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Original Research

Assessment of dental and skeletal fluorosis and its correlation with gingival/ periodontal diseases with clinical, radiographic, biochemical parameters, and urine fluoride level in fluoridated area of Sriganganagar, Rajasthan, India: A cross-sectional study

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ABSTRACT:
Background: In human nutrition, fluorine has two purposes: it can cause significant damage to bone and dental tissues while also preventing dental caries at a certain intake level. The present study was conducted to assess the prevalence of skeletal and non-skeletal Fluorosis and its relationship with Gingivitis or Periodontitis by evaluating Clinical, Biochemical, Radiological changes, water and Urine examination in patients visiting to Department of Periodontics, Surendera Dental College & Research Institute, Sriganganagar, Rajasthan.**Materials & Methods:**300 patients (both males & females) of Gingivitis or any form of Periodontitis aged between 15-75 years reporting to the department of Periodontics were selected. Gingival index (GI), plaque index (PI), probing pocket depth (PPD), Dean Fluorosis index (DFI) was recorded. Radiographic parameters (OPG, skull radiographs and X-rays of long bones), Biochemical parameters [RBC count, hemoglobin concentration (Hb%), serum fluoride level, and erythrocyte sedimentation rate (ESR)], water and urine fluoride level were recorded in each patient.**Results:**Theprevalence of gingivitis was 59.7% and periodontitis was 40.3%. In 72 (24%) gingivitis was localized and in 107 (35.6%) was generalized. In 23 (7.6%) it was aggressive periodontitis. Chronic periodontitis was localized in 57 (19%) and generalized in 41 (13.6%). Water fluoride level at different region ranged from 10.0 ppm to 15.0 ppm. Highest was recorded in Vill.1LNP, Sriganganagar (15.0 ppm) and lowest in SDC Campus, Gol Bazar, Vill.13G Chhoti, Vill. 4KLM and Vill.1D, Sriganganagar (10.0 ppm). The mean water fluoride level was 12.5±6.4 ppm, urine fluoride level was 3.1±1.6 ppm and serum fluoride level was 2.8± 0.7 ppm. **Conclusion:** There was increase in prevalence of gingival disease in subjects with dental fluorosis. The severity of gingivitis increased with increase in water and urine fluoride levels.
Keywords: Dental fluorosis, Gingivitis, Periodontitis

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INTRODUCTION

In human nutrition, fluorine has two purposes: it can cause significant damage to bone and dental tissues while also preventing dental caries at a certain intake level. [1] Skeletal changes and mottled enamel can happen when the fluoride content of drinking water above 2 parts per million. [2] Fluoride is rapidly absorbed by mineralized tissues, such as developing teeth and bone, according to clinical research. [3,4] The recommended daily intake of fluoride for adults is 1.5–4.0 mg, while lower levels are advised for children and those with renal impairment. [5] In endemic areas, daily fluoride intake ranges from 10 to 35 mg, and it may even be higher in the summer.

Because they are detrimental to human health, fluoride levels that are either below or beyond the permitted range should not be taken. Among the negative consequences of fluoride include tooth and

skeletal fluorosis. Additionally, the R.B.C. cell wall is impacted. The membrane structure of red blood cells, which contains the chemical components that determine blood type chemicals, has been the subject of extensive investigation. It is now known that when fluoride is consumed, it will accumulate on the erythrocyte membrane in addition to other cells, tissues, and organs. As a result, calcium is lost from the erythrocyte membrane.[5]

Gingivitis is inflammation of the gingiva and is reversible, but periodontitis is multifactorial and irreversible. Among the numerous risk factors for periodontal disease include age, sex, race, socioeconomic situation, cigarette smoking, systemic illnesses, and oral hygiene status. The interaction of these factors may lead to both advanced stages of periodontitis. The influence of fluoride on periodontal tissues is less clear, despite its well-established role in preventing tooth cavities. [6, 7], and [8] Studies have shown that gingival inflammation is higher in areas afflicted by fluorosis than in areas unaffected. [9,10] Other studies, however, did not find any difference in periodontal health between locations that were and were not fluoridated; in fact, some even proposed that areas that were fluoridated had greater gingival health. [11]

Hence, the present study was conducted to assess the prevalence of skeletal and non-skeletal Fluorosis and its relationship with Gingivitis or Periodontitis by evaluating Clinical, Biochemical, Radiological changes, water and Urine examination in patients visiting to Department of Periodontics, Surendera Dental College & Research Institute, Sriganganagar, Rajasthan.

MATERIALS & METHODS

The study was carried out on 300 patients (both males & females) of Gingivitis or any form of Periodontitis aged between 15-75 years reporting to the department of Periodontics, Surendera Dental College & Research Institute, Sriganganagar, Rajasthan. Ethical clearance was obtained from the Institutional Ethical Committee. Informed written consent was taken from study participants for being a part of the study.

Data such as name, age, gender etc. was recorded. A pre-designed structured questionnaire was used to collect information regarding oral hygiene practices, diet, source of drinking water. A complete oral examination was done and gingival index (GI), plaque index (PI), probing pocket depth (PPD), Dean Fluorosis index (DFI) was recorded on case history proforma. Radiographic parameters (OPG, skull radiographs and X-rays of long bones), Biochemical parameters [RBC count, hemoglobin concentration (Hb%), serum fluoride level, and erythrocyte sedimentation rate (ESR)], water and urine fluoride level were recorded in each patient. Results thus obtained were subjected to statistical analysis. P value < 0.05 was considered significant.

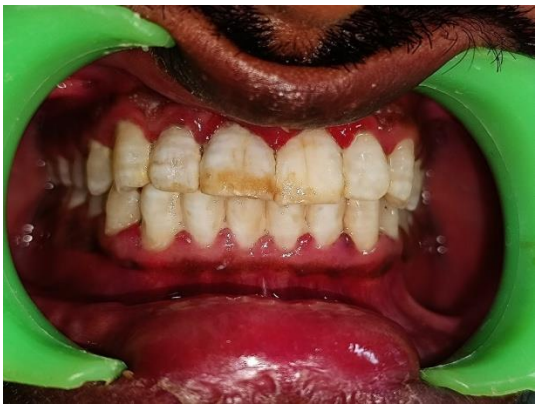

Figure I- Dental fluorosis and gingivitis

Figure II- Dental fluorosis and Periodontitis

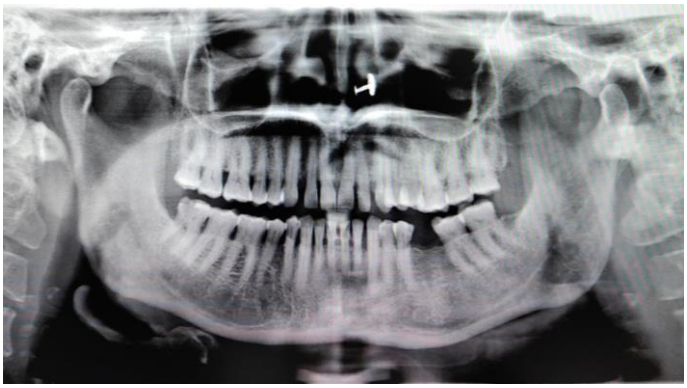

Fig III-OPG shows prominent marrow spaces

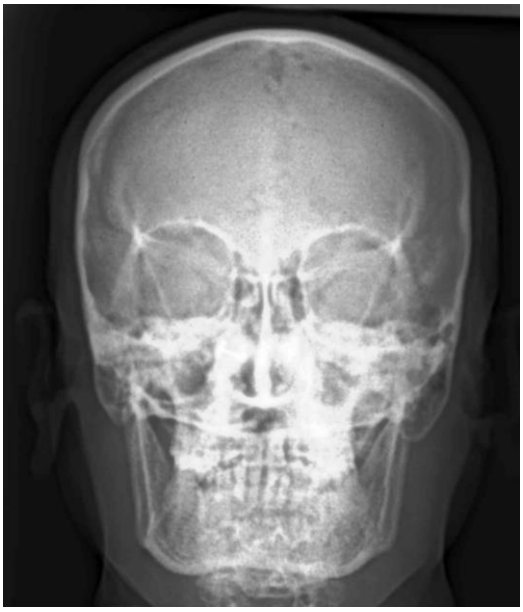

Fig IV- Skull radiograph shows thickened inner and outer table

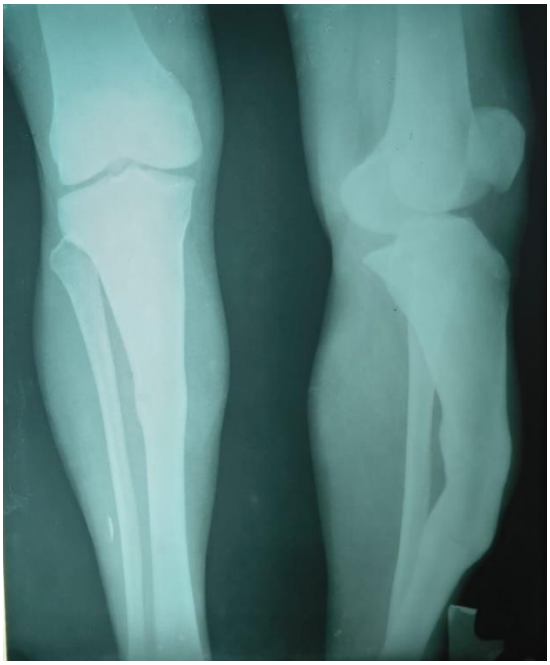

Fig V a- Radiograph showing barrowing of long bones

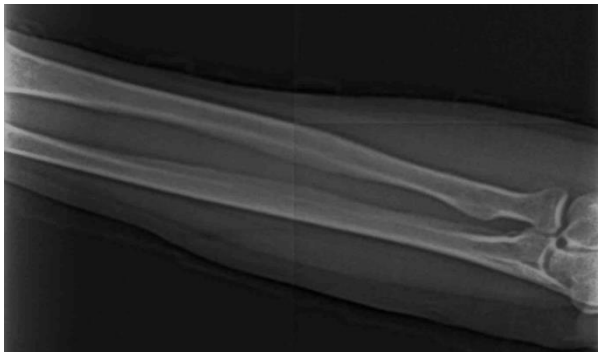

Fig V b- Radiograph showing barrowing of long bones

RESULTS

Table IDistribution of patients

Age group (years)	Male	Female	Total
15-25	24	30	54
26-35	55	58	113
36-45	46	32	78
46-55	20	7	27
56-65	9	8	17
66-75	6	5	11
Total	160	140	300

Table I shows that age group 15-25 years had 24 males and 30 females, 26-35 years had 55 males and 58 females, 36-45 years had 46 males and 32 females, 46-55 years had 20 males and 7 females, 56-65 years had 9 males and 8 females and 66-75 years had 6 males and 5 female patients.

Table II Assessment of parameters

Index	Interpretation	Number	Percentage
Plaque index	Excellent	0	0
	Good	47	15.7%
	Fair	178	59.3%
	Poor	75	25.0%
Gingival index	Mild	35	11.7%
	Moderate	181	60.3%
	Severe	84	28.0%
Dean’s Fluorosis index	Normal	0	0
	Questionable	16	5.3%
	Very mild	31	10.3%
	Mild	84	28.0%
	Moderate	112	37.3%
	Moderately severe	42	14.0%
	Severe	15	5.0%

Table II shows that plaque index found to be good in 47 (15.7%), fair in 178 (59.3%), poor in 75 (25.0%). Gingival index was mild in 35 (11.7%), moderate in 181 (60.3%) and severe in 84 (28.0%). Dean’s Fluorosis index was questionable in 16 (5.3%), very mild in 31 (10.3%), mild in 84 (28.0%), moderate in 112 (37.3%), moderately severe in 42 (14.0%) and severe in 15 (5.0%) patients.

Table III Prevalence of Gingivitis and Periodontitis

Disease		Number	Percentage	Prevalence of disease (Percentage)
Gingivitis	Localized	72	24%	59.7%
	Generalized	107	35.6%	
Aggressive Periodontitis		23	7.6%	40.3%
Chronic Periodontitis	Localized	57	19%	
	Generalized	41	13.6%	

Table III shows that prevalence of gingivitis was 59.7% and periodontitis was 40.3%. In 72 (24%) gingivitis was localized and in 107 (35.6%) was generalized. In 23 (7.6%) it was aggressive periodontitis. Chronic periodontitis was localized in 57 (19%) and generalized in 41 (13.6%).

Table IV Water fluoride level at various region

Location	Fluoride level
SDC Campus, Sriganganagar	10.0 ppm
Vill. Sadhuwali	14.0 ppm
Ridhi Sidhi Enclave, Sriganganagar	13.0 ppm
Basti near Railway Track, Sriganganagar	15.0 ppm
Mahalakshmi Enclave, Sriganganagar	12.0 ppm
Near Bus stand, Sriganganagar	14.0 ppm
Jawahar Nagar, Sriganganagar	11.0 ppm
Vill. Fojuwala	12.0 ppm
Near canal, Sriganganagar	11.0 ppm
Gol Bazar, Sriganganagar	10.0 ppm
Vill. 3E	15.0 ppm
Vill. 2E	14.0 ppm
Vill. Choti E	13.0 ppm
Vill. Ganeshgarh	15.0 ppm
Vill. Lalgarh Jattan	14.0 ppm
Vill.13G Chhoti	10.0 ppm
Vill. Anupgarh	13.0 ppm
Vill. Karanpur	12.0 ppm
Vill. Gharsana	11.0 ppm
Vill. 4KLM	10.0 ppm
Vill.12Lnp	14.0 ppm
Vill.1D	10.0 ppm
Vill.1Z	14.0 ppm
Vill.1LNP	15.0 ppm

Table IV shows that water fluoride level at different region ranged from 10.0 ppm to 15.0 ppm. Highest was recorded in Vill.1LNP, Sriganganagar (15.0 ppm) and lowest in SDC Campus, Gol Bazar, Vill.13G Chhoti, Vill. 4KLM and Vill.1D, Sriganganagar (10.0 ppm).

Table V Mean values of Hemoglobin and RBC

Parameters	Male	Female	P value
Hemoglobin (g/dl)	12.4±5.2	11.3±2.7	0.04
RBC (million cells per microliter (mcL) of blood)	5.34±3.6	4.61±2.4	0.02
ESR (mm/hour)	12.5±3.1	14.2±3.6	0.05

Table V shows that mean±SDhemoglobin was 12.4±5.2 g/dl in males and 11.3±2.7 g/dl in females. The mean RBC level was 5.34±3.6 million cells/mcL of blood and 4.61±2.4 million cells/mcL of blood. The mean ESR was 12.5±3.1 mm/hour in males and 14.2±3.6 mm/hour in females. The difference was significant (P< 0.05).

Table VI Assessment of water F levels, Urine F levels and Serum F levels

Parameters	Mean	SD
Water F levels	12.5	6.4
Urine F levels	3.1	1.6
Serum F levels	2.8	0.7

Table VI shows that mean water fluoride level was 12.5±6.4 ppm, urine fluoride level was 3.1±1.6 ppm and serum fluoride level was 2.8± 0.7 ppm.

Table VII Assessment of correlation between the clinical and laboratory variables

Parameters	GI	DFI	UFL	WFL	SFL
PI	0.851	0.763	0.382	0.476	0.085
GI	-	0.819	0.571	0.314	0.082
DFI	-	-	0.172	0.753	0.007
UFL	-	-	-	0.421	0.145
WFL	-	-	-	-	0.246

Table VII shows that there was statistically significant strong positive correlation between PI and GI (0.851), PI and DFI (0.763) and GI and DFI (0.819), DFI with Water F levels (0.753). Weak but statistically significant correlations were found between urine fluoride levels with GI (0.571), PI (0.382), DFI (0.819), WFL (0.421),

and between water fluoride levels and PI (0.476), GI (0.314). The correlations between serum and the other variables were not significant (P> 0.05).

DISCUSSION

Periodontal disorders are chronic infectious problems mostly caused by bacteria. Environmental, systemic, genetic, host response, and local factors are among the risk factors associated with periodontal illnesses. Oxidative stress is a major contributor to the pathogenesis of inflammatory diseases such as periodontitis.Panjamurthy et al[12] claimed that because of increased lipid peroxidation products at inflammatory sites, patients with periodontitis may have higher levels of oxidative stress due to abnormalities in the endogenous antioxidant defense system.

The frequency of periodontitis in areas with high water fluoride has varied throughout the world because of the participation of multiple risk factors in its etiology. Fluorosis may be an environmental risk factor for periodontitis due to its effects on the hard and soft structures of the periodontium. Although fluoride's effects on dental hard tissue, which may cause structural problems or enamel mottling (dental fluorosis), have been extensively studied, the effects on oral soft tissues (periodontium) have received less attention. Furthermore, fluoride levels are known to alter the pattern of blood protein distribution and induce genetic alterations that lead to both upregulation and downregulation of genes.[13] The present study was conducted to assess the prevalence of skeletal and non-skeletal Fluorosis and its relationship with Gingivitis or Periodontitis by evaluating Clinical, Biochemical, Radiological changes, water and Urine examination.

In our study, age group 15-25 years had 24 males and 30 females, 26-35 years had 55 males and 58 females, 36-45 years had 46 males and 32 females, 46-55 years had 20 males and 7 females, 56-65 years had 9 males and 8 females and 66-75 years had 6 males and 5 female patients. In a study by Rawlani et al[4], a total of 204 subjects were examined including 116 males and 88 females, the mean age of male subject was 17.4 years and that of female subject was 15.9 years. Singh et al[15] found that out of 1879 patients, maximum patients were seen in age group 31-40 years (27.3%), followed by 18-30 years (25.9%), 41-50 years (21.3%), 51-60 years (16.8%) and >60 (8.7%). 54.5% were males and 45.5% were females. In a study by Nagarajan et al[15] out of 1641 subjects, 47% were males and 53% were females.

We observed that plaque index found to be good in 47 (15.7%), fair in 178 (59.3%), poor in 75 (25.0%). Gingival index was mild in 35 (11.7%), moderate in 181 (60.3%) and severe in 84 (28.0%). Dean's fluorosis index was questionable in 16 (5.3%), very mild in31 (10.3%), mild in 84 (28.0%), moderate in 112 (37.3%), moderately severe in 42 (14.0%) and severe in 15 (5.0%). According to Nagarajan et al[15], 15.5% of the individuals had good and 15.3% had poor plaque scores, whereas the majority (69.2%) had fair interpretations. Moderate and severe dental fluorosis were seen in 30% and 24% of people, respectively. 7.6% of the individuals had questionable dental fluorosis, whereas 21% and 6% of the subjects had very mild and mild dental fluorosis, respectively. The proportion of individuals with normal translucent semi vitriform enamel was just 10.5%. The overall prevalence of dental fluorosis was 89.5%. In a study by Singh et al[14], 58.4% of participants exhibited dental fluorosis, with 27.4% having mild and 19.5% having moderate fluorosis.

In our study, prevalence of gingivitis was 59.7% and periodontitis was 40.3%. In 72 (24%) gingivitis was localized and in 107 (35.6%) was generalized. In 23 (7.6%) it was aggressive periodontitis. Chronic periodontitis was localized in 57 (19%) and generalized in 41 (13.6%). We found that the majority of individuals showed signs of mild plaque buildup. The fluoride-induced microporosities on tooth surfaces that result in more plaque accumulation could be the source of the rise in plaque scores. In a study by Nagarajan et al[15], moderate gingivitis was present in 39% of patients, whereas mild and severe gingivitis were present in 40% and 21% of subjects, respectively. There was a 100% prevalence of gingivitis. 14.4% of subjects showed poor oral hygiene and 23.8% had periodontitis in a study by Singh et al.[14] Our results are in contrast to the findings of Dalvi PJ et al.[16] They found high prevalence of periodontitis as compared to gingivitis in fluorosed group.

In our study, water fluoride level at different region ranged from 10.0 ppm to 15.0 ppm. Highest was recorded in Vill.1LNP, Sriganganagar (15.0 ppm) and lowest in SDC Campus, Gol Bazar, Vill.13G Chhoti, Vill. 4KLM and Vill.1D, Sriganganagar (10.0 ppm). In a study by Sinsiwar et al[17] in Sriganganagar district fluoride level in water ranged from 0.1- 28.2 ppm, in study by Gupta et al[18] it ranged from 0.0- 26.0 ppm and in study by Chaudhary et al[19] 0.5- 5.0 ppm.

In our results, the mean±SDhemoglobin was 12.4±5.2 g/dl in males and 11.3±2.7 g/dl in females. The mean RBC level was 5.34±3.6 million cells/mcL of blood and 4.61±2.4 million cells/mcL of blood. Rawlani found that Hb% in male patients was 12.44 ± 1.76 and in female patients it was 11.31 ± 1.34. RBC count in male patients was 5.03 ± 0.49 and in female patients it was 4.70 ± 0.47. Our findings are in agreement with the findings of the study performed by Gupta S et al.[18]

In present study, the mean ESR was 12.5±3.1 mm/hour in males and 14.2±3.6 mm/hour in females. Rawlani et al[4]found that ESR was raised in female patients (13.29±7.37) than male patients (11.41±8.75). This is in consistent with the results by Gupta S et al.[18]

In our study, the mean water fluoride level was 12.5±6.4 ppm, urine fluoride level was 3.1±1.6 ppm and serum fluoride level was 2.8± 0.7 ppm. Nagarajan et al[15] found that the mean water fluoride level was 1.36 ppm, urine fluoride level was 1.87 ppm, and serum fluoride level was 1.838. Our results showed higher fluoride level as compared to the study by Singh et al.[14]

It was observed that there was statistically significant strong positive correlation between PI and GI (0.851), PI and DFI (0.763) and GI and DFI (0.819), DFI with Water F levels (0.753). Weak but statistically significant correlations were found between urine fluoride levels with GI (0.571), PI (0.382), DFI (0.819), WFL (0.421), and between water fluoride levels and PI (0.476), GI (0.314). The correlations between serum and the other variables were not significant (P> 0.05). Singh et al[14] in their study observed that both the degree of dental fluorosis and periodontitis (p< 0.05) and oral hygiene status (p< 0.01) were found to be significantly correlated with each other.

In the present study, 2% had barrowing of long bone, while 45.0% shows thickened inner and outer table in skull radiograph. 31% showed prominent marrow spaces in jaw bones. These findings correlate with most of the studies conducted by Vandana et al[6], Raja Reddy[20], T. Chakma. S.B. Singh.[21]

Anthropogenic factors are not the cause of the very high F concentration found in the groundwater of Rajasthan's 33 districts. It results from the natural occurrence of more F-bearing minerals in the host rocks and sediments.[22]Granites, gneisses, mica, schists, limestone, sandstone, phosphorite, shales, clays, acid igneous rocks, basalts, alluvium, etc. are significant rocks that include fluorotic minerals that explain F in the average range of 180–3100 ppm. The primary cause of F in groundwater is thought to be their chemical behavior, which includes breakdown, dissociation, dissolution, and contact with water. The hydrogeological and climatic conditions of a region also affect the distribution of F. Other crucial elements are climate and physiography in addition to the hydrogeological setup.[22,23] Despite having similar hydrogeological formations, the groundwater in low-rainfall locations has a higher F concentration than that of high-rainfall areas.

The shortcoming of the study is relatively small sample size, and use of spot urine rather than a 24 hours estimation for fluoride analysis.

CONCLUSION

There was increase in prevalence of gingival disease in subjects with dental fluorosis. The severity of gingivitis increased with increase in water and urine fluoride levels.

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REFERENCES

1. Salah H, Arab N. Application of PIGE to determine fluorine concentration in human teeth: Contribution to fluorosis study. J NuclRadiochem Sci. 2007;8:31–4.
2. Davidsone S, Passmore R, Brook J, PandTrustwel AS. Human nutrition and dietetics. 6th ed. 1975. BABS-610.
3. Weidmann SM, Weatherell JA. Fluorides and Human Health. Geneva: World Health Organization; 1970. p. 104.
4. Sudhir Rawlani, Shobha Rawlani, Shivlal Rawlani. Fluorosis in endemic fluoridated area of Vidharbha region, India.Indian Journal of Community Medicine/Vol 35/Issue 2/April 2010.
5. Murray MM. Industrial fluorosis. Br Med Bull 1950;7:87-9.
6. Vandana KL, Reddy MS. Assessment of periodontal status in dental fluorosis subjects using community periodontal index of treatment needs. Indian J Dent Res 2007;18:67-71.
7. Kumar PR, John J. Assessment of periodontal status among dental fluorosis subjects using community periodontal index of treatment needs. Indian J Dent Res 2011;22:248-51.
8. Chopra A, Kaur G, Lakhanpal M, Gupta N, Suri V, Bhudhiraja S. A cross-sectional study to assess the effect of dental fluorosis on periodontal status. J Indian Assoc Public Health Dent 2016;14:150-3
9. Day M. Chronic endemic fluorosis in Northern India. Br Dent J 1940;68:409-24.
10. Massler M, Schour I. Relation of malnutrition, endemic dental fluorosis and oral hygiene to the prevalence and severity of gingivitis. J Periodontol1951;22:206-11.
11. Haikel Y, Turlot JC, Cahen PM, Frank R. Periodontal treatment needs in populations of high- and low-fluoride areas of Morocco. J Clin Periodontol1989;16:596-600.
12. Panjamurthy K, Manoharan S, Ramachandran CR. Lipid peroxidationand antioxidant status in patients with periodontitis. Cell Mol Biol Lett. 2005; 10: 255-264.
13. Ekstrand, J., Jagerskog, T., & Persson, L. G. Caries-preventive effect of fluoride in a low-fluoride community. Community Dentistry and Oral Epidemiology 2017;45(2): 119-125.
14. Singh PL, Shweta Sagar S, Rohini Sahoo. Assessment Of Dental Fluorosis Among Patients AtA Northern India District Hospital: A Cross-Sectional Study. Journal For Re Attach Therapy And Developmental Diversities. 2023 September; 6(1): 1675-1680.
15. Nagarajan S, Jayakumar ND, Jhansi A, Chandra V, Jithender N and Reddy A. Prevalence of Dental Fluorosis and Its Correlation with Periodontal Conditions, Serum, Urine and Water Fluoride Levels Among 14-18 Years Old Subjects of Mahabubagar District, Telangana – A Cross Sectional Analytical Study. J Dent & Oral Disord. 2019; 5(3): 1118.
16. Dalvi PJ, Ghosh S, Joshi VM, Bhat K, Prakash VH. Fluorosis: Environmental Risk Factor for Periodontal Disease?. Journal of Postgraduate Medicine, Education and Research. 2016 Dec 1;51(4):157-61.
17. Sinsiwar, P. S., Nathawat, D. S. and Saxen, S. C., Interrelationship among fluorine content of ground

waters, soil and plants of Sri Ganganagar district, north-west of Rajasthan. Trans. Indian Soc. Des. Technol., 1981; 6: 52–57.
18. Gupta, S. C. and Vijeya, R. P., Some inherent problem of ground water in western Rajasthan. Trans. Indian Soc. Des. Technol., 1988;13(1): 93–103.
19. Chaudhary, V., Sharma, M. and Yadav, B. S., Assessment of water fluoride toxicity levels in northern Rajasthan, India. Fluoride, 2008; 41(3): 212–215.
20. Raja Reddy D. Some observations on fluoride toxicity. NIMHANS J 1985;3:79-86.
21. Chakma T, Singh SB, Godbole S, Tiwary RS. Endemic fluorosis with genu valgum syndrome in a village of district Mandla, Madhya Pradesh. Indian Pediatr 1997;34:232-6.
22. Choubisa, S. L., A brief and critical review on hydrofluorosis in diverse species of domestic animals in India. Environ. Geochem. Health, 2017; 40(1): 99–114.
23. Gupta, S. C., Rathore, G. S. and Doshi, C. S., Fluoride distribution in ground water of southern Rajasthan. Indian J. Environ. Health, 1993; 33(2): 97–109.