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Association Between Dental Fluorosis Severity and Periodontal Health Parameters: A Retrospective Institutional Study

Running Title : Dental Fluorosis and Periodontal Health

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Abstract

Background: Dental fluorosis is a developmental enamel defect caused by excessive fluoride exposure during tooth formation. Surface irregularities associated with fluorosis may influence plaque accumulation and periodontal health. Evaluation of periodontal status in fluorosis-affected individuals is important for understanding its clinical implications.

Aim: To evaluate the association between dental fluorosis severity and periodontal health parameters among patients attending a dental teaching institution.

Materials and Methods: This retrospective institutional study was conducted using patient records from January 2020 to January 2026. A total of 200 patient records with documented Dean's Fluorosis Index scores and complete periodontal charting were included. Patients were categorized into normal, questionable, very mild, mild, moderate, and severe fluorosis groups according to Dean's Fluorosis Index. Periodontal parameters including Plaque Index (PI), Gingival Index (GI), probing pocket depth (PPD), clinical attachment loss (CAL), and bleeding on probing were recorded. Statistical analysis was performed using Chi-square test and one-way ANOVA.

Results: Mild fluorosis constituted the highest proportion of cases (34%), followed by moderate fluorosis (24%). Periodontal parameters demonstrated progressive deterioration with increasing fluorosis severity. The mean Plaque Index increased from 0.74 ± 0.22 in normal fluorosis cases to 2.18 ± 0.46 in severe fluorosis cases ($p = 0.001$). Gingival Index scores increased from 0.68 ± 0.19 to 2.04 ± 0.52 ($p = 0.001$). Mean probing pocket depth increased from 2.1 ± 0.3 mm to 4.3 ± 0.7 mm ($p = 0.003$), while clinical attachment loss increased from 0.5 ± 0.2 mm to 3.1 ± 0.8 mm ($p = 0.002$). Bleeding on probing was observed in 12.5% of normal fluorosis cases and 75% of severe fluorosis cases ($p = 0.004$).

Conclusion: Increased dental fluorosis severity was associated with poorer periodontal health parameters, particularly in moderate and severe fluorosis groups.

Keywords: Dental fluorosis; periodontal health; Dean's Fluorosis Index; plaque index; gingival index; retrospective study

Introduction :

Dental fluorosis is a developmental disturbance of enamel caused by excessive fluoride exposure during the period of tooth development. It occurs as a result of chronic ingestion of fluoride beyond optimal levels during amelogenesis, leading to alterations in enamel mineralization and maturation (1). The condition is characterized clinically by diffuse enamel opacities, discoloration, surface roughness, pitting, and structural defects depending on the severity of fluoride exposure. Dental fluorosis remains a significant public health concern in several regions worldwide, particularly in areas with naturally elevated fluoride levels in drinking water (2).

Fluoride is considered beneficial for prevention of dental caries when present within recommended concentrations. Its cariostatic action contributes to enamel remineralization and inhibition of demineralization, thereby reducing caries prevalence. However, prolonged exposure to excessive fluoride during enamel formation may adversely affect ameloblast function, resulting in hypomineralized and porous enamel. The severity of fluorosis depends on multiple factors including fluoride concentration, duration of exposure, nutritional status, climatic conditions, and individual susceptibility (3). The prevalence of dental fluorosis has increased considerably over recent decades because of multiple sources of fluoride exposure including drinking water, fluoridated toothpaste, dietary supplements, and industrial sources. In endemic regions, fluorosis affects both esthetics and oral health, often leading to psychosocial concerns and reduced quality of life. The condition is particularly significant in developing countries where groundwater fluoride concentrations frequently exceed optimal limits (4).

Dean's Fluorosis Index remains one of the most widely accepted and commonly used indices for assessment of fluorosis severity. The index categorizes fluorosis into normal, questionable, very mild, mild, moderate, and severe forms based on the clinical appearance of enamel changes. Very mild and mild fluorosis typically present as small opaque white areas on enamel surfaces, whereas moderate and severe fluorosis demonstrate marked discoloration, enamel pitting, and structural surface irregularities. As fluorosis severity increases, enamel surfaces become increasingly rough and porous, which may favor plaque retention and impair effective oral hygiene maintenance (5).The structural alterations associated with fluorosis may have important implications for periodontal health. Rough and irregular enamel surfaces can facilitate accumulation of plaque and calculus, thereby increasing the risk of gingival inflammation and periodontal destruction. Plaque biofilm is considered the primary etiological factor in periodontal disease, and any condition that promotes plaque retention may indirectly contribute to periodontal breakdown. Individuals affected with moderate and severe fluorosis may therefore be at increased risk for compromised periodontal health due to difficulties in maintaining adequate oral hygiene (6). Periodontal diseases are chronic inflammatory conditions affecting the supporting structures of the teeth, including gingiva, periodontal ligament, cementum, and alveolar bone. They are among the most prevalent oral diseases worldwide and remain a major cause of tooth loss in adults. The initiation and progression of periodontal disease are influenced by multiple local and systemic factors, with plaque accumulation serving as the principal etiological factor. Gingival inflammation caused by persistent plaque biofilm may progress to periodontal destruction characterized by increased probing depth, attachment loss, bone loss, and tooth mobility (7). Apart from plaque retention, esthetic concerns associated with fluorosis may also influence oral hygiene behavior and dental attendance patterns. Individuals with severe fluorosis may exhibit altered brushing practices because of enamel sensitivity or psychological concerns related to tooth appearance. Such factors may further contribute to deterioration of periodontal health over time. Additionally, surface irregularities and pitting in fluorosed enamel may create niches favorable for microbial colonization, thereby increasing gingival inflammation and periodontal tissue breakdown (8). Several studies have extensively investigated the relationship between fluorosis and dental caries; however, limited literature is available regarding the association between fluorosis severity and periodontal health parameters. Existing evidence regarding the influence of fluorosis on periodontal status remains inconsistent and insufficiently explored, particularly in institutional populations. Evaluation of periodontal parameters in fluorosis-affected individuals may therefore provide valuable insight into the potential impact of enamel surface changes on periodontal health.Understanding the relationship between fluorosis severity and periodontal status is important for early diagnosis, preventive care, and periodontal management in affected populations. Identification of periodontal changes associated with fluorosis may help clinicians develop targeted oral hygiene measures and preventive strategies aimed at reducing periodontal complications in fluorosis-affected individuals (9). Therefore, the present retrospective institutional study was undertaken to evaluate the association between fluorosis severity and periodontal health parameters among patients attending a dental teaching institution.

Materials and Methods :

Study Design and Study Setting: The present study was designed as a retrospective institutional record-based analysis. Patient records archived in the institutional electronic database between January 2020 and January 2026 were systematically reviewed and evaluated. The study included patients who had undergone routine periodontal examination along with fluorosis assessment during their dental visits.

Sample Selection: A total of 200 patient records fulfilling the inclusion criteria were included in the study. Case records were selected using simple random sampling from the institutional database. Records with documented Dean's Fluorosis Index scores and complete periodontal charting were included for retrospective evaluation.

Inclusion Criteria

- Patients aged 18 years and above
- Presence of documented Dean's Fluorosis Index scores
- Availability of complete periodontal charting records
- Presence of intraoral clinical photographs

Exclusion Criteria

- Incomplete or missing patient records
- Patients with systemic conditions affecting periodontal health

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- Smokers and tobacco users
- Patients undergoing active periodontal therapy
- Presence of developmental enamel defects other than fluorosis

Data Collection Procedure

The selected patient records were reviewed systematically using the institutional electronic database. Relevant demographic and clinical details were recorded using a standardized data collection sheet.

The following variables were collected:

- Age
- Gender
- Dean's Fluorosis Index score
- Plaque Index (PI)
- Gingival Index (GI)
- Probing Pocket Depth (PPD)
- Clinical Attachment Loss (CAL)

Clinical photographs and periodontal charts available in the institutional database were used for verification wherever necessary.

Assessment of Fluorosis Severity

Fluorosis severity was assessed using Dean's Fluorosis Index. The criteria for dental fluorosis classification developed by Dean in 1934 was originally based on a 7-point ordinal scale consisting of normal, questionable, very mild, mild, moderate, moderately severe, and severe fluorosis. Subsequently, a modified 6-point ordinal scale introduced in 1942 became widely used in epidemiological and clinical studies.

The following classification was used in the present study:

- 0 – Normal
- 1 – Questionable fluorosis
- 2 – Very mild fluorosis
- 3 – Mild fluorosis
- 4 – Moderate fluorosis
- 5 – Severe fluorosis

Patients were categorized based on the recorded Dean's Fluorosis Index scores documented in the institutional records and clinical photographs.

Periodontal Assessment

Periodontal health status was assessed using routinely documented periodontal parameters including Plaque Index, Gingival Index, probing pocket depth, and clinical attachment loss obtained from periodontal charting records.

Statistical Analysis

The collected data were entered into Microsoft Excel and analyzed using SPSS software version 23.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were expressed as frequency, percentage, mean, and standard deviation. Association between fluorosis severity and periodontal health parameters was analyzed using Chi-square test and one-way ANOVA. A p-value less than 0.05 was considered statistically significant.

Results :

A total of 200 patient records were retrospectively evaluated in the present study. Based on Dean's Fluorosis Index, patients were categorized into normal, questionable, very mild, mild, moderate, and severe fluorosis groups. Mild fluorosis constituted the highest proportion of cases (34%), followed by moderate fluorosis (24%), very mild fluorosis (18%), questionable fluorosis (12%), severe fluorosis (8%), and normal fluorosis (4%).

Evaluation of periodontal parameters demonstrated progressive deterioration in periodontal health with increasing fluorosis severity. Patients categorized under normal and questionable fluorosis demonstrated comparatively lower plaque accumulation and gingival inflammation, whereas moderate and severe fluorosis groups exhibited poorer periodontal health parameters.

The mean Plaque Index scores increased progressively from 0.74 ± 0.22 in the normal fluorosis group to 2.18 ± 0.46 in the severe fluorosis group, showing a statistically significant association between fluorosis severity and plaque accumulation ($p = 0.001$). Similarly, Gingival Index scores increased from 0.68 ± 0.19 in normal fluorosis cases to 2.04 ± 0.52 in severe fluorosis cases ($p = 0.001$).

Probing pocket depth also demonstrated an increasing trend with fluorosis severity. The mean probing depth increased from 2.1 ± 0.3 mm in normal fluorosis cases to 4.3 ± 0.7 mm in severe fluorosis cases, demonstrating statistical significance ($p = 0.003$). Clinical attachment loss showed a similar pattern, increasing from 0.5 ± 0.2 mm in normal fluorosis to 3.1 ± 0.8 mm in severe fluorosis groups ($p = 0.002$).

Bleeding on probing was observed in only 12.5% of normal fluorosis cases, whereas 75% of severe fluorosis cases demonstrated bleeding on probing, indicating increased gingival inflammation with increasing fluorosis severity ($p = 0.004$).

Overall, patients with moderate and severe fluorosis demonstrated comparatively poorer periodontal health parameters than individuals with normal, questionable, very mild, and mild fluorosis.

Table 1: Distribution of Dean's fluorosis index categories and periodontal health parameters among the study population

Variable	Normal (n=8)	Questionable (n=24)	Very Mild (n=36)	Mild (n=68)	Moderate (n=48)	Severe (n=16)	p-value
Male n (%)	4 (50.0)	12 (50.0)	18 (50.0)	38 (55.9)	28 (58.3)	9 (56.3)	0.428
Female n (%)	4 (50.0)	12 (50.0)	18 (50.0)	30 (44.1)	20 (41.7)	7 (43.7)	
Mean Plaque Index (PI)	0.74 ± 0.22	0.88 ± 0.26	1.02 ± 0.31	1.36 ± 0.42	1.84 ± 0.51	2.18 ± 0.46	0.001*
Mean Gingival Index (GI)	0.68 ± 0.19	0.81 ± 0.24	0.96 ± 0.30	1.28 ± 0.38	1.72 ± 0.49	2.04 ± 0.52	0.001*
Mean Probing Pocket Depth (PPD) (mm)	2.1 ± 0.3	2.3 ± 0.4	2.5 ± 0.5	2.9 ± 0.6	3.6 ± 0.7	4.3 ± 0.7	0.003*
Mean Clinical Attachment Loss (CAL) (mm)	0.5 ± 0.2	0.7 ± 0.3	1.0 ± 0.4	1.4 ± 0.5	2.2 ± 0.7	3.1 ± 0.8	0.002*
Bleeding on Probing Present n (%)	1 (12.5)	5 (20.8)	10 (27.8)	24 (35.3)	30 (62.5)	12 (75.0)	0.004*

*Statistically significant ($p < 0.05$).

Discussion :

The present retrospective institutional study evaluated the association between dental fluorosis severity and periodontal health parameters among patients attending a dental teaching institution. The findings demonstrated that increasing fluorosis severity was associated with comparatively poorer periodontal health parameters, including increased plaque accumulation, gingival inflammation, probing pocket depth, and clinical attachment loss. Patients with moderate and severe fluorosis consistently demonstrated greater periodontal deterioration when compared to individuals with normal, questionable, very mild, and mild fluorosis (10).

Dental fluorosis is a developmental enamel defect caused by excessive fluoride exposure during enamel formation. As fluorosis severity increases, enamel surfaces become rougher and more porous because of hypomineralization and pitting. These structural surface changes may favor plaque retention and microbial colonization, thereby influencing periodontal health. In the present study, plaque accumulation progressively increased with increasing fluorosis severity (11). Patients with severe fluorosis demonstrated the highest Plaque Index scores, whereas individuals with normal and questionable fluorosis showed comparatively lower plaque accumulation. This finding suggests that surface irregularities associated with fluorosis may interfere with effective plaque control and oral hygiene maintenance.

Gingival inflammation also demonstrated an increasing trend with fluorosis severity. The Gingival Index scores were comparatively higher among moderate and severe fluorosis groups, indicating greater gingival inflammation and bleeding tendency. Persistent plaque accumulation adjacent to gingival tissues may initiate inflammatory

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changes leading to gingivitis and progression of periodontal disease. Bleeding on probing was also more prevalent among severe fluorosis cases, further supporting the association between fluorosis severity and compromised gingival health (12).

The present study additionally demonstrated increasing probing pocket depth and clinical attachment loss with increasing fluorosis severity. Patients with severe fluorosis exhibited deeper periodontal pockets and greater attachment loss compared to patients with normal and mild fluorosis. Chronic plaque accumulation and prolonged gingival inflammation may contribute to periodontal tissue destruction over time. These findings suggest that severe fluorosis may indirectly influence periodontal breakdown by promoting conditions favorable for plaque retention and impaired oral hygiene maintenance (13).

The findings of the present study are consistent with previous studies reporting increased plaque retention and gingival inflammation in fluorosis-affected individuals. Several authors have suggested that rough enamel surfaces associated with fluorosis may predispose patients to periodontal inflammation by facilitating microbial accumulation (14). The comparatively better periodontal health observed among normal, questionable, and very mild fluorosis groups in the present study further supports the influence of fluorosis severity on periodontal status.

Apart from enamel surface irregularities, esthetic concerns associated with fluorosis may also influence oral hygiene behavior and dental attendance patterns. Individuals with severe fluorosis may demonstrate reduced motivation toward oral hygiene maintenance because of discoloration and enamel defects. Such factors may further contribute to periodontal disease progression (15).

The present study highlights the importance of early periodontal evaluation and preventive care in fluorosis-affected individuals. Patients with moderate and severe fluorosis may require regular periodontal monitoring, oral hygiene reinforcement, and preventive periodontal therapy to minimize periodontal deterioration associated with plaque retention.

Limitations :

The present study has certain limitations. As a retrospective institutional study, the analysis depended on previously recorded clinical data and availability of complete patient records. Factors such as oral hygiene practices, dietary habits, socioeconomic status, and duration of fluoride exposure were not evaluated. In addition, the study was conducted in a single institutional setting, which may limit generalizability of the findings.

Overall, the findings of the present study suggest that increasing fluorosis severity may be associated with deterioration of periodontal health parameters. Moderate and severe fluorosis demonstrated comparatively greater plaque accumulation, gingival inflammation, probing depth, and attachment loss, emphasizing the importance of preventive periodontal care and regular oral hygiene maintenance in fluorosis-affected individuals.

Conclusion :

Within the limitations of the present retrospective study, increased dental fluorosis severity was associated with poorer periodontal health parameters, including greater plaque accumulation, gingival inflammation, probing pocket depth, and clinical attachment loss. Moderate and severe fluorosis demonstrated comparatively compromised periodontal status when compared to mild and very mild fluorosis groups.

Conflicts of interest : nil
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