



African Journal of Biological Sciences

Journal homepage: <http://www.afjbs.com>



Research Paper

Open Access

Comparing two Orthodontic Brackets bond to Fluorosed and Non-Fluorosed Enamel - An in Vitro Study

¹Dr. Shrish Charan Srivastava ²Dr. Richa Singh ³Dr. Deepak Vishwakarma ⁴Dr. Swati Dubey ⁵Dr. Vikas Giri ⁶Dr. Amit Kumar Pandey

¹Professor & Head, Dept. of Orthodontics & Dentofacial Orthopaedics, Chandra Dental College and Hospital, Safedabad, Barabanki, Uttar Pradesh.

²Reader, Dept. of Orthodontics & Dentofacial Orthopaedics, Chandra Dental College and Hospital, Safedabad, Barabanki, Uttar Pradesh.

³PG 2nd Year, Dept. of Orthodontics & Dentofacial Orthopaedics, Chandra Dental College and Hospital, Safedabad, Barabanki, Uttar Pradesh.

⁴PG 2nd Year, Dept. of Orthodontics & Dentofacial Orthopaedics, Chandra Dental College and Hospital, Safedabad, Barabanki, Uttar Pradesh.

⁵PG 2nd Year, Dept. of Orthodontics & Dentofacial Orthopaedics, Chandra Dental College and Hospital, Safedabad, Barabanki, Uttar Pradesh.

⁶PG 2nd Year, Dept. of Orthodontics & Dentofacial Orthopaedics, Chandra Dental College and Hospital, Safedabad, Barabanki, Uttar Pradesh.

Volume 6, Issue 14, Aug 2024

Received: 15 June 2024

Accepted: 25 July 2024

Published: 29 Aug 2024

doi: [10.48047/AFJBS.6.14.2024.10666-10671](https://doi.org/10.48047/AFJBS.6.14.2024.10666-10671)

Abstract

Objective- To assess and compare the impact of fluorosis on the SBS obtained by directly bonding orthodontic ceramic and metal brackets to fluorosed teeth.

Materials and methods- In a dental study, 60 human teeth were divided equally into four groups (A to D) and stored in distilled water. The teeth were categorized by the Thylstrup-Fejerskov Index (TFI), known for its sensitivity in detecting lower levels of fluorosis. Groups A and B included 30 fluorosed teeth rated TF4-6, while Groups C and D comprised 15 non-fluorosed control teeth each. Subsequent data analysis, including ANOVA, compared the shear bond strengths (SBS) of fluorosed and non-fluorosed teeth, metal and ceramic brackets.

Results- The results of the shear bond strength, reveal a clear progression in strength: fluorosed teeth bonded to metal exhibit a strength of 8.05 MPa, while non-fluorosed teeth bonded to ceramic brackets show a strength of 10.74 MPa, and non-fluorosed teeth bonded to metal demonstrate the highest strength at 13.88 MPa.

Conclusion- Ceramic brackets demonstrate effective bonding capabilities with fluorosed teeth. It is essential to conduct a follow-up study to evaluate the extent of enamel damage incurred during the debonding process of fluorosed teeth. Given that this research is conducted in vitro, the implications for clinical practice should be approached with caution.

Keywords- ceramic, brackets, orthodontic

Introduction

The success of orthodontic treatment is fundamentally dependent on patient compliance and the capacity of orthodontic attachments to endure the forces exerted during treatment. It is essential for orthodontic attachments to exhibit strong bonding capabilities with a diverse array of tooth and prosthetic surfaces.¹ Factors such as the condition of the enamel surface, the enamel conditioning process, the type of adhesive employed, and the design and shape of the bracket base must all be optimal to ensure effective bonding of orthodontic brackets. Orthodontic bonding relies on the principle of mechanical interlocking between the adhesive and the irregularities present in the enamel surface, as well as the mechanical locks created in the base of the orthodontic attachment.² Ceramic brackets, made from aluminum oxide, are available in both polycrystalline and monocrystalline forms. Research indicates that the estimated shear bond strength (SBS) of polycrystalline ceramic brackets surpasses that of stainless steel brackets. The recommended shear bond strength that orthodontic attachments should be able to withstand is estimated to range from 5.9 MPa to 7.8 MPa. Although aesthetic ceramic brackets offer enhanced cosmetic appeal and increased bond strength, they also present certain drawbacks, such as potential enamel wear and fracture during the debonding process, as these brackets are structurally harder and stronger than enamel.³ Dental fluorosis, a condition resulting from excessive fluoride intake exceeding 1-2 ppm during tooth development, has been associated with significant differences in enamel structure between nonfluorosed teeth and those with varying degrees of fluorosis.^{4,5} Hence; the present study was conducted for comparing two Orthodontic Brackets bond to Fluorosed and Non-Fluorosed Enamel.

Materials and methods

The present study was conducted for comparing two Orthodontic Brackets bond to Fluorosed and Non-Fluorosed Enamel. In a dental study, 60 human teeth were divided equally into four groups (A to D) and stored in distilled water. The teeth were categorized by the Thylstrup-Fejerskov Index (TFI), known for its sensitivity in detecting lower levels of fluorosis. Groups A and B included 30 fluorosed teeth rated TF4-6, while Groups C and D comprised 15 non-fluorosed control teeth each. These teeth, sourced from dental institutions, were mounted in acrylic blocks, exposing only their crowns. Each tooth was aligned in an Instron Material Testing Device for shearing strength tests, ensuring the labial surface was parallel to the applied force. Metal orthodontic brackets were bonded to teeth in Groups A and C, while ceramic

monocrystalline brackets were used in Groups B and D, following a standard bonding protocol. After curing with an LED light, the bonded teeth were stored before debonding.

Debonding was performed using the Instron Material Testing Device set at a controlled speed, measuring the force required to shear brackets off in Mpa. Subsequent data analysis, including ANOVA, compared the shear bond strengths (SBS) of fluorosed and non-fluorosed teeth, metal and ceramic brackets.

Results

The results of the shear bond strength, as illustrated in the table, reveal a clear progression in strength: fluorosed teeth bonded to metal exhibit a strength of 8.05 MPa, while non-fluorosed teeth bonded to ceramic brackets show a strength of 10.74 MPa, and non-fluorosed teeth bonded to metal demonstrate the highest strength at 13.88 MPa.

Table 1: Shear Bond strengths by group

Group	Sample size	Minimum	Maximum	Mean (Mpa)	Standard deviation	p-value
A	15	1.52	24.89	8.05	4.21	0.001 (significant)
B	15	1.41	36.10	15.12	8.67	
C	15	2.79	13.92	13.88	5.81	
D	15	3.57	10.78	10.74	5.47	

Discussion

The substantial bond strength associated with ceramic brackets has been linked to instances of enamel fractures in previous studies. While aesthetic ceramic brackets offer the benefits of enhanced cosmetic appeal and superior bond strength, they also present certain clinical disadvantages.⁶ These drawbacks may lead to increased enamel wear and the potential for enamel fractures during the debonding process. Ceramic brackets possess a structural hardness and strength that surpasses that of enamel. In contrast, metal brackets primarily utilize mechanical retention for bonding, typically employing a mesh base to achieve this retention, whereas ceramic brackets may depend on a combination of chemical and mechanical factors for their bonding efficacy.⁷

In this study, the average shear bond strength (SBS) values ranged between 8.05 MPa and 15.12s MPa. These findings align with previous studies where SBS values ranged from 3.9 MPa to 18.6 MPa reported. Notably, adhesive strengths documented in the literature typically fell within the 5.9 MPa to 11.3 MPa range, although a few studies reported SBS as high as 29.4 MPa. It's established that a minimum bond strength falling between 5.9 MPa and 7.8 MPa is adequate for most orthodontic treatments.^{8,9} Gaur A et al elucidated the effects of fluorosis in orthodontic bonding and to evaluate the efficiency of an adhesion promoter (Assure Universal Bonding Resin) in bonding to fluorosed teeth. Extracted premolars were divided into two groups on the basis of Thylstrup and Fejerskov Index. Ten samples from each group were etched and evaluated for etching patterns using scanning electron microscope (SEM). The remaining samples were subdivided into four groups of 20 each on the basis of adhesives used: IA, IIA - Transbond XT and IB, IIB - Transbond XT plus Assure Universal Bonding Resin. Shear bond strength (SBS) was measured after 24 h using the universal testing machine. Adhesive remnant index (ARI) scores were recorded using SEM. Statistical analysis was conducted using a two-way analysis of variance, and Tukey's post hoc test was performed on SBS and ARI scores. Similar etching patterns were observed in both fluorosed and nonfluorosed teeth. No significant differences were found in the SBS values observed in both groups (8.66 ± 3.19 vs. 8.53 ± 3.44 , $P = 1.000$). Increase in SBS was observed when Assure Universal Bonding Resin was used. Higher ARI scores were observed when adhesion promoter was used for bonding. Mild-moderately fluorosed teeth etch in a manner similar to the nonfluorosed teeth.¹⁰ Baherimoghadam T et al evaluated shear bond strength (SBS) of the orthodontic brackets bonded to fluorosed and nonfluorosed teeth using Light Bond with and without adhesion promoters and compare their enamel damages following debonding. 30 fluorosed (Thylstrup and Fejerskov Index = 4–5) and 30 nonfluorosed teeth were randomly distributed between two subgroups according to the bonding materials: Group 1, fluorosed teeth bonded with Light Bond; Group 2, fluorosed teeth bonded with adhesion promoters and Light Bond; Group 3, nonfluorosed teeth bonded with Light Bond; Group 4, nonfluorosed bonded with adhesion promoters and Light Bond. After bonding, the SBS of the brackets was tested with a universal testing machine. While fluorosis reduced the SBS of orthodontic bracket ($P = 0.017$), Enhance Locus Ceruleus LC significantly increased the SBS of the orthodontic bracket in fluorosed and nonfluorosed teeth ($P = 0.039$). Significant increasing in the number and length of enamel crack after debonding was found in all four groups. There were no significant differences in the length of enamel crack increased after debonding among four groups ($P = 0.768$) while increasing in the number of enamel cracks after debonding was

significantly different among the four groups ($P = 0.023$). Teeth in Group 2 showed the highest enamel damages among four groups following debonding. Adhesion promoters could improve the bond strength of orthodontic brackets, but conservative debonding methods for decreasing enamel damages would be necessary.¹¹

Conclusion

Ceramic brackets demonstrate effective bonding capabilities with fluorosed teeth. It is essential to conduct a follow-up study to evaluate the extent of enamel damage incurred during the debonding process of fluorosed teeth. Given that this research is conducted in vitro, the implications for clinical practice should be approached with caution.

References

1. Sunna S, R.W. Clinical performance of orthodontic brackets and adhesive systems: a randomized clinical trial, *British journal of orthodontics*; 1998; 25(4); 283-287.
2. Viazis AD, Cavanaugh G, Bevis RR. Bond strength of ceramic brackets under shear stress: An in vitro report. *American Journal of Orthodontics and Dentofacial Orthopedics*, 1990; 98(3); 214-221.
3. Bowen RL, R.M. Tensile strength and modulus of elasticity of tooth structure and several restorative material. *J. Am Dent Ass*, 1962; 64; 378-387.
4. Fejerskov O, Larsen MJ, Richards A, Baelum V "Dental tissue effects of fluoride.", *Advances in Dental Research*, 1994; 8(1); 15-31.
5. Adanir, N., Turkkahraman, H. & Gungor, A.Y. "Effects of fluorosis and bleaching on shear bond strengths of orthodontic brackets", *European journal of dentistry*, 2007;1(4);230-235
6. Viazis A.D, , Cavanaugh G, & Bevis R.R. "Bond strength of ceramic brackets under shear stress: An in vitro report", *American Journal of Orthodontics and Dentofacial Orthopedics*, 1990; 98(3); 214-222
7. Bishara, S.E., Fehr, D.E. & Jakobsen, J.R. "A comparative study of the debonding strengths of different ceramic brackets, enamel conditioners, and adhesives", *American Journal of Orthodontics and Dentofacial Orthopedics*. 1993; 104(2); 170- 179
8. Hyer KE., An in vitro study of shear and tensile bond strengths comparing mechanically and chemically bonded ceramic brackets with three bonding agents. University of Iowa. 1989.
9. Reynolds, R. "A review of direct orthodontic bonding", *Br Dent J*, 1975; 2, 171-178.

10. Gaur A, Maheshwari S, Verma SK, Tariq M. Effects of adhesion promoter on orthodontic bonding in fluorosed teeth: A scanning electron microscopy study. J Orthod Sci. 2016;5(3):87-91. doi:10.4103/2278-0203.186165
11. Baherimoghadam T, Akbarian S, Rasouli R, Naseri N. Evaluation of enamel damages following orthodontic bracket debonding in fluorosed teeth bonded with adhesion promoter. Eur J Dent. 2016;10(2):193-198. doi:10.4103/1305-7456.178296