Journal of Advanced Medical and Dental Sciences Research

@Society of Scientific Research and Studies *NLM ID: 101716117*

Journal home page: www.jamdsr.com doi: 10.21276/jamdsr Indian Citation Index (ICI) Index Copernicus value = 100

(e) ISSN Online: 2321-9599; (p) ISSN Print: 2348-6805

Original Research

Evaluating the effects of different prophylactic aids on white spot lesions and correlating it with pH of saliva and oral hygiene status during fixed orthodontic treatment

Malhar Damor[1], Renuka Patel[2], Falguni Mehta[3], Megha Goswami Atit[4], Taniya Khandelwal[5], Pranali Mate[6]

[1,5,6]Post Graduate, [2]Professor, [3]Professor and Head of Department, [4]Associate Professor, Department of Orthodontics and Dentofacial Orthopedics, Government Dental College, Ahmedabad, Gujarat, India

ABSTRACT:

Background: Fixed orthodontic treatment improves dental appearance and function, but it increases the risk of white spot lesions, which are early signs of enamel demineralization appearing as chalky white marks near brackets. These lesions result from plaque accumulation, reduced salivary pH, and acid-producing bacteria. Various preventive products - including fluoride mouthwashes, remineralizing toothpastes, and calcium-based agents - are advised, yet their long-term effectiveness during active orthodontic treatment remains uncertain. **Methods:** Total of 150 orthodontic patients were divided into five groups (n = 30 each): Control (Sodium Monofluorophosphate (Colgate Strong Toothpaste)),Calcium Sodium Phosphosilicate (SHY-NM), Sodium Fluoride Mouthwash (Fluoritop) + Control Toothpaste, Amine Fluoride Toothpaste (Amflor), and Amine Fluoride Mouthwash (Amflor) + Control Toothpaste. WSLs (Decalcification Index), salivary pH, and oral hygiene (OHI-S) were recorded at baseline, 2, 4, and 6 months. Statistical analysis included One-way ANOVA, Bonferroni test, and Pearson correlation (p<0.05). **Results:** All groups showed an increase in white spot lesions over time. Greatest progression occurred in the Control and Calcium Sodium Phosphosilicate groups, whereasthe Amine Fluoride Mouthwash group showedthe least increase, indicatinga significant protective effect (p<0.05). Oral hygiene levels remained similar among groups. Salivary pH declined in the Control and SHY-NM groups, while fluoride-based groups maintained more stable pH values. Lower pH and poorer hygiene showed a moderate association with increased white spot lesions. **Conclusion:** Amine fluoride mouthwash was most effective in reducing white spot lesions and maintaining salivary pH. Routine use of fluoride-based prophylaxis, particularly amine fluoride, is recommended for patients undergoing fixed orthodontic treatment.

Received: 13 December, 2025 Accepted: 10 January, 2026 Published: 12 January, 2026

Corresponding Author: Taniya Khandelwal, Post Graduate, Department of Orthodontics and Dentofacial Orthopedics, Government Dental College, Ahmedabad, Gujarat, India

This article may be cited as: Damor M, Patel R, Mehta F, Atit MG, Khandelwal T, Mate P. Evaluating the effects of different prophylactic aids on white spot lesions and correlating it with pH of saliva and oral hygiene status during fixed orthodontic treatment. J AdvMed Dent Scie Res 2026; 14(1):55-68.

INTRODUCTION

Orthodontic fixed appliance treatment improves functional efficiency, dental and facial aesthetics through tooth movement, but at the same time has a potential risk of developing White spot lesions (WSL) by hindering the oral hygiene, increasing plaque retention around the brackets, including acidogenic bacteria such as Streptococcus Mutans and various Lactobacilli.[1] Fejerskov et. al. in 2008 first coined the word white spot lesion (WSL) and defined it as “The first sign of carious lesion on enamel that can be detected with the naked eye.”.[2] WSLs are the earliest clinical manifestation of dental caries, appearing as opaque, white areas on the enamel surface due to subsurface mineral loss.

The occurrence of WSLs in orthodontic patients can be prevented throughprophylactic measures such as implementing a good oral hygiene regimen with proper toothbrushingusing a fluoridated dentifrice.Usually, either sodium fluoride, monofluorophosphate, stannous fluoride, amine fluoride, or a combination of thesecompounds is added to dentifrices.[3]Various components like calcium sodium phosphosilicate glass (CSPG), casein phosphopeptide-amorphous calcium phosphate (CPP-ACP), sodium fluoride, amine fluoride,

hydroxyapatite, etc, are present in different prophylactic aids, such as mouthwashes and toothpastes, which can remineralize the teeth.
There are many available prophylactic measures with different contents for remineralization of enamel in white spot lesion management and its prevention; there is still not enough thorough research for assessing their relative efficacies during active fixed orthodontic treatment.

METHODS

An in vivo study was conducted in the Department of Orthodontics and Dentofacial Orthopaedics of Government Dental College and Hospital, Ahmedabad. The institutional ethical committee (No. IEC GDCH/ORTHO.4/2023) reviewed and approved the study protocol. The study included patients undergoing orthodontic treatment using fixed appliances in the postgraduate orthodontic clinic.

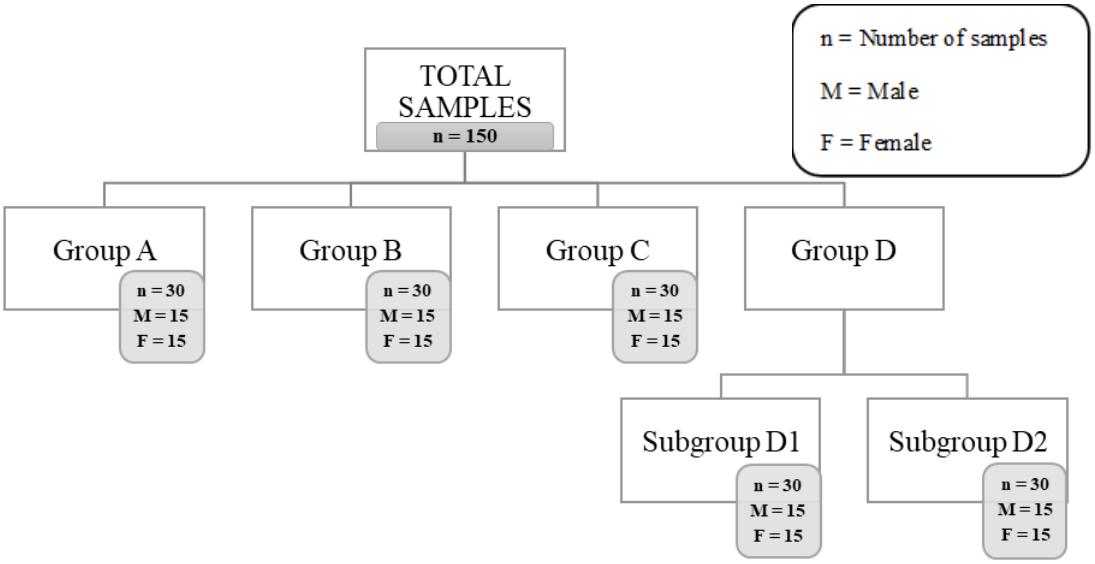
Inclusion Criteria

- Patients aged between 18 to 25 years, with no medical history and systemic disturbances.
- Patients bonded with fixed orthodontic appliance (0.022 MBT PEA Metal brackets) on maxillary and mandibular anterior teeth.

Exclusion Criteria

- Patients having fluorosis.
- Patients having any periodontal and endodontic problems.
- Patients with enamel hypoplasia or any other developmental anomaly.
- Patients having destructive oral habits (bruxism, nail biting, tongue thrusting, etc.).

Sample Size



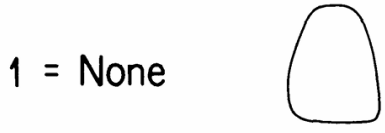
Groups

- **Control Group:**
  - *Group A:* Sodium Monofluorophosphate (Colgate Strong Toothpaste).
- **Experimental Groups:**
  - *Group B:*Calcium Sodium Phosphosilicate (SHY-NM Toothpaste).
  - *Group C:*Sodium Fluoride 0.044% w/v (Fluoritop Mouthwash) + Sodium Monofluorophosphate (Colgate Strong Toothpaste).
  - *Group D:*
    - Subgroup *D1*: Amine Fluoride (Amflor Toothpaste).
    - Subgroup *D2*: Amine Fluoride (Amflor Mouthwash) + Sodium Monofluorophosphate (Colgate Strong Toothpaste).

Before the start of the orthodontic treatment, professional dental cleaning was done, and the patients were given oral hygiene instructions.
Clinical evaluation was done at pretreatment (0 months - baseline) before direct bonding of 0.022 slot MBT PEA Metal brackets for white spot lesions by decalcification index, oral hygiene status of the patient by OHI-S index, and pH of saliva measured using a pen-type pH meter.
Subjects were instructed to use the prescribed toothpaste or mouthwash according to their designated group.

Decalcification Index

- Decalcification index given by Gorelick et al.
- The white spot lesions were scored as follows:
- No white spot formation



Slight white spot formation

Excessive white spot formation

White spot formation with cavitation

OHI-S Index

Oral hygiene status of the patients was evaluated by the simplified oral hygiene index (OHI-S). OHI-S was developed in 1964 by John C. Greene and Jack R. Vermillion.

Simplified index differed from the original oral hygiene index (1960) in:

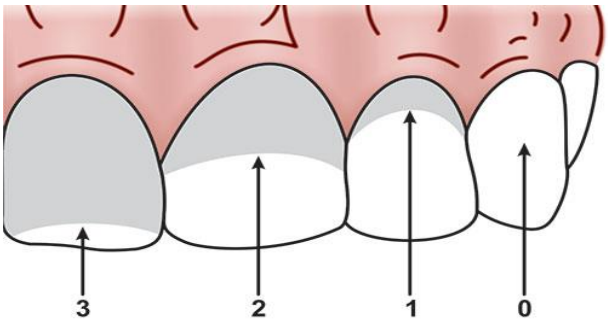
- The tooth surfaces scored are 6 rather than 12.
- The method of selection of the surface to be scored.
- The scores, which are to be obtained.

Mouth mirror and Curved Probe (Shepherd's Hook – No. 23 explorer) were used.

Simplified Oral Hygiene Index (OHI-S) has two components, the Simplified Debris Index (DI-S) and the Simplified Calculus Index (CI-S).

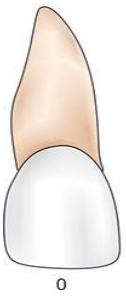
Simplified Debris Index

Scoring	Interpretation



0	No debris or stain present
1	Soft debris covering not more than 1/3rd of the tooth surface, or presence of extrinsic stains without any other debris, regardless of surface area covered
2	Soft debris covering more than 1/3rd but not more than 2/3rd of the exposed tooth surface
3	Soft debris covering more than 2/3rd of the exposed tooth surface

Simplified Calculus Index

Scoring	Interpretation	
0	No Calculus present	 0
1	Supragingival calculus covering not more than 1/3rd of the exposed tooth surface	 1
2	Supragingival calculus covering more than 1/3rd but not more than 2/3rd of the exposed tooth surface or the presence of individual flecks of subgingival calculus around the cervical portion of the tooth or both	 2

The debris and calculus scores were added and divided by the number of tooth surfaces scored for each patient.

$$\text{DI-S score: } \frac{\text{Total score}}{\text{No. of surfaces examined}}$$

$$\text{CI-S score: } \frac{\text{Total score}}{\text{No. of surfaces examined}}$$

Once the patients' DI-S and CI-S scores are calculated, they are then added together to obtain the OHI-S score.
OHI-S = DI-S + CI-S.

OHI-S

Score	Interpretation
0.0 to 1.2	Good
1.3 to 3.0	Fair
3.1 to 6.0	Poor

pH of Saliva

The patient was asked to sit for 5-10 minutes in an upright position, and saliva was allowed to accumulate in the floor of the mouth and then transferred to a container by the passive drooling method. By this method, 5 mL of unstimulated whole saliva was collected in a container from the oral cavity.

Pen-type pH meter was used to calibrate the pH of saliva.

A follow-up clinical evaluation was done for the same patients after 2 months, 4 months, and 6 months in the same region for oral hygiene status by OHI-S index, white spot lesion by decalcification index, and measuring of pH of saliva.

Data was analysed using the statistical package **SPSS 26.0** (SPSS Inc., Chicago, IL) and the level of significance was set at $p<0.05$.

Descriptive statistics were performed to assess the mean and standard deviation of the respective groups. Inferential statistics to find out the difference between the groups was done by a One-way ANOVA test, followed by BONFERRONI TEST Posthoc test. Repeated Measures of ANOVA test was used for within-group analysis. Pearson correlation test was used for correlation analysis.

RESULTS

Decalcification Index

According to within-group analysis ($p< 0.05$), the Decalcification Index went up statistically significantly over time in all groups. The Control group exhibited the most significant increase from baseline to four and six months ($F = 14.44$, $p = 0.0001$). The Calcium Sodium Phosphosilicate group ($F = 12.49$, $p = 0.0001$) and the Sodium Fluoride Mouthwash + Control group ($F = 9.41$, $p = 0.0001$) exhibited a similar significant increase. During the study, the Amine Fluoride Toothpaste ($F = 3.56$, $p = 0.017$) and Amine Fluoride Mouthwash + Control groups ($F = 5.07$, $p = 0.002$) exhibited modest yet significant increases. Post hoc analysis showed that there were big changes in the Control group between the baseline and both 4 and 6 months. The Calcium Sodium Phosphosilicate group saw big changes between the baseline and four months, as well as between two and four months. The Amine Fluoride groups exhibited significant differences primarily between baseline and subsequent time points, maintaining stability thereafter. In contrast, the Sodium Fluoride Mouthwash + Control group demonstrated significant changes from baseline to all follow-up periods. **(Table I)**

There were no noticeable differences between the groups at the beginning and two months later. At 4 months, there was a trend toward significance ($p = 0.07$), but no pairwise differences were found. At six months, a statistically significant difference was observed between the groups ($F = 2.34$, $p = 0.04$), with post hoc analysis indicating that Group D2 (Amine Fluoride Mouthwash + Control) significantly differed from the Control group ($p = 0.044$). **(Table II)**

Oral Hygiene Index Simplified (OHI-S)

According to within-group analysis ($p > 0.05$), OHI-S scores did not change statistically significantly over time in any group. There were small changes during the follow-up periods, but none of them were statistically significant. Post hoc comparisons showed that there were no big differences between any of the time points in any of the groups. **(Table III)**

The analysis between groups revealed no significant differences in OHI-S scores at baseline, 2 months, 4 months, or 6 months ($p> 0.05$). Post hoc analysis further validated that none of the interventions exhibited superiority over the control group regarding oral hygiene status throughout the study period. **(Table IV)**

Salivary pH

Within-group analysis showed that the salivary pH went down a lot over time in both the Control group ($F = 3.29$, $p = 0.03$) and the Calcium Sodium Phosphosilicate group ($p = 0.001$). Post hoc analysis revealed significant reductions from baseline to 4 and 6 months in the Control group, and from baseline to all follow-up intervals in the Calcium Sodium Phosphosilicate group. On the other hand, there were no statistically significant changes in salivary pH in the Sodium Fluoride Mouthwash + Control, Amine Fluoride Toothpaste, or Amine Fluoride Mouthwash + Control groups ($p> 0.05$). This means that the pH levels in these groups stayed pretty stable. **(Table V)**

There were no statistically significant differences in salivary pH between groups at any time point (baseline to 6 months). This means that all groups had similar pH levels throughout the study. **(Table VI)**

Correlation Analysis

There was a statistically significant positive correlation between the Decalcification Index and OHI-S scores in all groups ($p = 0.0001$), with correlation coefficients between 0.56 and 0.77. This suggests that inadequate oral hygiene was consistently linked to heightened enamel decalcification. A correlation analysis of the Decalcification Index and salivary pH showed significant negative correlations in all groups, with the exception of the Calcium Sodium Phosphosilicate group. In the Control, Sodium Fluoride Mouthwash + Control, Amine Fluoride Toothpaste, and Amine Fluoride Mouthwash + Control groups, lower pH levels were linked to higher decalcification scores ($p = 0.0001$). The Calcium Sodium Phosphosilicate group exhibited a tenuous and statistically insignificant correlation. **(Table VII)**

Table I: One-way ANOVA and Post Hoc Analysis of Decalcification Index (Within Group)

GROUPS	TIME POINT	N	MEAN (SD)	F VALUE	*p*-VALUE (WITHIN GROUP)	POST HOC COMPARISON - SIGNIFICANCE (VS. BASELINE)	POST HOC COMPARISON - SIGNIFICANCE (VS. 2M)	POST HOC COMPARISON - SIGNIFICANCE (VS. 4M)
Control (Group A)	Baseline	30	1.00 (.000)	14.44	**0.0001***	—	—	—
	2 Months	30	1.27 (.450)			0.537	—	—
	4 Months	30	1.83 (.791)			**0.0001***	**0.002***	—
	6 Months	30	1.83 (.791)			**0.0001***	**0.002***	1.000
Calcium SodiumPhosphosilicate (Group B)	Baseline	30	1.00 (.000)	12.49	**0.0001***	—	—	—
	2 Months	30	1.30 (.466)			0.235	—	—
	4 Months	30	1.77 (.774)			**0.0001***	**0.009***	—
	6 Months	30	1.70 (.651)			**0.0001***	**0.038***	1.000
Sodium Fluoride Mouthwash + Control (Group C)	Baseline	30	1.00 (.000)	9.41	**0.0001***	—	—	—
	2 Months	30	1.47 (.507)			**0.005***	—	—
	4 Months	30	1.63 (.718)			**0.0001***	1.000	—
	6 Months	30	1.60 (.563)			**0.0001***	1.000	1.000
Amine Fluoride (Group D1)	Baseline	30	1.00 (.000)	3.56	**0.017***	—	—	—
	2 Months	30	1.23 (.430)			0.449	—	—
	4 Months	30	1.37 (.669)			**0.033***	1.000	—
	6 Months	30	1.37 (.615)			**0.033***	1.000	1.000
Amine Fluoride Mouthwash + Control (Group D2)	Baseline	30	1.00 (.000)	5.07	**0.002***	—	—	—
	2 Month	30	1.30 (.466)			0.192	—	—

	s							
	4 Months	30	1.47 (.681)			**0.006***	1.000	—
	6 Months	30	1.47 (.681)			**0.006***	1.000	1.000

***p<0.05 is statistically significant (Shapiro-Wilk test, *p*<0.05)**
One-way ANOVA
Post Hoc Test (Bonferroni Test)

Table II: One-way ANOVA and Post Hoc Analysis of Decalcification Index (Between Group)

TIME POINT	GROUPS	N	MEAN (SD)	F VALUE	*p*-VALUE (BETWEEN GROUP)	POST HOC COMPARISON - SIGNIFICANCE (VS. GROUP A)	POST HOC COMPARISON - SIGNIFICANCE (VS. GROUP B)	POST HOC COMPARISON - SIGNIFICANCE (VS. GROUP C)	POST HOC COMPARISON - SIGNIFICANCE (VS. GROUP D1)
Baseline	Group A	30	1.00 (.000)	0	1	—	—	—	—
	Group B	30	1.00 (.000)			1.000	—	—	—
	Group C	30	1.00 (.000)			1.000	1.000	—	—
	Group D1	30	1.00 (.000)			1.000	1.000	1.000	—
	Group D2	30	1.00 (.000)			1.000	1.000	1.000	1.000
2 Months	Group A	30	1.27 (.450)	1.12	0.34	—	—	—	—
	Group B	30	1.30 (.466)			1.000	—	—	—
	Group C	30	1.30 (.466)			1.000	1.000	—	—
	Group D1	30	1.47 (.507)			0.976	1.000	1.000	—
	Group D2	30	1.23 (.430)			1.000	1.000	1.000	0.537
4 Months	Group A	30	1.83 (.791)	2.19	0.07	—	—	—	—
	Group B	30	1.77 (.774)			1.000	—	—	—
	Group C	30	1.47 (.681)			0.532	1.000	—	—
	Group D1	30	1.63 (.718)			1.000	1.000	1.000	—
	Group D2	30	1.37 (.669)			0.142	0.351	1.000	1.000
6 Months	Group A	30	1.83 (.791)	2.34	**0.04***	—	—	—	—
	Group B	30	1.70 (.651)			1.000	—	—	—
	Group C	30	1.47 (.681)			0.344	1.000	—	—
	Group D1	30	1.60 (.563)			1.000	1.000	1.000	—

	Group D2	30	1.37 (.615)			**0.044***	0.541	1.000	1.000

***p<0.05 is statistically significant (Shapiro-Wilk test, p<0.05)**
One-way ANOVA
Post Hoc Test (Bonferroni Test)

Table III: One-way ANOVA and Post Hoc Analysis of OHI-S (Within Group)

GROUPS	TIME POINT	N	MEAN (SD)	F VALUE	*p*-VALUE (WITHIN GROUP)	POST HOC COMPARISON - SIGNIFICANCE (VS. BASELINE)	POST HOC COMPARISON - SIGNIFICANCE (VS. 2M)	POST HOC COMPARISON - SIGNIFICANCE (VS. 4M)
Control (Group A)	Baseline	30	1.597 (.695)	0.84	0.47	—	—	—
	2 Months	30	1.597 (.705)			1.000	—	—
	4 Months	30	1.847 (1.02)			1.000	1.000	—
	6 Months	30	1.857 (1.02)			1.000	1.000	1.000
Calcium Sodium Phosphosilicate (Group B)	Baseline	30	1.460 (.753)	0.14	0.93	—	—	—
	2 Months	30	1.557 (.822)			1.000	—	—
	4 Months	30	1.583 (.799)			1.000	1.000	—
	6 Months	30	1.547 (.754)			1.000	1.000	1.000
Sodium Fluoride Mouthwash + Control (Group C)	Baseline	30	1.593 (1.05)	0.16	0.97	—	—	—
	2 Months	30	1.663 (1.12)			1.000	—	—
	4 Months	30	1.800 (1.22)			1.000	1.000	—
	6 Months	30	1.640 (1.30)			1.000	1.000	1.000
Amine Fluoride (Group D1)	Baseline	30	1.483 (.848)	0.41	0.74	—	—	—
	2 Months	30	1.573 (.950)			1.000	—	—
	4 Months	30	1.717 (1.00)			1.000	1.000	—
	6 Months	30	1.700 (.954)			1.000	1.000	1.000
Amine Fluoride Mouthwash + Control (Group D2)	Baseline	30	1.573 (.901)	0.08	0.98	—	—	—
	2 Months	30	1.623 (.960)			1.000	—	—
	4	3	1.687			1.000	1.000	—

	Months	0	(1.06)					
	6 Months	30	1.680 (1.04)			1.000	1.000	1.000

***p*<0.05 is statistically significant (Shapiro-Wilk test, *p*<0.05)**
One-way ANOVA
Post Hoc Test (Bonferroni Test)

Table IV: One-way ANOVA and Post Hoc Analysis of OHI-S (Between Group)

TIME POINT	GROUPS	N	MEAN (SD)	F VALUE	*p*-VALUE (BETWEEN GROUP)	POST HOC COMPARISON - SIGNIFICANCE (VS. GROUP A)	POST HOC COMPARISON - SIGNIFICANCE (VS. GROUP B)	POST HOC COMPARISON - SIGNIFICANCE (VS. GROUP C)	POST HOC COMPARISON - SIGNIFICANCE (VS. GROUP D1)
Baseline	Group A	30	1.597 (.695)	0.17	0.95	—	—	—	—
	Group B	30	1.460 (.753)			1.000	—	—	—
	Group C	30	1.593 (1.05)			1.000	1.000	—	—
	Group D1	30	1.483 (.848)			1.000	1.000	1.000	—
	Group D2	30	1.573 (.901)			1.000	1.000	1.000	1.000
2 Months	Group A	30	1.597 (.705)	0.06	0.99	—	—	—	—
	Group B	30	1.557 (.822)			1.000	—	—	—
	Group C	30	1.663 (1.12)			1.000	1.000	—	—
	Group D1	30	1.573 (.950)			1.000	1.000	1.000	—
	Group D2	30	1.623 (.960)			1.000	1.000	1.000	1.000
4 Months	Group A	30	1.847 (1.02)	0.29	0.88	—	—	—	—
	Group B	30	1.583 (.799)			1.000	—	—	—
	Group C	30	1.800 (1.22)			1.000	1.000	—	—
	Group D1	30	1.717 (1.00)			1.000	1.000	1.000	—
	Group D2	30	1.687 (1.06)			1.000	1.000	1.000	1.000
6 Months	Group A	30	1.857 (1.02)	0.35	0.83	—	—	—	—
	Group B	30	1.547 (.754)			1.000	—	—	—
	Group C	30	1.640 (1.30)			1.000	1.000	—	—
	Group D1	30	1.700 (.954)			1.000	1.000	1.000	—
	Group D2	30	1.680 (1.04)			1.000	1.000	1.000	1.000

***p*<0.05 is statistically significant (Shapiro-Wilk test, *p*<0.05)**
One-way ANOVA

Post Hoc Test (Bonferroni Test)

Table V: One-way ANOVA and Post Hoc Analysis of pH of Saliva (Within Group)

GROUPS	TIME POINT	N	MEAN (SD)	F VALUE	*p*-VALUE (WITHIN GROUP)	POST HOC COMPARISON - SIGNIFICANCE (VS. BASELINE)	POST HOC COMPARISON - SIGNIFICANCE (VS. 2M)	POST HOC COMPARISON - SIGNIFICANCE (VS. 4M)
Control (Group A)	Baseline	30	6.860 (.403)	3.29	**0.03***	—	—	—
	2 Months	30	6.710 (.466)			0.905	—	—
	4 Months	30	6.557 (.364)			**0.025***	0.853	—
	6 Months	30	6.557 (.364)			**0.025***	0.853	1.000
Calcium Sodium Phosphosilicate (Group B)	Baseline	30	6.853 (.408)	0.88	**0.001***	—	—	—
	2 Months	30	6.530 (.381)			**0.006***	—	—
	4 Months	30	6.530 (.381)			**0.006***	1.000	—
	6 Months	30	6.507 (.300)			**0.003***	1.000	1.000
Sodium Fluoride Mouthwash + Control (Group C)	Baseline	30	6.833 (.392)	1.37	0.25	—	—	—
	2 Months	30	6.703 (.406)			1.000	—	—
	4 Months	30	6.663 (.409)			1.000	0.651	—
	6 Months	30	6.637 (.418)			1.000	0.383	1.000
Amine Fluoride (Group D1)	Baseline	30	6.823 (.391)	2.21	0.09	—	—	—
	2 Months	30	6.650 (.471)			0.723	—	—
	4 Months	30	6.603 (.470)			0.301	1.000	—
	6 Months	30	6.557 (.373)			0.125	1.000	1.000
Amine Fluoride Mouthwash + Control (Group D2)	Baseline	30	6.817 (.386)	0.65	0.58	—	—	—
	2 Months	30	6.730 (.408)			1.000	—	—
	4 Months	30	6.720 (.418)			1.000	1.000	—
	6 Months	30	6.673 (.402)			0.762	1.000	1.000

***$p<0.05$ is statistically significant (Shapiro-Wilk test, $p<0.05$)**

One-way ANOVA
Post Hoc Test (Bonferroni Test)

Table VI: One-way ANOVA and Post Hoc Analysis of pH of Saliva (Between Group)

TIME POINT	GROUPS	N	MEAN (SD)	F VALUE	*p*-VALUE (BETWEEN GROUP)	POST HOC COMPARISON - SIGNIFICANCE (VS. GROUP A)	POST HOC COMPARISON - SIGNIFICANCE (VS. GROUP B)	POST HOC COMPARISON - SIGNIFICANCE (VS. GROUP C)	POST HOC COMPARISON - SIGNIFICANCE (VS. GROUP D1)
Baseline	Group A	30	6.860 (.403)	0.06	0.97	—	—	—	—
	Group B	30	6.853 (.408)			1.000	—	—	—
	Group C	30	6.833 (.392)			1.000	1.000	—	—
	Group D1	30	6.823 (.391)			1.000	1.000	1.000	—
	Group D2	30	6.817 (.386)			1.000	1.000	1.000	1.000
2 Months	Group A	30	6.710 (.466)	1.06	0.37	—	—	—	—
	Group B	30	6.530 (.381)			1.000	—	—	—
	Group C	30	6.703 (.406)			1.000	1.000	—	—
	Group D1	30	6.650 (.471)			1.000	1.000	1.000	—
	Group D2	30	6.730 (.408)			1.000	0.727	1.000	1.000
4 Months	Group A	30	6.557 (.364)	1.07	0.37	—	—	—	—
	Group B	30	6.530 (.381)			1.000	—	—	—
	Group C	30	6.663 (.409)			1.000	1.000	—	—
	Group D1	30	6.603 (.470)			1.000	1.000	1.000	—
	Group D2	30	6.720 (.418)			1.000	0.752	1.000	1.000
6 Months	Group A	30	6.557 (.364)	0.97	0.42	—	—	—	—
	Group B	30	6.507 (.300)			1.000	—	—	—
	Group C	30	6.637 (.418)			1.000	1.000	—	—
	Group D1	30	6.557 (.373)			1.000	1.000	1.000	—
	Group D2	30	6.673 (.402)			1.000	0.866	1.000	1.000

***$p<0.05$ is statistically significant (Shapiro-Wilk test, $p<0.05$)**
One-way ANOVA
Post Hoc Test (Bonferroni Test)

Table VII: Correlation Analysis of Decalcification Index with OHI-S and pH of Saliva

GROUPS	OHI-S (r-Value)	OHI-S (*p*-Value)	pH of Saliva (r-Value)	pH of Saliva (*p*-Value)
Control (Group A)	0.69	**0.0001***	-0.59	**0.0001***
Calcium Sodium Phosphosilicate (Group B)	0.61	**0.0001***	-0.11	0.22
Sodium Fluoride Mouthwash + Control (Group C)	0.77	**0.0001***	-0.54	**0.0001***
Amine Fluoride (Group D1)	0.56	**0.0001***	-0.48	**0.0001***
Amine Fluoride Mouthwash + Control (Group D2)	0.73	**0.0001***	-0.48	**0.0001***

Pearson correlation test

DISCUSSION

In a clinical environment, white spot lesions (WSLs) are the earliest signs that enamel is losing minerals. They are also a common concern during fixed orthodontic treatment because plaque builds up around brackets and the pH level in the area goes down.[4,5] If these lesions are not treated, they could become cavitated caries. This is why preventing them is such a crucial part of orthodontic therapy.

The pH of saliva is highly crucial for keeping the levels of demineralization and remineralization in check. If the pH drops below 5.5, it is more likely that enamel will lose minerals. If the pH is neutral or above, it is more likely that remineralization will happen since calcium and phosphate are more available.[6,7] Additionally, oral hygiene status acts as a behavioural factor of WSL risk and provides essential context for assessing the clinical effectiveness of preventative medicines.

In this study, all groups showed an increase in the Decalcification Index (DI) during six months, which proved that fixed appliances naturally increase the risk of enamel demineralization. The level of decalcification, however, differed among the groups. The Control and Calcium Sodium Phosphosilicate (CSPS) groups had the most significant increase in DI, indicating that CSPS alone may be ineffective in preventing WSLs. These findings confirm previous studies that demonstrate no significant advantage of bioactive glass–infused dentifrices over conventional fluoride formulations in orthodontic patients.[8,9]

The Sodium Fluoride Mouthwash + Control group exhibited a degree of protection against enamel demineralization. The limited preventative impact found in this study may be attributable to the relatively lower fluoride concentration (0.044% w/v) applied, in contrast to larger concentrations utilized in other trials. Hanna et al. discovered that elevated fluoride concentrations more effectively inhibited demineralized lesions, underscoring the significance of fluoride dosage for therapeutic efficacy.[10]

Amine fluoride-based therapies demonstrated the least increase in DI, indicating improved defence against WSL advancement. These findings support earlier research demonstrating the effectiveness of amine fluoride mouthwash and toothpaste in reducing the incidence and severity of white spot lesions during orthodontic therapy.[11,12] Amine fluoride's surface-active qualities may help fluoride stay on enamel longer and make it more resistant to acid attacks, especially if you use it for a long time.

The outcomes of decalcification varied; nonetheless, there were no significant alterations in OHI-S scores, either within or across groups, throughout the study period. This differs from short-term research indicating that amine fluoride or fluoride-based therapies reduce plaque and gingival indices.[13–15] These discrepancies may stem from the duration of the research, the indices employed (OHI-S compared to PI and GI), the nature of the items utilized, and the adherence of patients to the prescribed protocols. Despite this, the strong positive link seen between OHI-S scores and DI fits with what we already know: poor oral hygiene is a major risk factor for getting WSL, even with fluoride treatment.[16-20]

The analysis of salivary pH showed that it dropped significantly over time in both the Control and CSPS groups. This suggests that the mouth is becoming more acidic, which is good for demineralization. The pH levels, however, remained constant in the Sodium Fluoride and Amine Fluoride groups. This supports previous studies that indicated fluoride-based treatments assist in maintaining consistent salivary pH levels.[21,22] The absence of a significant pH–decalcification connection in the CSPS group contrasts with several research suggesting buffering benefits of CSPS,[23] potentially due to differences in study design, duration, or patient characteristics.

Correlation analysis demonstrated a strong negative association between salivary pH and DI across the majority of groups, hence corroborating the documented involvement of acidic oral environments in the etiology of white spot lesions (WSL).[24,25] These results show that WSL development is affected by many different factors, showing howchemical prophylaxis, salivary parameters, and dental hygiene behaviours, all work together.

Within the limitations of this in vivo observational investigation, the results suggest that amine fluoride–based preventive medications offer superior protection against enamel decalcification during fixed orthodontic treatment, particularly when combined with appropriate oral hygiene practices. However, no single prophylactic treatment was sufficient to completely prevent WSLs, underscoring the need to improve plaque control methods alongside chemical preventive approaches.

CONCLUSION

White spot lesions are still a common and clinically important problem that can happen during fixed orthodontic treatment. This study assessed the relative efficacy of various prophylactic agents and their correlation with oral hygiene status and salivary pH over a six-month duration.

All groups exhibited an increase in enamel decalcification, thereby corroborating the heightened risk linked to fixed appliances. The degree of white spot lesion progression, however, differed across interventions. The Control and Calcium Sodium Phosphosilicate groups exhibited the most significant increase in decalcification, suggesting restricted protective efficacy. The Amine Fluoride Mouthwash, when used with regular oral hygiene, showed the least progression of white spot lesions and the best results after six months.

No statistically significant changes in oral hygiene status (OHI-S) were observed within or between groups, indicating similar oral hygiene practices throughout the study. Nonetheless, a robust positive correlation between OHI-S and enamel decalcification underscores inadequate oral hygiene as a significant risk factor for the development of white spot lesions.

Salivary pH analysis indicated a substantial reduction in the Control and Calcium Sodium Phosphosilicate groups, whereas pH levels remained constant in the Sodium Fluoride and Amine Fluoride groups, suggesting enhanced pH stabilization with fluoride-based interventions. A moderate negative correlation between salivary pH and decalcification underscores the significance of an acidic oral environment in enamel demineralization.

Within the constraints of this study, amine fluoride–based mouthwash proved to be the most efficacious prophylactic measure in reducing the progression of white spot lesions and preserving salivary pH during fixed orthodontic treatment. These results highlight the necessity of integrating pH-stabilizing prophylactic agents with continuous oral hygiene reinforcement to mitigate enamel demineralization. Long-term studies that include more clinical and behavioural factors are needed to improve preventive strategies in orthodontic care.

REFERENCES

1. Srivastava K, Tikku T, Khanna R, Sachan K. Risk factors and management of white spot lesions in orthodontics. J Orthod Sci. 2013;2:43–9.
2. Fejerskov O, Kidd E, Nyvad B, Baelum V. Dental Caries: The Disease and Its Clinical Management. Victoria: Blackwell Publishing Asia Pty Ltd; 2008.
3. Bishara SE, Ostby AW. White spot lesions: formation, prevention, and treatment. Semin Orthod. 2008;14(3):174–82.
4. Øgaard B. Prevalence of white spot lesions in 19-year-olds: a study on untreated and orthodontically treated persons 5 years after treatment. Am J Orthod Dentofacial Orthop. 1989;96(5):423–7.
5. Gorelick L, Geiger AM, Gwinnett AJ. Incidence of white spot formation after bonding and banding. Am J Orthod. 1982;81:93–8.
6. Featherstone JD. The continuum of dental caries—evidence for a dynamic disease process. *J Dent Res*. 2004;83 Spec No C:C39–42.
7. Julian E, Tarres J, Beltran G, Vinuesa T, Torres B, Alía P, et al. Salivary pH and caries risk in orthodontic patients. *BMC Oral Health*. 2016;16(1):131.
8. Hoffman DA, Clark AE, Rody WJ Jr, McGorray SP, Wheeler TT. The effect of a NovaMin-containing dentifrice on white spot lesions and gingivitis during orthodontic treatment: a randomized clinical trial. *Am J Orthod Dentofacial Orthop*. 2015;148(3):440–7.
9. Johal A, Keogh A, Bolooki H. The effectiveness of Bio-Min toothpaste in the management of white spot lesions: a randomised control trial. Trials. 2024;25:605.
10. Enerbäck H, Lövgren ML, Strömberg N, Westerlund A. Effect of high-fluoride toothpaste and mouth rinse on the prevention of demineralized lesions during orthodontic treatment: a randomized controlled trial. Eur J Orthod. 2023 Oct;45(5):477–484.
11. Ravi Kiran KR, Sabrish S, Mathew S, Shivamurthy PG, Sagarkar R. Effectiveness of amine fluoride mouthwash in preventing white spot lesions during fixed orthodontic therapy: A randomized control trial. Indian J Dent Res. 2023;34(3):261–5.
12. Nalawade VA, Jeri SY, Dash BP, Narayanamurthy S, Mohammed JS, Babu M. Effectiveness of various remineralizing agents on white spot lesions after orthodontic treatment: a comparative study. J Contemp Dent Pract. 2021 May;22(5):545–548.
13. Madléna M, Dombi C, Gintner Z, Bánóczy J. Effect of amine fluoride/stannous fluoride toothpaste and mouthrinse on dental plaque accumulation and gingival health. *Oral Dis*. 2004;10(5):294–7.
14. Lorenz K, Hoffmann T, Heumann C, Noack B. Effect of toothpaste containing amine fluoride and stannous chloride on the reduction of dental plaque and gingival inflammation: a randomized controlled 12-week home-use study. Int J Dent Hyg. 2019;17(3):237–243.
15. Sundas S, Rao A. Comparative evaluation of 0.2% chlorhexidine and 0.05% sodium fluoride mouthwashes on plaque reduction: a randomized controlled trial. J Nepal Health Res Counc. 2015 May;13(30):133–37.
16. Doley S, Srivastava M, Piplani A, Gupta R, Gautam Y, Singh C. Status of dental caries and its association with oral hygiene practices among school-going children of rural and urban areas in Kamrup district of Assam. Int J Clin Pediatr Dent. 2022;15(2):182–6.
17. Austin D, JayaKumar HL, Chandra KM, Kemparaj V, Prahladka P. Cross-sectional study on white spot lesions and its association with dental caries experience among school children. Int J Clin Pediatr Dent. 2020;13(2):107–112.
18. Nicoline LH, Luciana F, Heitor H, Marcos FP. The influence of oral hygiene on white spot lesion development during fixed orthodontic treatment: A systematic review. Angle Orthod. 2021;91(4):491–498.
19. Alavi S, Yaraghi N. The effect of fluoride varnish and chlorhexidine gel on white spots and gingival and plaque indices in fixed orthodontic patients: A placebo-controlled study. Dent Res J (Isfahan). 2018;15(4):276–282.
20. Eltayeb M, Elhassan E, Shama O, El-Sohemy A. Prevalence and risk factors of white spot lesions among

patients undergoing fixed orthodontic treatment. J Orthod Sci. 2021;10:12.
21. Khoriba HA, Raafat R. Salivary pH changes after using a 0.05% sodium fluoride mouth rinse and Miswak in high-caries-risk patients. Egypt Dent J. 2024;70(1):699–705.
22. Frese C, Wohlrab T, Sheng L, Kieser M, Krisam J, Wolff D. Clinical effect of stannous fluoride and amine fluoride containing oral hygiene products: A 4-year randomized controlled pilot study. Sci Rep. 2019;9(1):7681.
23. Athuluru D, Reddy C, Sudhir KM, Kumar K, Gomasani S, Nagarakanti S. Evaluation and comparison of efficacy of three desensitizing dentifrices on dentinal hypersensitivity and salivary biochemical characteristics: a randomized controlled trial. Dent Res J (Isfahan). 2017 Mar-Apr;14(2):150–157.
24. Al-Blaihed M, Al-Shahrani I, Al-Mutairi M. White spot lesions in orthodontics: A literature review. Saudi Dent J. 2018;30(3):143–152.
25. Ludovichetti FS, Chibinski AC, Nunes MF, Bagnato VS. Effectiveness of fluoride-based agents in preventing enamel demineralization: a review. Braz Oral Res. 2019;33:e032.