

ORIGINAL ARTICLE

Early Diagnosis and Complete Recovery from Fluorosis Through Practice of Interventions

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Abstract

Objectives: The objective of this communication is to disseminate scientific and technical information for early diagnosis of Fluorosis; recent developments in care and management of patients of Fluorosis.

Material and Methods: Body fluids collected from patients suspected of Fluorosis referred by hospitals, samples of drinking water used by them are the materials that have been investigated. Fluoride level in body fluids and water samples are tested by the ion selective electrode (ISE) potentiometry. Fore-arm X-ray radiograph is taken to assess interosseous membrane calcification. Upon diagnosis of the disease, two corrective measures, namely diet editing and diet counselling are introduced for practice in daily life. In the former, all sources of fluoride ingestion and use are withdrawn whereas in the latter, the patient is encouraged to consume a diet rich in essential nutrients, antioxidants and micronutrients through fruits, vegetables and dairy products. The patients are monitored at intervals to assess fluoride in body fluids. Reduction in fluoride levels has a direct relationship with disappearance of health complaints and subsequent recovery.

Results : Eight case studies (5 male + 3 female) are described. Patients' complaints are gastro-intestinal discomfort, polyuria, polydipsia, muscle weakness, fatigue and joint pain. Body fluids may have high fluoride with normal or high fluoride level in drinking water. The main source(s) of fluoride entry identified are (i) consuming fluoride contaminated food / snacks / beverages laced with black rock salt; (ii) drinking of untreated ground water; (iii) using fluoridated toothpaste. The duration of recovery varies from patient to patient depending upon their body physiology and the seriousness with which the interventions were practiced. Recurrence of the disease may occur in some patients due to change in life-style, not practicing interventions, entry of fluoride inadvertently.

Conclusion: This communication provides an overview of Fluorosis, its occurrence, manifestations, diagnostic tests, results, interventions practiced, monitoring and recovery from the disease.

Introduction

Fluorosis disease is a public health problem caused by consumption of fluoride (F^-) through water, food and use of F^- containing dental products. Long term treatment with F^- containing drugs and exposure to industrial emission has severely affected the community in India.^{1,2} The first report on patients of Fluorosis from India was reported in 1937.³

Amarjeet Singh and Jolly had investigated patients and revealed their clinical, biochemical and radiological characteristics in great detail.^{4,5} What is most striking is that the initial reports by Indian medical professionals were focussing on skeletal and dental Fluorosis only. The concept was based on the fact that electronegative and highly reactive element fluorine reacted with the positively charged cations i.e. Ca^{++} , abundantly found in the bones and teeth, resulting in skeletal and dental fluorosis entities. The concept that a chemical poison F^- can bind with Ca^{++} or other positively charged ions in tissues in the body other than bone and teeth was seldom explored.

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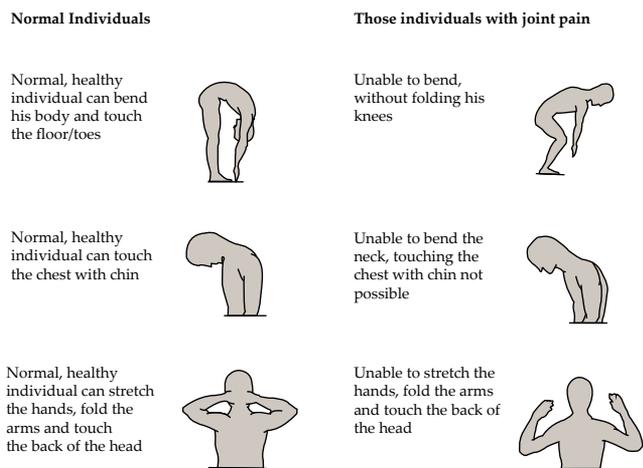


Fig. 1 : Three physical tests for assessing pain in major joints

The scientific community reported dental and skeletal manifestations, which obviously appeared at advanced stages of the disease, when there was very little room for providing relief to the patients. This led to the concept among physicians / clinicians till date that Fluorosis cannot be treated and there is no mitigation from the disease. However, Fluorosis can be easily prevented; patient can recover fully, provided the disease is diagnosed at early stages, much before skeletal aberrations are observed. Patients of Fluorosis are seldom admitted to hospitals for fear of blocking a bed unless it is with research interest.

The diagnostic test for differentiating skeletal Fluorosis from other bone disorders, viz. ankylosing spondylitis, non-specific back-ache and osteoporosis has been field tested for a number of years.⁶ The method developed requires a number of days and highly skilled personnel to conduct the biochemical investigation and it was considered unsuitable for routine laboratory diagnostic procedure. This communication reports yet another simple procedure which any hospital including a district hospital can practice and arrive at the correct diagnosis within a reasonable time frame of 1-2 days.⁷ As the disease has no treatment, it is easily controlled and the manifestations are rectified through practice of two interventions: monitoring the patient for reduction of F⁻ levels in body fluids and rise in haemoglobin (Hb), a sign of absorption of nutrients from diet; as a result of withdrawal of F⁻ intake leading to regeneration of the mucosa and microvilli of the GI tract.

The objectives of this report are two-fold. One is to disseminate scientific and technical information for early diagnosis of Fluorosis, the other is to document recent developments in care and management of patients of Fluorosis for complete recovery.



Fig. 2 : Calcified interosseous membrane sticking out from the Radius (↑) seen in the fore-arm X-ray radiograph

Material and Methods

Patients (male and female) having complaints suggestive of Fluorosis were referred to the Foundation by Clinicians from different hospitals in Delhi and the neighbouring states for confirming diagnosis. The patients were tested for F⁻ poisoning / Fluorosis. The tests and methods of testing enumerated below.

Diagnostic procedure for early detection of Fluorosis

Health complaints for ascertaining F⁻ toxicity manifestations are recorded in a pre-coded proforma through interviews. The manifestations under (a) skeletal, (b) non-skeletal and (c) dental Fluorosis are recorded to understand the severity of F⁻ toxicity in the patient.

- a. Health complaints due to suffering from skeletal Fluorosis: Pain in the major joints viz. neck, shoulder, elbow, back (lumbar spine), hip (pelvic region) and knee are recorded. Three physical tests for assessing pain in the various joints of the body are carried out. A pictorial depiction of the physical tests is shown in Figure 1.
- b. Under non-skeletal manifestations, gastrointestinal complaints like discomfort in the stomach, gas formation, nausea, loss of appetite, constipation followed by intermittent diarrhoea similar to non-ulcer dyspeptic (NUD) complaints, are recorded. Polyuria, polydipsia, muscle weakness, fatigue, anaemia, allergic reactions, complaints of repeated abortions or still birth (in case of pregnant women), male infertility (if known) are recorded.
- c. To assess whether there is any exposure to excess F⁻ from childhood, enamel surface in the front row of the teeth in the upper and lower jaw of the patient is examined. Any prevailing discolouration away from the gums, appearing as horizontal streaks or spots on the enamel surface and bilaterally symmetrical, suggestive of dental Fluorosis, are also recorded.

After collecting the history i.e. place of residence, source of drinking water and health complaints, three laboratory tests are carried out to arrive at a definitive diagnosis of Fluorosis. The tests include:

- i. F⁻ levels in the [a] urine,⁸ [b] blood (serum) and [c] drinking water samples are estimated

by a potentiometric method using ion selective electrode (ISE) technology. Body fluids and drinking water are collected in plastic bottles only. Results are reported in mg F⁻/ liter.

- ii. Radiograph of the fore-arm X-ray examined for interosseous membrane calcification (Figure 2). The fore-arm X-ray is essential for diagnosis of Fluorosis at early stages as well as for differential diagnosis of Fluorosis from other orthopedic conditions such as arthritis and osteomalacia.
- iii. Haemoglobin (Hb) level of the patients; Hb is used as an indicator for assessing the health status and as an indicator for assessing nutrient absorption from diet resulting from regeneration of microvilli following withdrawal of F⁻ source(s). Hb is estimated by a portable battery-operated Haemoglobinometer, HemoCue Hb 201+, Angelholm, Sweden by the method of Schenck.⁹ Results are expressed in g of Hb /dl.

Dietary status: The patients are interviewed for an answer (Yes or No) to ascertain whether F⁻ is entering the body through F⁻ laced food products, drinking untreated ground water, dental products or a drug. When the test reports are compiled, the disease is confirmed as being Fluorosis. After the laboratory tests are carried out, reports are generated for each patient. Patients are informed and explained about the F⁻ levels and recommended that they practice interventions for recovery from the disease. The interventions introduced are the following:

- i. **Intervention 1 :** Diet editing is introduced to correct the diet by avoiding consumption of F⁻ containing food, water and use of fluoridated toothpaste. Upon reviewing the data on F⁻ content in drinking water, if F⁻ is beyond normal limits (> 1.1 mg/l), the patients are shifted to an existing safe source of water in their neighbourhood for drinking and cooking purposes or they are advised to install a reverse osmosis filter (RO) in their supply line. In the event that drinking water F⁻ is below 1.0 mg/l (and therefore safe) but urinary F⁻ is high (reference range 0.1-1.0 mg/l), the source(s) of F⁻ is traced through retrieving information on diet and dietary habits to find the food item(s) consumed; the source(s) known to contain high F⁻ are also edited to eliminate the intake of the poison.

Items leading to high F⁻ intake are traced to (i) use of black rock salt (CaF₂) with 157 ppm F⁻ in cooking;¹⁰ (ii) all snacks enriched with black rock salt; (iii) black tea without milk/with lemon, (iv) churans (ayurvedic tablets) containing black rock salt; (v) spices smeared with black rock salt and (vi) toothpaste with F⁻. Patients are also warned to avoid consume black rock salt-smeared fruit

juice, lemon water, ready-to-eat cut fruits etc.

Editing the use of toothpaste is also required. The toothpastes available are either fluoridated or not fluoridated i.e. ayurvedic or herbal brands. The patient can use ayurvedic or herbal paste, which has much less F⁻. It is also advised to squeeze a very small amount (size of a whole black pepper) on to the brush for brushing. Moreover, it is not necessary to use the paste each time for brushing in a day except once in the morning. This recommendation is for all F⁻ poisoned patients unless they are prescribed medicated toothpaste for a specific dental problem.

- ii. **Intervention 2:** Diet counselling is offered for promoting intake of essential nutrients, micronutrients and antioxidants through dairy products, vegetables and fruits.

To reinforce diet editing and diet counselling, a pictorial booklet revealing various aspects of food viz. items that need to be eliminated and how intake of larger portions of fruits, vegetables and dairy products are possible through fruits juices, lassi, milk-shakes, salads and soups, are provided to every patient when they come for counseling.

After being subjected to interventions, the patient is monitored initially one month after and thereafter a couple of times for measuring F⁻ levels in blood, urine and Hb. The health complaints initially recorded, and those that disappeared after practicing interventions are reported in results.

Results

This communication reports results of patients suspected of Fluorosis and referred to the Foundation. There is yet another category of patients who find the Foundation on their own because they do not respond to treatment through orally administered drugs. After going around shopping for doctors while not responding to treatment, they assess their health complaints through internet search and end up with the Foundation after visiting the Foundation's website ([www. fluorideandfluorosis.com](http://www.fluorideandfluorosis.com)). Patients from overseas also reach out to the Foundation in a similar manner.

A few case studies (Table 1) and their results (Table 2) reported in this communication will highlight that recovery from F⁻ poisoning / Fluorosis is possible through early diagnosis and practice of interventions. Drug prescription is not required. Better results of recovery are observed through improving the daily diet through a procedure of diet editing cum counseling.

During the past, patients, young and old, men and

Table 1 : Case studies of fluorosed patients, disease occurrence, health complaints, diagnostic tests and interventions practiced are mentioned below

Case studies	Patient's details	Skeletal Fluorosis (if Yes, then ✓)		Non-skeletal Fluorosis (if Yes, then ✓)			Fluoride content [Raised ↑; Reduced ↓]			Interosseous membrane calcification	Source(s) of Fluoride ingestion	Intervention introduced (Y / N)	Recovery status
		Joints pain	Back-ache	GI discomfort (IBS) /NUD	Muscle Weakness/ Tiredness	Polyuria / Polydipsia	Urine (mg/l)	Serum (mg/l)	Drinking water (mg/l)				
Patient – 1: M/58 Yrs.	Professional from an Institute of Technology, Kanpur (UP)	-	✓	✓	✓	-	↑	↑	↓	✓	<ul style="list-style-type: none"> Daily consumption of snack with black rock salt (BRS) Chewing Ayurvedic tablet (Hajmola) rich in BRS Using Fluoridated toothpaste 	Y	<ul style="list-style-type: none"> Recovered well, though the gait of the patient was slightly changed. Later on shifted to Mumbai and life-style changed Health complaints re-surfaced in spite of drinking of RO water Diet edited and recovered from health complaints
Patient – 2: M/35 Yrs.	Farmer from Jharkhand	✓	-	✓	✓	✓	↑	↑	↑	✓	<ul style="list-style-type: none"> Tube well / ground water contaminated with fluoride 	N	<ul style="list-style-type: none"> Advised to shift safe sources of water but did not turned up due to family problems
	After 9 years, visited Foundation with aggravated health complaints	✓	✓	✓✓	✓	✓	↑	↑	↑	-	<ul style="list-style-type: none"> Shifted to a water source with least fluoride content out of 7 water samples brought for F testing 	Y	<ul style="list-style-type: none"> GI discomfort, Polyuria, Polydipsia reduced considerably There was less pain in joints though stiffness and rigidity of joints continued
Patient – 3: M/54 Yrs.	School Teacher from Kanpur	✓	-	✓	✓	✓	↑	↑	-	-	<ul style="list-style-type: none"> Street food/snacks laced with BRS from road side- stalls 	Y	<ul style="list-style-type: none"> Initially health complaints did not disappear as he was unable to change his food habit/life-style Finally understood the importance of interventions and recovered
Patient-4: M/49 Yrs.	Business man from Delhi	✓	-	-	✓	-	↑	↑	↓	✓	<ul style="list-style-type: none"> Consumption of street food, rich in BRS Use of ready-made/ packaged spices added with BRS Using fluoridated toothpaste 	Y	<ul style="list-style-type: none"> Stopped taking food from road-side vendors Carries home-made food Health complaints disappeared and feels energetic (Hb level increased)
Patient – 5: F/48 Yrs.	House wife from Delhi	✓ ✓	-	✓	✓	-	↑	-	↑	✓	<ul style="list-style-type: none"> Contaminated ground water 	Y	<ul style="list-style-type: none"> GI complaints disappeared Less pain in joints Hb raised in comparison to baseline data Recovering well; gradually Opted for a surgery for relief from joints pain, no information thereafter
Patient – 6: F/44 Yrs.	Housewife from a village in Haryana	✓	-	✓	-	-	↑	↑	↑	-	<ul style="list-style-type: none"> Contaminated ground water 	Y	<ul style="list-style-type: none"> Shifted to safe drinking water (Canal water) sources Health complaints reduced significantly
	After 4½ years, body fluids tested again as her health complaints recurred	✓	-	✓	✓	✓	↑	↑	-	-	<ul style="list-style-type: none"> Fluoride levels in body fluids were high due to consumption of contaminated supply water 	Y	<ul style="list-style-type: none"> Advised to consume RO filter water Pain in joints reduced considerably and GI problems disappeared

Contd. 2..

Table 1 : Case studies of fluorosed patients, disease occurrence, health complaints, diagnostic tests and interventions practiced are mentioned below (contd...)

Case studies	Patient's details	Skeletal Fluorosis (if Yes, then ✓)		Non-skeletal Fluorosis (if Yes, then ✓)		Fluoride content [Raised ↑; Reduced ↓]			Interosseous membrane calcification	Source(s) of Fluoride ingestion	Intervention introduced (Y / N)	Recovery status
		Joints pain	Back-ache	GI discomfort (IBS) / NUD	Muscle Weakness/ Tiredness	Polyuria / Polydipsia	Urine (mg/l)	Serum (mg/l)				
Patient -7: F/45 Yrs.	Housewife from a village in Haryana	✓	-	✓	-	-	-	-	-	• Untreated tube well water	N	• No diagnostic tests for Fluorosis were done by the orthopaedic surgeon, advised to consume RO Filter water
	After 4 years,	✓	-	✓	✓	-	↑	-	✓	• Drinking of contaminated bore well water • Consuming ready-made masala added with black rock salt • Eating salad laced with black rock salt	Y	• Presently drinking RO filter water but occasionally uses contaminated bore well water • Urine fluoride reduced significantly
Patient-8: An employee M/30 Yrs. of MNC from Kolkata		-	✓	✓	-	-	↑	↑	↓	• Most of the time out of station for job execution • During travelling, depends on restaurant food / snacks laced with BRS although drinking safe water (packaged water) • Using Fluoridated toothpaste	Y	• Avoid street food as much as possible during travelling • Carrying home-made masala/spices for sprinkle on steamed food/dal • Non-skeletal manifestations disappeared, pain in back reduced. • Finally all health complaints disappeared.

IBS: Irritable Bowel Syndrome; NUD: Non-Ulcer dyspepsia; GI discomfort: Gastro-Intestinal problems

women have benefitted from correct diagnosis, and practice of interventions led to complete recovery. Patients are tested for F⁻ in body fluids and monitored for the same until recovery. Some come on their own for monitoring whereas some have to be reminded. Cases of some patients reporting after a long interval due to recurrence of the disease are not uncommon.

The confirmation of the disease through diagnostic tests carried out and the recovery patterns are described in eight case studies. The case studies provide an overview of Fluorosis, its occurrence, patient complaints, diagnostic tests, results, interventions practiced; and data that emerged from monitoring would adequately reveal the management and care offered for complete recovery.

Discussion

Fluoride poisoning and Fluorosis is on the rise in the country. The major cause of concern is wrong diagnosis and treatment; the disease gets aggravated to an irreparable stage. Grossly inadequate infrastructure for F⁻ testing in body fluids

in Government hospital laboratories or in private testing laboratories could be one of the major reasons for incorrect diagnosis.

Irritable bowel syndrome (IBS)/non-ulcer dyspepsia (NUD): From all the case studies reported, it is evident that early manifestations of F⁻ toxicity commence from the gastro-intestinal system.^{11,12} At that point of time, F⁻ toxicity as a primary cause for the complaint should be suspected. Many patients not responding to orally administered drugs for IBS/NUD, without reporting on the ineffectiveness of the drug to the treating physician, go around shopping for a "good doctor". Fluoride intake continues and disease manifestations get aggravated resulting in joint pain. In search of a "good doctor", they may spend three to four to five years, by which time interosseous membrane calcification becomes evident and that often draws the attention of orthopaedic surgeons. It is then that cause of the health problems gets identified.

Polyuria and Polydipsia : It is evident from the history retrieved from a number of patients that polyuria and polydipsia can also be an early

Table 2 : Showing the effect of practice of interventions; the F levels in serum (SFL), urine (UFL), drinking water (DWFL) and Haemoglobin (Hb) level at various intervals

Case Studies	SFL (mg/l)	UFL (mg/l)	DWFL (mg/l)	Hb (g/dl)	Remarks
Patient- 1: Baseline data	0.08	2.50	<1.0 mg/l (safe)	-	In spite of consuming safe water, one can get afflicted with Fluorosis; F ⁻ entry from sources viz. food, spices, dental products, way side snacks etc. can be the F ⁻ source(s). Practice of interventions relieves; recurrence is possible if care is not taken.
M/58 Yrs. Monitoring (Re-tested) after practice of interventions					
1 month	0.04	1.46	-	-	
5 months	0.03	1.00	-	-	
12 months	0.03	0.70	-	-	
After shifted to Mumbai:					
2.5 years	0.06	1.61	-	-	
4.5 years	0.09	1.48	-	-	
Patient- 2: Baseline data	0.120	1.05	6.58 (Tube Well)		If ground water consumed has high F ⁻ , immediate necessity is to change the source. In course of time, if instructions are not followed, rigidity of joints may set in. Not able to squat for defaecation is a sign of advanced stage of Skeletal Fluorosis. Good nutrition can combat marginally higher F ⁻ in drinking water
M/35 Yrs. (2000):					
Baseline data (2009):	0.226	1.88	i. 2.49 (HP in his own house)		
enhanced	(88%)	(79%)	ii. 2.54 (HP-1 st neighbour's house)		
in 9 yrs.)			iii. 1.63 (HP- 2 nd neighbour's house)- using for consumption		
			iv. 1.82 (OW- 3 rd neighbour's house)		
			v. 2.78 (HP-school)		
			vi. 4.23 (HP-4 th neighbour's house)		
			vii.3.92 (HP-5 th neighbour's house)		
Patient- 3: Baseline data:	0.172	2.119	--	--	Some individuals are highly susceptible to F ⁻ toxicity and may suffer even with low levels of F ⁻ . To be aware of F ⁻ poisoning effects and its control, the patient has to make the efforts. In this case, it has taken 6-7 years for him to feel normal
M/54 Yrs. Monitored (Re-tested) after practice of interventions:					
6 months	0.093	1.439	-	14.4	
1 Year 8 months	0.116	1.642	-	16.1	
2 Years 5 months	0.096	1.792	-	16.6	
4 Years 8 month	0.097	1.580	-	17.7	
5 Years 5 months	---	1.790	-	14.5	
6 Years 2 months	---	0.812	-	14.5	
7 Years 5 months	0.061	0.312	-	16.9	
Patient-4: Baseline data:	0.165	2.65	--	13.7	Withdrawal of F ⁻ sources and consumption of nutritive diet with plenty of vegetables, fruits and dairy products would nullify the toxic effects of F ⁻ . Nutritive food yields better results than drugs prescribed
M/49 Yrs. Monitored (Re-tested) after practice of interventions:					
2 Months	--	1.25	--	13.0	
1 Year 4 Months	--	0.531	--	13.7	
2 Years	--	0.363	--	14.4	
3 Years	--	0.835	--	15.4	
Patient – 5: F/48 Yrs. Baseline data:	8.51	--	10.9 (Bore well)	9.8	In an advanced case of Fluorosis, the patient is unable to bear the pain and opts for surgery. Whether surgery in such an advanced case would lead to complete recovery needs to be seen
Monitored (Re-tested) after practice of interventions:					
2 Months		5.49	0.275 (RO Filter)	9.4	
6 Months		3.51	"	11.2	
Patient-6 : Baseline data:	0.08	8.0	3.0 (Bore well); 0.27 (Canal water)		Health complaints may recur when the F ⁻ burden of the body becomes enhanced. After 4½ years, the patient is unable to understand the reason for recurrence and will react to it immediately. Here is a case of canal water contaminated with F ⁻ , due to mixing of F ⁻ containing ground water, which led to recurrence of the disease
F/44 Yrs. Monitored (Re-tested) after practice of interventions:					
1 Month	0.03	4.5	Shifted to canal water		
4 Months	0.02	1.6	"		
6 Months	0.02	0.6	Recovered completely		
4 Years 6 Months	0.086	2.66	3.14 (Bore well) 2.39 (Canal water contaminated with F ⁻)		
5 Years 6 Months	0.161	2.49	0.210 (Shifted to RO Filter water)		
Patient – 7: Baseline data	5.89	--	4.02 (Bore well)		There may be other source(s) of F ⁻ entry into the body besides drinking water from bore well. For patient management, testing of body fluids is a must to find out the source(s) of F ⁻ entry. Patient monitored to determine reduction in F ⁻ level, impact of diet editing and diet counselling. This message conveyed to the patient, so that she continues her efforts for improving health
F/45 Yrs. Monitored (Re-tested) after practice of interventions at an interval of 5 wks.					
Recovery	1.70	--	RO Filter water	--	
	(71%)				
Patient-8: Baseline data:	0.054	0.773	--	13.1	Some individuals may be hypersensitive even at low levels of F ⁻ ingestion. There is no alternative but to change dietary habits. Those who travel a lot, should depend on boiled food, carry home-made masala / spices without black rock salt, the safest way, to get out of the ailments due to F ⁻ poisoning
M/30 Yrs. Monitored (re-tested) after practice of interventions at an interval of 2 months	0.034	0.434	--	13.6	

Normal reference Range of F⁻ in serum: 0.02-0.05 mg/l; in urine: 0.1-1.0 mg/l; in drinking water: up to 1.0 mg/l is permissible, less the better (As per BIS guideline). Normal Hb level for Men: >13.0 g/dl; Women: >12.0 g/dl. Number in the parenthesis is in percentage. HP: Hand pump; OW: Open well

manifestation of Fluorosis. Differential diagnosis of diabetes versus Fluorosis may be necessary. In diabetes insipidus, withdrawal of F^- from all sources is adequate to control polyuria and polydipsia. Antidiuretic hormone (ADH) production would commence upon withdrawal of F^- , a powerful enzyme inhibitor which has interfered with ADH production. There are unfortunate instances of steroids prescribed to control polyuria for patients hailing from endemic states of Fluorosis. Though not reported, such instances exist.

Muscle weakness : Patients may complain of muscle weakness and may be unable to walk even short distances. Investigating creatine phosphokinase (CPK-ase) besides F^- in serum may be an additional test for confirming muscle destruction as CPK-ase would be enhanced in serum in patients of Fluorosis.¹³ It is not a test that is absolutely necessary to conduct for correct diagnosis.

Low Haemoglobin (anaemia): Fatigue and extreme tiredness should not be dismissed as casual. Haemoglobin should be tested to find out whether the patient is anaemic. If anaemia is of severe / moderate / mild variety, (i) RBC count, (ii) Vitamin B_{12} level in serum and (iii) thyroid hormone status may provide a cue, to understand why Hb production is affected and how that can be rectified.¹⁴⁻¹⁶ F^- toxicity has adverse effects on Hb production and control of anaemia.¹⁷

It is evident that in patients of Fluorosis a wide variety of health complaints emanate from soft and hard tissues. Skeletal Fluorosis manifestations take a long time to surface. Damage to the matrix molecules of bones and the soft tissues, i.e. ligaments covering the bones, surfaces in advanced stages. When restricted movements and rigidity have set in, it may be irreparable.

Skeletal Fluorosis : Joint pain surfaces in an advanced stage of Fluorosis. Presently pain relievers appear to be the most favourable drug of choice for treatment. Unfortunately the patient is unaware that though the pain is less, F^- continues to invade the body and the disease is getting aggravated. A patient of skeletal Fluorosis may also suffer from osteomalacia due to calcium and vitamin-D deficiency. Co-existence of osteomalacia with Fluorosis is possible. High F^- levels in body fluids and interosseous membrane calcification would appear only in Fluorosis and not in osteomalacia.¹⁸ Differential diagnosis of Fluorosis from arthritis / ankylosing spondylitis / osteoporosis / non-specific back-ache is essential. However, the simple diagnostic tests described in our case studies is adequate for differential diagnosis of fluorosis from other orthopaedic conditions.

Food – a major source of F^- : A good number of food items contaminated with F^- compared to ground

water are a major cause of concern. It is very unlikely that one can make a prediction of food contamination with F^- . The only method of approach to assess consumption of F^- is by assessing urine F^- level.

With recent developments in the avenue of patient care and management, Fluorosis can be prevented through early diagnosis, the protocol for which has been developed and field tested for over a couple of decades and the successes announced. Diet editing to avoid F^- contaminated drinking water and food is an intervention that the patients are introduced to, for rectifying the damage(s) caused to the GI mucosa and other health complaints.^{19,20} The damaged mucosa is known to regenerate within a short interval of a few days. Upon withdrawal of F^- , absorption of nutrients from the diet would commence. Gastro-intestinal discomfort would disappear.

In conclusion, by confirming the disease through simple diagnostic tests comprises of testing F^- in serum, urine and drinking water besides fore-arm X-ray radiograph, the patient should be introduced to practice of interventions and monitored at intervals when the patient can recover from F^- poisoning / Fluorosis at an early stage and lead a normal healthy life.

Developing infrastructure for Fluorosis diagnosis in hospitals and a continuing medical education programme (CME) on all aspects of F^- poisoning and Fluorosis for the doctors employed in the hospitals appear to be the only two pre-requisites for addressing the problem(s) of patients of Fluorosis. The samples from patients of Fluorosis obtained could be utilised for research by residents as unexplored avenues are many and are likely to add to new developments in medical sciences.

Possibly the State Health Department and Directorate of Health Services and Medical Education may adopt appropriate strategies to promote affordable procedures to address Fluorosis mitigation in the state concerned.

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