher than that of stainless steel metal brackets.[2] While the recommended amount of SBS the orthodontic attachment should withstand has been estimated to be between 5.9 MPa and 7.8 MPa.[3]

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Aesthetic ceramic brackets are being more cosmetic and have increased bond strength, but they have few shortcomings also. They may result in increased enamel wear and enamel fracture during the debonding process. The brackets are made up structurally harder and stronger than enamel. The dental fluorosis is a condition that occurs due to the excessive ingestion of fluoride of more than 1-2 ppm during tooth development.[4] Significantly marked differences in the enamel structure between non-fluorosed and different degrees of fluorosed teeth has been noted down in the previous studies which proved that the fluorosed enamel may pose a huge challenge for orthodontists working in endemic fluorosed regions.[5] In literature various studies have been performed to test the SBS on fluorosed teeth using metal bracket but very less literature is available to test the SBS using ceramic brackets. So, the aim of our 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.

MATERIALS & METHODS

One hundred extracted human maxillary premolar teeth were equally divided into four Groups (1 to 4) and stored in distilled water. Thylstrup- Fejerskov Index (TFI)) has been shown to be more sensitive with regards to the lower degrees of fluorosis that's why teeth used in this study were classified

according to this index. Teeth having mild to moderate TFI (TFI= 3-4) were included in this study. Groups 1 and 2 comprised of 25 fluorosed teeth Groups 3 and 4 constituted the control samples of 25 non-fluorosed teeth each. The teeth were embedded in acrylic blocks with exposed crowns. In Groups 1 and 3, metal orthodontic brackets (Gemini bracket; 3M Unitek, Monrovia, California, USA) were used, and in Groups 2 and 4, ceramic monocrystalline brackets **(**Clarity advanced brackets,3M Unitek Monrovia, California, USA) were bonded to the teeth using the conventional bonding protocol. Tooth surfaces are etched for 15 second. The primer and adhesive resin of Transbond XT of 3M Unitek are used in this study. Polymerisation of the bonding agent was performed with a conventional LED curing light for 15 seconds for ceramic brackets and 20 seconds for metal brackets. Before determining the SBS and subsequent debonding, bonded teeth were stored in distilled water for 24 hours. The shearing blade was set to move at a speed of 1 mm/min during debonding. The shearing debonding force was directed occluso-gingivally and recorded in MPa. Bond strengths were compared by ANOVA test. P value > 0.05 considered to be significant.

RESULTS

Table 1: Number of Groups and the Sample Size

Group	N
1	25
2	25
3	25
4	25

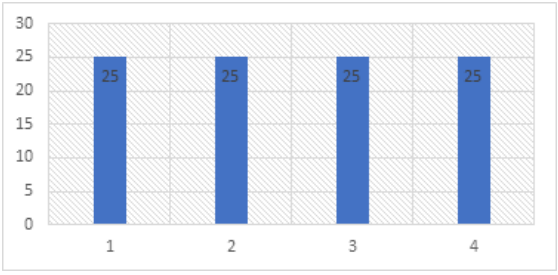


Table 2: Shear Bond Strength in Different Groups

Group	Minimum	Maximum
1	1.64	25.61
2	1.00	36.62
3	2.42	23.11
4	3.54	31.33

The results in our study show SBS in order of increasing strength as: fluorosed teeth to metal (8.40 MPa) < non fluorosed teeth to ceramic brackets (11.21 MPa) < Non fluorosed teeth to metal (13.44 MPa) < fluorosed teeth to ceramic brackets (15.72 MPa). Group 1 displayed significantly lower shear bond strength when compared with the group 2 (p>0.05). Group 3 displayed a significantly higher bond strength when compared with group 1 (p>0.05).

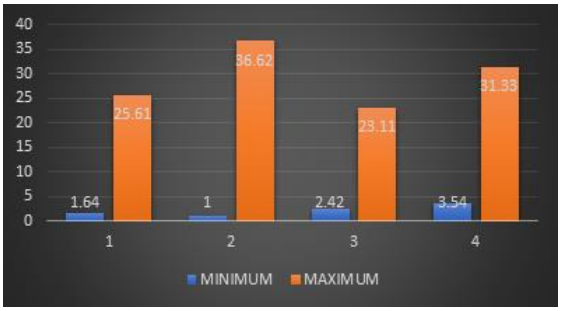
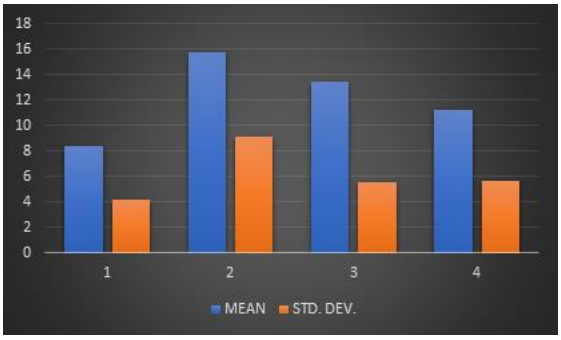


Table 3: Comparision of Shear Bond Strength in Different Groups

Group	Mean	Std. Deviation
1	8.40	4.22
2	15.72	9.12
3	13.44	5.55
4	11.21	5.64



DISCUSSION

Due to the high bond strength of ceramic brackets, the occurrence of the enamel fractures has been previously reported. Though aesthetic ceramic brackets have an advantage of being more cosmetic and have increased bond strength but they also come with some clinical shortcomings. Which may result in increased enamel wear and enamel fracture during the debonding process. The brackets are structurally harder and stronger than enamel.[6] Metal brackets depends 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] In our study, the mean SBS value ranges between 8.40 MPa and 15.72 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 and few studies have reported SBS as high as 29.4 MPa.[7-10] The minimum bond strength of between 5.9 MPa and 7.8 MPa has been established to be adequate for most clinical orthodontic needs.[11] The SBS obtained in this study for the two types of brackets irrespective of the 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 (8.40 MPa) than that to non-fluorosed teeth (13.44 MPa). These observations were in agreement with the findings of previous studies. 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.[12-15] 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 a significantly higher SBS when comparing fluorosed teeth bonded with ceramic brackets (15.72 MPa) with those bonded to metal brackets (8.40 MPa). However, with regards to non-fluorosed teeth, this study found a statistically significant difference in SBSs between ceramic brackets (11.21 MPa) and metal brackets (13.44 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.[16]

CONCLUSION

Metal Brackets bonded to fluorosed teeth have the lower SBS and ceramic brackets bonded to fluorosed teeth have the higher 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. Further studies are required in this area because there have been conflicting reports in the literature. 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

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