

DOI: 10.58240/1829006X-2025.21.11-275



ORIGINAL RESEARCH

EFFECT OF CASEIN APPLICATION ON SHEAR BOND STRENGTH OF ORTHODONTIC BRACKET IN FLUOROSSED ENAMEL SURFACE: AN IN VITRO STUDY.

Sameera Saad Mohammed Saeid^{1*}, Wael Mohamed Mobark Refai², Mohamed El-Sayed Saad Ibrahim³.¹Faculty of Dentistry, Minia University, Egypt.²professor of orthodontics, Head of Orthodontic Department, Faculty of Dentistry, Minia University.³Associate professor of orthodontics, Minia University.*Corresponding Author: Sameera Saad Mohammed saeid¹, Faculty of Dentistry, Minia University, Egypt.

e-mail: Saadsmeer2019@gmail.com

Received: Oct 29, 2025; Accepted: Nov 29, 2025; Published: Dec. 16, 2025

ABSTRACT

Background: Dental fluorosis alters enamel microstructure through increased porosity, subsurface hypomineralization, and irregular prism formation, resulting in compromised etching patterns and reduced shear bond strength (SBS) during orthodontic bonding. Casein phosphopeptide–amorphous calcium phosphate (CPP-ACP) has demonstrated remineralization potential, but its effect on bonding to fluorosed enamel remains insufficiently explored.

Aim: To evaluate the effect of CPP-ACP pretreatment on the shear bond strength of orthodontic brackets bonded to fluorosed enamel and to assess the mode of bond failure using the Adhesive Remnant Index (ARI).

Materials and Methods: Thirty-eight premolars with moderate fluorosis (TFI 4–5) were confirmed using laser-induced fluorescence and TFI scoring, then randomly allocated into two groups (n = 19): Group I: Control (no pretreatment).

Group II: Experimental (CPP-ACP applied twice daily for three weeks).

All samples underwent standardized bonding procedures, thermocycling, SBS testing using a universal testing machine, and ARI evaluation. Data were analyzed using independent samples t-test and Chi-square test ($p < 0.05$).

Results: CPP-ACP significantly increased both maximum load and SBS compared with untreated fluorosed enamel ($p < 0.001$). SBS improved from 14.8 ± 1.3 MPa in the control group to 23.2 ± 2.6 MPa in the treated group. ARI scores also differed significantly between groups ($p < 0.05$), with the CPP-ACP group exhibiting higher frequencies of ARI 2 and 3, indicating improved enamel–adhesive interface integrity.

Conclusion: CPP-ACP pretreatment substantially enhances the shear bond strength of orthodontic brackets bonded to moderate fluorosis teeth, and it also modifies the failure pattern toward more favorable ARI scores. This suggests that CPP-ACP may serve as an effective, noninvasive adjunct to improve bonding reliability in patients with moderate dental fluorosis.

Keywords: Fluorosis; CPP-ACP; Shear bond strength; Orthodontic bonding; Adhesive Remnant Index (ARI); Laser-induced fluorescence; TFI.

INTRODUCTION

Dental fluorosis is a hypomineralization defect resulting from excessive systemic fluoride exposure during enamel formation. Its clinical presentation ranges from mild opacities to severe surface breakdown, reflecting the underlying structural alterations that fluoride induces in developing enamel. Foundational epidemiological and diagnostic work by Dean (1934, 1942)^{1,2} established the first classification of fluorosis severity, laying the groundwork for later

histological correlation studies. Subsequent research by Thylstrup and Fejerskov (1978)³ provided a more refined and biologically meaningful index the TFI demonstrating that fluorosed enamel exhibits distinct histopathologic features, including increased surface porosity, subsurface hypomineralization, and disorganized enamel prisms. These microstructural defects significantly impair the enamel's response to acid etching, reducing the quality of the etching pattern

and limiting the formation of resin tags necessary for strong micromechanical bonding⁴⁵.

Because of these structural limitations, orthodontic bonding to fluorosed enamel remains a persistent clinical challenge. Several authors have documented reduced shear bond strength (SBS), higher rates of bracket failure, and increased treatment time in patients with fluorosis^{6,7,8,9}. These bonding difficulties are particularly relevant in fluorosis-endemic populations, where orthodontists frequently encounter compromised enamel substrates. To improve diagnostic precision, researchers have incorporated optical technologies especially laser-induced fluorescence (LIF) which detect mineral changes and fluorescent properties that distinguish fluorosed from sound enamel. Studies such as Bahrololoomi et al. (2013) have demonstrated that LIF provides objective, quantitative confirmation of enamel hypomineralization, making it a useful adjunct to visual fluorosis indices¹⁰.

In recent years, attention has shifted toward remineralization-based strategies to address the intrinsic weaknesses of fluorosed enamel. Among these, casein phosphopeptide amorphous calcium phosphate (CPP-ACP) has gained prominence due to its unique ability to stabilize bioavailable calcium and phosphate ions in the form of nanoclusters. Foundational work by Reynolds (1997)¹¹ and subsequent studies by Shen et al. (2001)¹², Cai et al. (2003)¹³, and Walker et al. (2006)¹⁴ demonstrated that CPP-ACP enhances enamel microhardness, increases subsurface mineral content, and improves resistance to acid challenges. More recently, researchers have explored its effect on bonding performance. Adebayo et al. (2007)¹⁵ and Muntean et al. (2023)¹⁶ reported that CPP-ACP pretreatment increased bond strength in compromised enamel substrates, suggesting its potential value for fluorosed teeth.¹¹

Despite this promising evidence, limited research has specifically examined the effect of CPP-ACP on orthodontic bonding to moderately fluorosed enamel. Given the susceptibility of fluorosed enamel to weaker bonding and altered failure patterns, there is a need to evaluate biologically based, noninvasive interventions capable of stabilizing the enamel structure and improving bonding reliability. Therefore, the present study aimed to assess whether CPP-ACP pretreatment enhances the shear bond strength of orthodontic brackets bonded to moderately fluorosed enamel (TFI 4–5) and whether it modifies the adhesive failure pattern as reflected by the Adhesive Remnant Index (ARI).

MATERIALS AND METHODS

This *in vitro* experimental study was conducted to evaluate the effect of casein phosphopeptide–amorphous calcium phosphate (CPP-ACP) pretreatment

on the shear bond strength of orthodontic brackets bonded to moderately fluorosed enamel. A total of thirty eight extracted human premolars exhibiting fluorosis were collected. The initial diagnosis of fluorosis was confirmed using laser-induced fluorescence, an objective optical method capable of detecting mineral changes associated with fluorotic hypomineralization¹⁰. The severity of fluorosis was subsequently classified according to the Thylstrup and Fejerskov Index (TFI), a histologically correlated system widely accepted for epidemiologic and structural assessment of fluorosis³. Teeth scoring TFI 4–5 were included in the experiment.

Immediately after extraction, all specimens were cleaned and stored following ISO-recommended laboratory guidelines for adhesion testing¹⁷. Teeth were initially stored in distilled water to maintain hydration, minimize dehydration related microcracks, and prevent ionic contamination that could influence enamel optical or bonding properties. Long term storage was carried out in artificial saliva at 37°C, which helped simulate intraoral environmental conditions and preserve enamel mineral balance. Both storage media have been widely utilized in laboratory studies evaluating enamel integrity and remineralization.

After diagnostic confirmation, specimens were randomly allocated into two equal groups using a simple randomization protocol under laboratory supervision to ensure allocation concealment.

- Group I (Control): No surface pretreatment.
- Group II (Experimental): Application of CPP-ACP paste (GC Tooth Mousse®).

For the experimental group, CPP-ACP was applied twice daily for three consecutive weeks, following remineralization protocols previously implemented in studies assessing the effect of CPP-ACP on enamel subsurface lesions and bonding performance Reynolds, E. (1997). Remineralization of enamel subsurface lesions by casein phosphopeptide-stabilized calcium phosphate solutions. *Journal of Dental Research*, 76(9), 1587–1595. Each application remained on the enamel surface for the recommended duration before rinsing, allowing sufficient ion stabilization and interaction with the enamel matrix.

Following pretreatment, all teeth underwent standardized orthodontic bonding procedures. The enamel surfaces were cleaned with fluoride-free pumice, etched with 37% phosphoric acid for 30 seconds, rinsed, and dried until a frosty appearance was observed. The choice of a 30-second etching time was based on evidence demonstrating no additional benefits from extended etching in fluorosed teeth⁴. Stainless-steel MBT premolar brackets with a mechanical retention base (10.29 mm²) were bonded using a light-

cured adhesive system according to manufacturer recommendations.

To simulate intraoral thermal fluctuations, all bonded specimens were subjected to thermocycling between 5°C and 55°C with a 30-second dwell time, following established artificial aging protocols commonly applied in orthodontic bond strength research.

Shear bond strength testing was performed using a universal testing machine at a crosshead speed of 1 mm/min. Maximum load values (in Newtons) were recorded, and SBS (in MPa) was calculated by dividing load by bracket base area. After debonding, the Adhesive Remnant Index (ARI) was assessed under stereomicroscopy to determine the predominant site of bond failure according to the scoring system established by Årtun and Bergland (1984)18.

Data were statistically analyzed using descriptive and inferential tests to compare mean SBS values and ARI distributions between groups, with significance set at $p < 0.05$.

RESULTS

A total of 38 moderately fluorosed premolars were analyzed, equally assigned to the control and CPP-ACP treated groups. All quantitative outcome variables demonstrated normal distribution according to the Shapiro Wilk test, permitting parametric comparison using the Independent

Samples t-test. Descriptive statistics revealed clear separation between groups for both the maximum load test and shear bond strength (SBS). The untreated control group exhibited maximum load values ranging from 132–175 N with a mean of 152.8 ± 13.6 N, reflecting the compromised mechanical integrity of fluorosed enamel.

By contrast, the CPP-ACP-treated group demonstrated markedly enhanced performance, with maximum load values between 200–283 N and a mean of 238.6 ± 26.3 N, indicating substantial reinforcement of enamel resistance following remineralization. This difference was confirmed to be very highly statistically significant ($p < 0.001$).

A similar pattern was observed for shear bond strength. Control specimens demonstrated SBS values of 12.8–17 MPa (mean 14.8 ± 1.3 MPa), consistent with the reduced etching efficacy and weak micromechanical

retention typical of fluorosed enamel. In contrast, the CPP-ACP group exhibited SBS values between 19.4–27.5 MPa, with a significantly higher mean of 23.2 ± 2.6 MPa, representing an approximate 57% improvement, which was very highly statistically significant ($p < 0.001$). Notably, the lowest SBS recorded in the treated group exceeded the highest SBS observed in the control group, reflecting a uniform and clinically meaningful enhancement.

Qualitative analysis of the Adhesive Remnant Index (ARI) demonstrated significant differences in failure patterns between groups. The control group predominantly exhibited lower ARI scores ARI 0: 42.11% and ARI 1: 42.11% indicating adhesive failure at the enamel interface with minimal adhesive remaining after debonding. Conversely, the treated group showed a clear shift toward higher ARI scores ARI 2: 47.37% and ARI 3: 47.37% reflecting stronger enamel adhesive bonding and a tendency toward cohesive failure within the adhesive. Chi-square testing confirmed that all ARI categories differed significantly between the groups (ARI 0: $p = 0.00535$; ARI 1: $p = 0.02206$; ARI 2: $p = 0.03186$; ARI 3: $p = 0.00992$), with an overall chi-square value of 24.30 ($p = 0.0000216$), indicating a highly significant and systematic shift in failure mode favoring the CPP-ACP group. Collectively, these findings demonstrate that CPP-ACP pretreatment leads to substantial mechanical and adhesive improvements in moderately fluorosed enamel, enhancing bracket retention strength and modifying bond-failure patterns toward more favorable, clinically stable outcomes.

Table 1. Compressive strength of group I and group II.

		Control Group	Treated Group	P value
		N=19	N=19	
Maximum Load (N)	Range Mean ± SD	(132-175) 152.8±13.6	(200-283) 238.6±26.3	<0.001*

- Independent Samples T test
- *: very highly significant level at p value < 0.001.

Table 2. Comparison of the shear bond strength between the two groups

		Control Group	Treated Group	P value
		N=19	N=19	
Shear bond strength (MPa)	Range Mean ± SD	(12.8-17) 14.8±1.3	(19.4-27.5) 23.2±2.6	<0.001*

- Independent Samples T test
- *: very highly significant level at p value < 0.001.

Table 3 . Comparison of the Adhesive Remnant Index Between the Two Groups

Adhesive Remnant Index	Control (N=19)	Treated (N=19)	Casein	P value
No (ARI = 0)	42.11 %	0 %		0.00535
<50% (ARI = 1)	42.11 %	5.26%)		0.02206
>50% (ARI = 2)	10.53 %	47.37 %		0.03186
All adhesive (ARI = 3)	5.26 %	47.37 %		0.00992

- Chi-square test
- Significant at p < 0.05

DISCUSSION

The present study investigated whether CPP-ACP pretreatment could enhance the shear bond strength

(SBS) and bonding performance of orthodontic brackets on moderately fluorosed enamel. Dental fluorosis is known to compromise etching efficacy and

resin infiltration due to its characteristic mineralization defects namely increased subsurface porosity, hypomineralization, and altered prism morphology leading to reduced bond strength and higher rates of bracket failure. These structural limitations have been documented extensively in the literature, including the foundational work of Thylstrup & Fejerskov (1978)¹⁹, Al-Sugair & Akpata (1999)²⁰, and Isci et al. (2011)²¹, all of whom reported significantly weaker bonding behavior in fluorosed enamel compared with sound enamel. To ensure correct diagnosis and standardization, two validated methods were used in the current study: (1) Laser-Induced Fluorescence (LIF) to confirm mineral changes associated with fluorosis, a technique supported by Bahrololoomi et al. (2013)¹⁰²², who demonstrated the diagnostic reliability of laser fluorescence in detecting enamel porosity and demineralization.

Adebayo et al. (2007)²³, Tantbirojn et al. (2008)²⁴, Mayne et al. (2011)²⁵, and Muntean et al. (2023)²⁶, all of whom observed enhanced enamel resistance or improved bracket bonding after CPP-ACP application.

When comparing these findings with previous research on bonding performance in fluorosed enamel, the improvement is more pronounced. Studies by Silva-Benítez et al. (2013)²⁷, Mendes et al. (2014)²⁸, Grover et al. (2015)²⁹, and Sharma et al. (2017)²² consistently showed inferior enamel–adhesive interaction and increased bond failure in fluorosed teeth. However, none of these studies combined remineralizing pretreatment with bonding protocols. The enhanced performance observed here therefore highlights the value of biologically based enamel strengthening rather than relying solely on mechanical or chemical surface treatments.

The Adhesive Remnant Index (ARI) results further support this interpretation. Whereas control specimens exhibited predominantly low ARI scores reflecting early adhesive failure at the enamel interface the CPP-

ACP group showed significantly higher ARI scores, indicating improved adhesive penetration and stronger enamel resin micromechanical interlocking. This pattern aligns with observations by Grover et al. (2015)²¹³¹ and Trakinienė et al. (2019)⁹³², who noted

that improving enamel quality shifts the failure mode to more favorable outcomes.

Overall, the findings of the current study confirm that CPP-ACP pretreatment meaningfully improves bond performance on moderately fluorosed enamel. These results agree with decades of research demonstrating the remineralizing and enamel stabilizing effects of CPP-ACP, while also addressing a long-standing clinical problem documented in the fluorosis and orthodontic bonding literature. The outcome suggests that CPP-ACP offers a conservative, noninvasive, and clinically practical approach for improving orthodontic bonding reliability in fluorosis-endemic regions

CONCLUSION

The present study demonstrated that pretreatment of moderately fluorosed enamel with CPP-ACP significantly enhances the mechanical and adhesive performance of orthodontic brackets. CPP-ACP application resulted in a marked increase in maximum load resistance and shear bond strength, indicating substantial improvement in enamel quality and resin–enamel interaction. Additionally, the shift toward higher Adhesive Remnant Index (ARI) scores reflects a more favorable and durable bond failure pattern. Collectively, these findings suggest that CPP-ACP is an effective, noninvasive adjunct capable of overcoming the inherent bonding limitations of fluorosed enamel and may improve clinical outcomes in orthodontic patients from fluorosis-endemic regions.

Clinical Recommendations:

1. CPP-ACP pretreatment is recommended for orthodontic patients with moderate dental fluorosis (TFI 4–5), especially in fluorosis-endemic regions where bracket failure is common.
2. Daily application of CPP-ACP for three consecutive weeks may be adopted as a clinically feasible protocol to improve enamel quality prior to bonding.
3. Given the significantly increased ARI scores in treated specimens, clinicians should expect safer and more predictable debonding, with reduced risk of enamel damage.
4. CPP-ACP may be particularly useful when bonding ceramic brackets, where enamel preservation at debonding is a priority

Research Recommendations:

1. In Vitro Nature of the Study. Laboratory conditions cannot fully replicate the complex oral environment, including salivary flow, pH fluctuations, masticatory forces, thermal changes, and patient-specific enamel variability.
2. Single CPP-ACP Protocol Evaluated. The study used one standardized CPP- ACP application regimen. Alternative durations, frequencies, or formulations (e.g., CPP-ACPF) were not assessed and may yield different outcomes.
3. Use of Extracted Teeth. Variation in the severity of fluorosis, enamel thickness, hydration status, and storage conditions, although controlled, may differ from in-vivo conditions.
4. One Adhesive System and Etching Protocol. Other bonding agents, primers, or self-etch systems may interact differently with treated fluorosed enamel, limiting generalizability.
5. Short Term Evaluation Only. The study assessed immediate shear bond strength after thermocycling; long-term durability, fatigue resistance, and failure patterns under intraoral aging remain untested.
6. Results Limited to Premolars. Only fluorosed premolars were evaluated. Enamel morphology and mechanical response may differ in incisors or molars

DECLARATIONS

Ethical approval and consent to participate

Ethical permission was granted by the Medical Ethics Committee of the Faculty of Dentistry, Sana'a University (Ref. No.: 703; Date: 2/8/2024). All patient identifiers were anonymized for confidentiality *with the ethical principles outlined in the Declaration of Helsinki*.

Availability of data and material

All data generated or analyzed during this study are included in the published article.

Competing interests

The authors declare that there are no competing interests

REFERENCES

1. Dean, H. T. (1934). Classification of mottled enamel diagnosis. *Journal of the American Dental Association*, 21(8), 1421–1426.
2. Dean, H. T. (1942). The investigation of physiological effects by the epidemiological method. In *Fluorine and Dental Health* (pp. 23–31).
3. Thylstrup, A., & Fejerskov, O. (1978). Clinical appearance of dental fluorosis in permanent teeth in relation to histologic changes. *Community Dentistry and Oral Epidemiology*, 6(6), 315–328.
4. Al-Sugair, M. H., & Akpata, E. S. (1999). Effect of fluorosis on etching of human enamel. *Journal of Oral Rehabilitation*, 26(6), 521–528.
5. Isci, D., Sahin Saglam, A. M., Alkis, H., Elekdag-Turk, S., & Turk, T. (2011). Effects of fluorosis on the shear bond strength of orthodontic brackets bonded with a self-etching primer. *The European Journal of Orthodontics*, 33(2), 161–166.
6. Adanir, N., Türkkahraman, H., & Güngör, Y. A. (2013). Effects of fluorosis and bleaching on shear bond strengths of orthodontic brackets. *European Journal of Dentistry*, 7(1), 230–235.
7. Silva-Benítez, E. L., Zavala-Alonso, V., Martinez-Castanon, G. A., Loyola-Rodriguez, J. P., Patiño-Marin, N., Ortega-Pedrajo, I., & García-Godoy, F. (2013). Shear bond strength evaluation of bonded molar tubes on fluorotic molars. *The Angle Orthodontist*, 83(1), 152–157.
8. Mendes, M., Portugal, J., Arantes-Oliveira, S., & Mesquita, P. (2014). Shear bond strength of orthodontic brackets to fluorosed enamel. *Revista Portuguesa de Estomatologia, Medicina Dentária e Cirurgia Maxilofacial*, 55(2), 73–77.
9. Trakinienė, G., Petravičiūtė, G., Smailienė, D., Narbutaitė, J., Armalaitė, J., Lopatienė, K., & Trakinis, T. (2019). Impact of fluorosis on the tensile bond strength of metal brackets and the prevalence of enamel microcracks. *Scientific Reports*, 9, 5957.
10. Bahrololoomi, Z., Musavi, S. A., & Kabudan, M. (2013). In vitro evaluation of the efficacy of laser

fluorescence (DIAGNOdent) to detect demineralization and remineralization of smooth enamel lesions. *Journal of Conservative Dentistry*, 16(4), 362–366.

11. Reynolds, E. (1997). Remineralization of enamel subsurface lesions by casein phosphopeptide-stabilized calcium phosphate solutions. *Journal of Dental Research*, 76(9), 1587–1595.

12. Shen, P., Cai, F., Nowicki, A., Vincent, J., & Reynolds, E. C. (2001). Remineralization of enamel subsurface lesions by sugar-free chewing gum containing casein phosphopeptide–amorphous calcium phosphate. *Journal of Dental Research*, 80(12), 2066–2070.

13. Cai, F., Shen, P., Morgan, M. V., & Reynolds, E. C. (2003). Remineralization of enamel subsurface lesions in situ by sugar-free lozenges containing casein phosphopeptide–amorphous calcium phosphate. *Australian Dental Journal*, 48(4), 240–243.

14. Walker, G., Cai, F., Shen, P., Reynolds, C., Ward, B., Fone, C. & Reynolds, E. (2006). Increased remineralization of tooth enamel by milk containing added casein phosphopeptide–amorphous calcium phosphate. *Journal of Dairy Research*, 73(1), 74–78.

15. Adebayo, O. A., Burrow, M. F., & Tyas, M. J. (2007). Effects of conditioners on microshear bond strength to enamel after carbamide peroxide bleaching and/or casein phosphopeptide–amorphous calcium phosphate (CPP–ACP) treatment. *Journal of Dentistry*, 35(11), 862–870.

16. Muntean, A., Dârgău, C. M., Pacurar, M., Neagoe, S., & Delean, A. G. (2023). Effect of remineralizing agents on shear bond strength of orthodontic brackets—in vitro study. *Children*, 10(2), 268.

17. Reynolds, E. (1997). Remineralization of enamel subsurface lesions by casein phosphopeptide-stabilized calcium phosphate solutions. *Journal of Dental Research*, 76(9), 1587–1595.

18. Årtun, J., & Bergland, S. (1984). Clinical trials with crystal growth conditioning as an alternative to acid-etch enamel pretreatment. *American Journal of Orthodontics*, 85(4), 333–340.

19. Thylstrup, A., & Fejerskov, O. (1978). Clinical appearance of dental fluorosis in permanent teeth in relation to histologic changes. *Community Dentistry and Oral Epidemiology*, 6(6), 315–328.

20. Al-Sugair, M. H., & Akpata, E. S. (1999). Effect

of fluorosis on etching of human enamel. *Journal of Oral Rehabilitation*, 26(6), 521–528.

21. Isci, D., Sahin Saglam, A. M., Alkis, H., Elekdag-Turk, S., & Turk, T. (2011). Effects of fluorosis on the shear bond strength of orthodontic brackets bonded with a self-etching primer. *The European Journal of Orthodontics*, 33(2), 161–166.

22. Bahrololoomi, Z., Musavi, S. A., & Kabudan, M. (2013). In vitro evaluation of the efficacy of laser fluorescence (DIAGNOdent) to detect demineralization and remineralization of smooth enamel lesions. *Journal of Conservative Dentistry*, 16(4), 362–366.

23. Adebayo, O. A., Burrow, M. F., & Tyas, M. J. (2007). Effects of conditioners on microshear bond strength to enamel after carbamide peroxide bleaching and/or casein phosphopeptide–amorphous calcium phosphate (CPP–ACP) treatment. *Journal of Dentistry*, 35(11), 862–870.

24. Thylstrup, A., & Fejerskov, O. (1978). Clinical appearance of dental fluorosis in permanent teeth in relation to histologic changes. *Community Dentistry and Oral Epidemiology*, 6(6), 315–328.

[25. Isci, D., Sahin Saglam, A. M., Alkis, H., Elekdag-Turk, S., & Turk, T. (2011). Effects of fluorosis on the shear bond strength of orthodontic brackets bonded with a self-etching primer. *The European Journal of Orthodontics*, 33(2), 161–166.

26. Muntean, A., Dârgău, C. M., Pacurar, M., Neagoe, S., & Delean, A. G. (2023). Effect of remineralizing agents on shear bond strength of orthodontic brackets—in vitro study. *Children*, 10(2), 268.

27. Silva-Benítez, E. L., Zavala-Alonso, V., Martinez-Castanon, G. A., Loyola-Rodriguez, J. P., Patiño-Marin, N., Ortega-Pedrajo, I., & García-Godoy, F. (2013). Shear bond strength evaluation of bonded molar tubes on fluorotic molars. *The Angle Orthodontist*, 83(1), 152–157.

28. Mendes, M., Portugal, J., Arantes-Oliveira, S., & Mesquita, P. (2014). Shear bond strength of orthodontic brackets to fluorosed enamel. *Revista Portuguesa de Estomatologia, Medicina Dentária e Cirurgia Maxilofacial*, 55(2), 73–77.

29. Grover, S., Sidhu, M. S., Prabhakar, M., Dabas, A., Malik, V., Yadav, P., & Kumar, S. (2015). A comparative evaluation of two adhesion promoters on bonding of orthodontic brackets to fluorosed enamel:

An in vivo study. *Journal of Orofacial Research*, 5(1), 1–5.

30. Sharma, R., Kumar, D., & Verma, M. (2017). Deproteinization of fluorosed enamel with sodium hypochlorite enhances the shear bond strength of orthodontic brackets: An in vitro study. *Contemporary Clinical Dentistry*, 8(1), 20–25.

31. Grover, S., Sidhu, M. S., Prabhakar, M., Dabas, A., Malik, V., Yadav, P., & Kumar, S. (2015). A comparative evaluation of two adhesion promoters on bonding of orthodontic brackets to fluorosed enamel: An in vivo study. *Journal of Orofacial Research*, 5(1), 1–5.

32. Trakinienė, G., Petravičiūtė, G., Smailienė, D., Narbutaitė, J., Armalaitė, J., Lopatienė, K., & Trakinis, T. (2019). Impact of fluorosis on the tensile bond strength of metal brackets and the prevalence of enamel microcracks. *Scientific Reports*, 9, 5957.