

Experiences on Combating Fluorosis Cases in India

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Summary: India is one among the 23 nations around the globe where health problems occur due to excess ingestion of fluoride. Fluorosis being an untreatable disease, prevention is the solution to mitigate the disease. Two major interventions i.e. safe water and nutritional supplementation are practised for combating the health problems arising due to fluoride poisoning.

Present study has been designed to assess the impact of interventions on fluorosis patients. The essential tests were conducted for diagnosing the disease and confirmed cases of fluorosis were selected for the interventions. The source of fluoride of the patient was withdrawn, provided with safe water and were counselled for nutritional supplementation. After introducing interventions, the patients were monitored up to 12 months.

Complete recovery / improvement in the health status with decline in fluoride levels in body fluids and no recurrence was observed. The procedure of monitoring of the interventions is dealt with.

Key Words: Fluorosis, intervention, impact assessment, control, mitigation, India, fluoride, blood, serum, urine.

INTRODUCTION:

Fluoride contamination of drinking water, fluorosis and associated health problems arising as a result are on the increase in India and 23 other countries around the globe. Excess ingestion of fluoride is the basic cause for fluorosis. An estimated 67 million people in India, which includes 6 million children in 17 out of the 35 states, and Union Territories are affected with a variety of health problems due to fluoride poisoning in the form of dental, skeletal and non-skeletal fluorosis.

It is known that deficiencies in protein, vitamin C, calcium and poor nutrition in general aggravate fluoride toxicity^{1, 2, 3}. Data obtained from dietary surveys, suggest that inadequate ascorbic acid and calcium are related to severity of fluorosis⁴. Earlier studies reported that toxic effects of fluoride are reversible and could be effectively reversed by withdrawal of the fluoride source and subsequent supplementation of calcium, vitamin C, E and D^{5, 6, 7}. The extent of reversal observed was more pronounced and highly beneficial by combined supplementation of calcium and vitamin C on the recovery of the fluoride induced alterations on structure and

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metabolism of soft tissues^{6, 7}. Fluoride inhibited enzymatic activities in epididymal sperms^{8, 9}, and on testicular and cauda epididymal metabolism in fluoride exposed animals¹⁰.

The treatment with calcium, vitamin C and D showed a significant improvement in the skeletal fluorosis and biochemical parameters in children consuming water containing 4.5 mg/L of fluoride¹¹. A protective role of β carotene and superoxide dismutase was observed on impaired growth and poor antioxidant state of the rat due to fluoride toxicity¹².

Fluorosis, being an untreatable disease, can only be mitigated through prevention and control. If the disease is diagnosed early, it is easily preventable. Two major interventions: 1) safe water and 2) nutritional supplementation are now practised in India for combating with the health complaints arising due to fluorosis¹³. The interventions have been widely field-tested both in hospital and field based patients. The present communication is reporting on the protocol that need to be followed for fluorosis management.

MATERIALS AND METHODS

Fluorosis diagnosis. This study focus on fluorosis diagnosis and management for mitigation of the disease in hospital based patients, where monitoring of the health improvement and data reporting were possible.

The suspected cases of fluorosis referred for diagnosis of the disease from hospitals in Delhi were selected for the study. A detailed history was recorded, radiographs of affected regions of the body and forearm were taken and fluoride content in serum, urine and water was estimated using ion selective electrode technology. After confirming diagnosis of the disease, the patients were diverted to safer source of water for consumption (fluoride as low as possible but not to exceed 1.0 mg / L) and counselled for nutritional supplementation.

A pre-coded pro forma was designed to collect the background information of the patients. Information on dental, skeletal and non-skeletal manifestations were sought through interview. The procedure adopted for assessing the health complaints involves administering certain physical tests, radiological evaluation and history taking for ascertaining, fluoride toxicity manifestations¹³.

- The 3 simple physical tests administered to check the rigidity and pain in the neck, back, knee and shoulder joints are revealed in Figure 1¹⁴.
- Radiological evaluation of bone density and calcification of interosseous membrane of forearm were assessed as evidence of fluorosis¹⁵.
- Chronic and persistent headache if experienced were recorded.

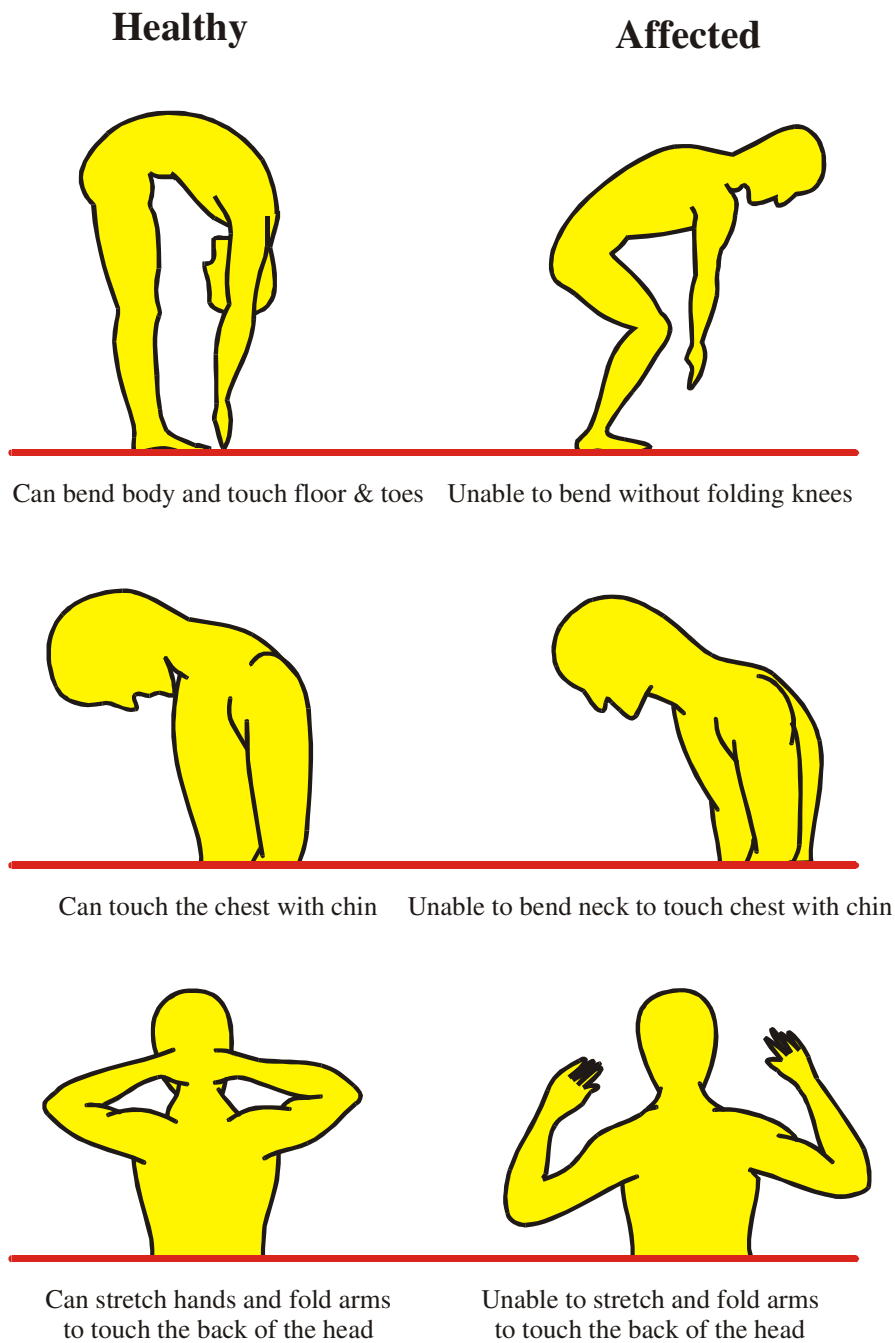


FIGURE 1. The physical test used in the study as a part of the diagnosis of fluorosis.

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- Gastro-intestinal complains, in the form of nausea, loss of appetite, pain in the stomach, gas formation, constipation followed by intermittent diarrhoea (Non-ulcer dyspeptic complaints) were recorded to assess early warning signs of Fluoride toxicity manifestations ¹⁶⁻²¹.
- Muscular manifestations i.e. muscle weakness, fatigue were recorded ²².
- Anaemia was assessed by finding the haemoglobin level of the individual ²³.
- Polyurea, i.e. the tendency to urinate more often though the volume of urine may or may not be high, was also recorded.
- Polydypsea, i.e. the feeling of excessive thirst, was also assessed.
- Information on the use of fluoride contaminated food and other items as black and red rock salts, canned food items and black tea, tobacco, aracnut were recorded ²⁴.
- Discoloration of teeth suggestive of dental fluorosis, if present is also made note off.

The response of each patient was ascertained in terms of “Yes” or “No” for the above complaints in a pre-coded specially designed proforma which can be evaluated using optical mark reader.

Fluoride in drinking water. Approximately 50 ml of drinking water of the patient was collected directly from the source in a plastic container. Fluoride in drinking water was estimated with the help of Ion 85 Ion analyser by potentiometric method according to the User’s handbook of Radiometer, Copenhagen ²⁵.

Fluoride in serum. Blood, 5 ml, was drawn from antecubital vein and allowed to coagulate at room temperature. Serum was separated by centrifugation and stored in plastic vials in a refrigerator. The fluoride concentration determined by the method of Hall et al ²⁶ using the ion selective electrode as above.

Fluoride in urine. Spot samples of urine were collected in plastic bottles, pH adjusted between 5.2 – 5.5 with 30 % perchloric acid and each sample diluted with acetate buffer ²⁶. The fluoride concentration was determined as above.

Interventions: For complete recovery from fluoride poisoning the patients were advised to go through or practice two interventions 1) safe drinking water 2) nutritional supplementation with diet rich in calcium, vitamin C & E and anti-oxidants. Provision for safe water through existing safe sources was recommended and the patients are followed up at certain intervals for impact assessment.

Nutritional supplementation. Nutritional supplementation requires counselling of the patients and to educate the female members of the household who are responsible for cooking and serving the food for the families. They are informed on the locally grown / available food items which are rich in calcium, vitamin C, E and anti-oxidants that they need to be consumed on a daily basis, through breakfast, lunch and dinner. Before counselling the patient, the status of the diet that the family consumes, food habits and way of cooking the food were assessed. Then they are advised to consume food rich in calcium, vitamin C, E and anti-oxidants and the different

recipes for consuming the nutrient rich items are also explained. The food items suggested to the family should be affordable and easily available. We also provide them diet chart for breakfast, lunch and dinner and the various variables that they can practice, seven days a week to ensure adequate intake of the essential nutrients to combat Fluorosis. The different recipes are discussed with patient, so that they are aware of the different ways of preparing food rich in nutrients.

Impact assessment. After Introducing the interventions the patients are monitored up to 1 year at the intervals of 2 – 3 weeks for first assessment, 3 – 6 months for second assessment and 12 months for third assessment. The assessment included fluoride levels in urine and blood and again taking history of health complaints.

RESULTS

The drinking water fluoride levels of the patients before and during interventions are shown in Table 1. It is observed from the present study that some patients with complaints associated with fluorosis were consuming safe water as fluoride was within permissible limits. In these cases it is assumed that the high fluoride intake originates from food.

TABLE 1 Drinking water fluoride level of the study patients before and during intervention.

Patient No.	Before intervention		During intervention
	mg F /L	Water source	mg F /L
1.	3.00	Hand pump	0.27
2.	5.80	Hand pump	0.90
3.	26.07	Hand pump	0.55
4.	1.74	Tube well	0.55
5.	29.00	Hand pump	0.80
*6.	1.06	Municipal water supply	1.06
7.	0.38	Municipal water supply	0.38
*8.	2.00	Municipal water supply	0.38
*9.	0.14	Municipal water supply	0.14
10.	0.90	Hand pump	0.52

* Water fluoride level of these patients is within permissible limit of 1 mg/L. Their source of fluoride was food items.

TABLE 2. Fluoride concentrations in urine of the study patients before and during the intervention's three impact assessments, I.A..

Normal upper limit of fluoride in urine is 0.1 mg/L.

Patient no.	Before intervention	First I.A.	Second I.A.	Third I.A.
1.	8.00	4.50	1.60	0.60
2.	9.00	1.80	1.0	0.21
3.	24.10	15.00	6.00	0.58
4.	2.21	1.16	0.80	0.31
5.	5.00	4.11	1.00	0.50
6.	2.50	1.46	1.00	0.70
7.	1.00	0.90	-	-
8.	2.00	0.80	-	-
9.	0.70	0.51	-	-
10.	1.27	1.00	-	-

TABLE 3. Blood serum fluoride concentrations in mg/L for the study patients before and during the intervention's three impact assessment, I.A..

Normal upper limit of fluoride in Blood: 0.02 mg/L

Patient No.	Before Intervention	First I.A.	Second I.A.	Third I.A.
1.	0.08	0.03	0.03	0.02
2.	0.12	0.10	0.08	0.02
3.	0.22	0.13	0.09	0.05
4.	0.08	0.04	0.03	0.03
5.	0.63	0.40	0.10	0.08
6.	0.20	0.16	0.11	0.03
7.	0.09	0.04	-	-
8.	0.04	0.04	-	-
9.	0.09	0.04	-	-
10.	0.09	0.04	-	-

A reduction in fluoride content in serum and urine is observed on the first impact assessment. The reduction in health complaints specially the relief in non-ulcer dyspeptic complaints or gastrointestinal complaints are the most striking. This conveys the message to the patient that fluoride has been responsible for the GI problems and they need to continue to drink safe water with nutritional supplementation and/or to eliminate fluoride rich food from the diet for complete

recovery. The first impact assessment is also a confidence building exercise for the patient to consume safe drinking water and practice nutritional supplementation.

TABLE 4. Health complaints elicited by the patients before the study interventions and during the interventions three impact assessments I.A..

No	Manifestations	Before, %	1 st I.A., %	2 nd I.A., %	3 rd I.A., %
1.	Gastro-intestinal	100	70	100	-
2.	Muscular	60	40	50	Complete recovery
3.	Polyurea	30	20	30	Complete recovery
5.	Polydypsea	50	20	40	10
6.	Pain and rigidity in the joint	90	30		Complete recovery

During the second impact assessment, a significant reduction in fluoride levels in urine and serum is observed. The patient also felt relief in joint pains. After third impact assessment, the patient reported complete recovery from gastrointestinal problems and pain in the joints. After each impact assessment certain minor changes needed to be introduced to the diet chart for obtaining better results. The

reduction in fluoride levels in urine and serum of patients during impact assessment are shown in the Table 2 & 3. The percent reduction in health complains during impact assessment are shown in Table 4. Figure 2 shows the reduction of the fluoride concentrations as observed on an average (geometric means).

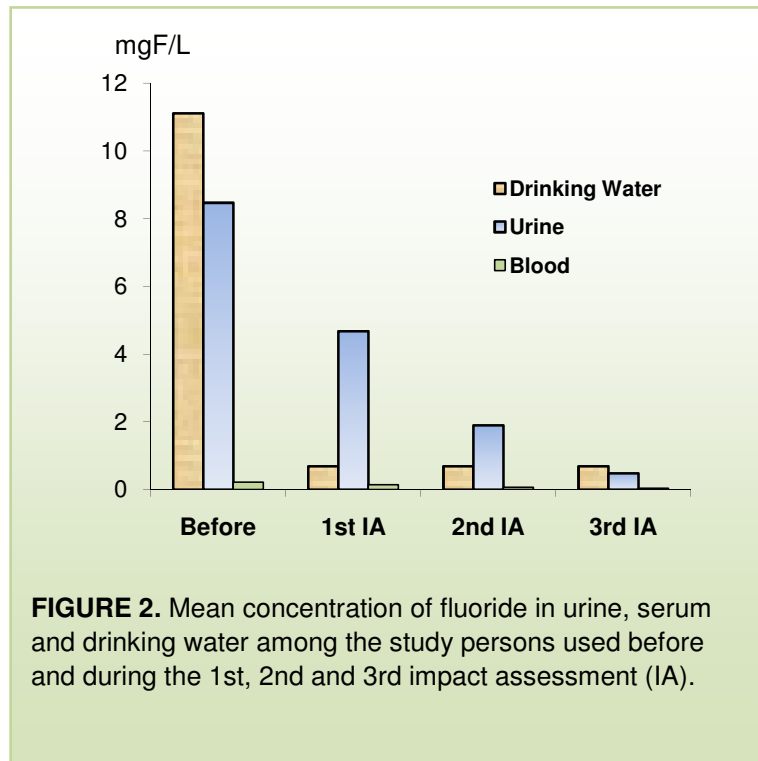


FIGURE 2. Mean concentration of fluoride in urine, serum and drinking water among the study persons used before and during the 1st, 2nd and 3rd impact assessment (IA).

DISCUSSION

The results of the present study reveals that after introducing interventions for prevention and control of fluorosis, the improvement in health status was observed as decrease in fluoride levels in serum and urine and a great relief to the patient. As evident from earlier animal studies that the fluoride induced changes were transient and reversible by withdrawal of sodium fluoride treatment⁶ and by feeding ascorbic acid and calcium during the withdrawal period.^{27, 28}

The supplementation of ascorbic acid has been observed markedly to reduce fluoride retention in the bones of mice². It is also observed that vitamin C administration prevented the development of severe bone fluorosis²⁹ and diminished the toxic effects of fluoride in bones of monkeys³. Parker et al³⁰ investigated that the interaction of dietary vitamin C, protein and calcium with fluoride and observed an increased accumulation of fluoride in the group maintained on low protein diet.

The present study substantiates the concept that fluorosis management and mitigation are achieved, by early diagnosis and practising interventions with safe water and nutritional supplementation, over a period of 15 days to 12 months. The patients recover rather well and get back to normal. The patients need to be closely monitored by introducing new food items and recipes for the daily diet. This ensures that the patients continue to practice nutritional supplements with the new items and recipes, as the food prepared would be tasty and acceptable to the family.

Present study indicates that calcium, vitamin C, E and antioxidants have a significant beneficial role in mitigating the fluoride induced toxicity. Therefore these nutrients are recommended to be used for preventing and combating fluorosis in endemic areas for fluorosis.

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