Mitigation of Fluorosis in Nalgonda District Villages

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SUMMARY: Previous attempts to solve the fluorosis problem in Nalgonda by using the alum precipitation technique have been of little success. In stead the Sai Oral Health Foundation assisted by the Government of Andhra Pradesh, has adopted a strategy of providing low fluoride water in affected villages through the use of bone char based domestic defluoridators and rainwater harvesting systems. Besides children, age 8-13 years, are given vitamin A and D.

The intervention was introduced to two villages previously having 3.7 and 3.8 mgF/L in their drinking water. The base line study showed that the two villages had prevalence of dental fluorosis, 96-97 %, skeletal fluorosis 45-60 %, genu valgum, 0.56-2.2 %, genu varum, 1.8-2.0 % and paraplegia 0.3-0.7 %. Joint pain, neck rigidity, gastric problems and burning sensation during urination were reported in 50-70 % of the people.

Twelve 8-13 years school children and eight 27- 60 years adults were recruited for testing of intervention effects. The results show, on an average: 38 % of decrease of urinary fluoride, 6 % increase of serum calcium, 5 % increase of serum phosphorus and 8 % increase in serum alkaline phosphatase. Furthermore a significant decrease in joint pain, an improvement in body movements and a relief in the gastric problems and in the burning sensation during urination were observed.

The villagers expressed high acceptability of the used bone char defluoridators and rainwater harvested system.

Key wards: Skeletal fluorosis, dental fluorosis, fluorosis effects, intervention, bone char, rainwater harvesting, India, Nalgonda, Nalgonda technique, serum fluoride, serum calcium, serum phosphorus, serum phosphatase, acceptability.

INTRODUCTION

Fluorosis occurrence: Fluorosis is a major public health problem spot wise all over the world, including India. Endemic fluorosis has been recognized as a major public health problem in 18 States out of 33 constituent States and Union Territories in India [1], around 62 million people including 6 million children suffer from fluorosis due to excessive consumption of fluoride through water[1]

Fluorosis effects: Excessive fluoride intake causes fluorosis, paraplegia, arthritis and other diseases [2-6]. It also affects human intelligence, especially in children, who are most susceptible to early fluoride toxicity [3, 6]. Contamination of water with fluoride beyond acceptable limits occurs because of the earth's crust in those regions has

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relatively soluble fluoride-bearing minerals [8]. In some regions of India, water contains fluoride up to 38 mg/L, which is extremely high compared to the maximum permissible limit of 1.0 mg/L [1, 9].

Andhra Pradesh situation: Nalgonda district is highly affected by fluorosis in Andhra Pradesh State in India: 17 out of 21 districts in Andhra Pradesh are affected. The fluoride levels in these districts range from 2 to 7 mg/L. People suffer from various skeletal deformities like genu varum, genu valgum, antero posterior bowing of tibia, kyphosis, exostosis etc, and muscular tenderness, neck rigidity, stiffness of joints and mental retardation.

There are 15 huge defluoridation plants based on the use of alum, the so-called Nalgonda technique, were constructed by Rajiv Gandhi Water Mission. However, all of them are not working, except one at Choutuppal, in this regard Government of Andhra Pradesh is taking steps to improve the status of the defluoridator. The severally affected subjects were physically handicapped and psychologically upset, which added burden to their families. The social stigma attached to this village made it difficult to get spouses for their youth and can lead to unrest and become a social problem.

Study background: The Sai Oral Health Foundation has been working since 15 years in the affected villages of the district. The foundation, with help from the Government of Andhra Pradesh, has taken actions towards sustainable supply of safe low fluoride drinking water to the villages. This is done either by giving the families bone char based domestic defluoridators and by constructing rainwater harvesting systems.

The present study was undertaken in two affected villages to investigate the effects of the intervention on biological fluids of the beneficiaries and their reaction to the introduced systems.

MATERIAL AND METHODS

Villages and subjects: Two villages, Anthampet, village A, and Batlapally, village B, were selected. Both villages lie in the Nalgonda district, 25 and 40 km respectively, away towards south of the National Highway No. 9. Village A had 2691 inhabitants, while village B had only 395. In both cases villagers were engaged mostly as small farmers and agricultural labourers. The only source of drinking water in both villages was bore wells, 4 wells in village A and 2 in village B. The mean fluoride level in the village's drinking water was 3.7 and 3.8 mg/L respectively.

Twelve children, age 8 - 13 years, from Village A and 8 adults, age 27 - 60 years, from Village B were recruited for the evaluations of the study.

Intervention:
Village A was given 90 bone char defluoridators and in village B constructed 11 rainwater harvesting units. The domestic defluoridator was used containing 1 kg of bone char [10].

FIGURE 1. The utilised bone char filter.

A typical roof top rainwater harvesting system, cf. Figure 1, comprises: 1) Roof catchment. 2) Gutters. 3) Down pipe and first flush pipe. 4) Filter unit. 5) Storage tank.

Beside the low fluoride water, 9 children in Village A were given, daily, 6000 I.U. vitamin A, 400 I.U. vitamin D and 500 mg of calcium.

Sampling and analyses: Six month after the start of the intervention program, urine of 24 hours for three consecutive days and blood samples were collected from the study subjects both before and after six month use of the defluoridated/rain harvested water. Fluoride was analysed in urine using ion selective electrode, EA940, Boston, MA. Serum calcium, phosphorous and alkaline phosphatase were analysed using a kit, supplied by Roche Diagnostic, Germany. Before and after 6 month of the intervention, the water was analysed for some chemical parameters, conductivity, pH, alkalinity, hardness, chloride and fluoride, using the Standard Methods.

FIGURE 2. Illustration of on of rainwater harvesting system installed.

Statistical analysis: Statistical analysis was carried out with SPSS 11.5 for windows. The unpaired 't' test was used to check the parameters differences between groups. The statistical significance was set at $P<0.05$ and $P<0.01$.

RESULTS

In both villages people were motivated to use the low fluoride water from the provided units for drinking and cooking. Table 1 shows the results of chemical analysis of the well water, the rain-harvested water and the defluoridated water from both the villages.

Clinical manifestation: The prevalence of different clinical manifestations observed in the population is presented in table 2. Among the school children age 6 – 13 years of village A and B respectively, dental fluorosis of various degrees prevails in 97 % and 96 %, skeletal fluorosis in 60 % and 45 %, genu valgum in 0.56 % and 2.2 %, genu varum in 1.8 % and 2 % and paraplegia in 0.3 % and 0.7 %. Joint pain, neck rigidity, gastric problems and burning sensation during urination were reported in 50 – 70 % of the people in both the villages.

After the intervention there was a significant decrease in joint pain, an improvement in body movements and a relief in the gastric problems and in the burning sensation during urination.

TABLE 1: Chemical analysis of drinking water before and after the provision of low fluoride water.

Parameter,	& Unit	Village A		Village B		Supplied A&B
Water Sources:		**Well**	**Defluoridated**	**Well**	**Harvested**	**Lake**
Conductivity,	µS/cm	885	833	868	295	344
pH	-	7.51	7.51	7.4	9.74	7.8
Total Dissolved Solids,	mg/L	566.4	541	559	188	223
Alkalinity:						
a) Carbonate,	mg $CaCO_3$/L	0	0	0	80	0
b) Bicarbonate,	mg $CaCO_3$/L	476	468	352	0	140
c) Hydroxide,	mg $CaCO_3$/L	0	0	0	2	0
Hardness,	mg $CaCO_3$/L	344	324	332	98	116
Calcium,	mg $CaCO_3$/L	92	124	196	56	62
Magnesium,	mg $CaCO_3$/L	252	120	136	36	54
Chloride,	mg/L	68	68	72	40	40
Fluoride,	mg/L	3.8	0.2	3.7	0.08	0.45

Biochemical findings: Mean fluoride content in drinking water sources was 3.7 and 3.8 in village A and B respectively. Due to supply of low fluoride water to the village A (0.18) and village B (0.04) were relieved from joint pain and joint stiffness particularly in village B, there was significant decrease in urinary fluoride in both the villages. Serum calcium status was improved in village B but not in village A. Serum alkaline phosphatase KA units/L was increased in village A as well as in village B subjects, cf. Table 3.

DISCUSSION

In the earlier studies [1, 11-13], it was reported that the deformities like genu varum have been associated persistently with high fluoride in drinking water in both adolescent and adult population as well as in the younger age group children, in the fluorotic areas of the country. No abnormal skeletal deformities were reported in villages where fluoride content of drinking was within acceptable limits [11-14]. In the present study, it was found that the crippling bone deformities were associated with poor socio-economical status of the community. This is in agreement with findings earlier studies [11, 12].

TABLE 2: Village base line data and analysis data of fluoride calcium and phosphorus before and after the intervention.

Base line data:		**Village A**		**Village B**	
Total Population		2681		395	
Number of households		950		84	
Drinking water Fluoride,	mg/L	3.7		3.8	
Prevalence of dental fluorosis, %		97		96	
Prevalence of skeletal fluorosis,%		60		45	
Cases of genu valgum,	No (%)	15 (0.56)		9 (2.2)	
Cases of genu varum,	No (%)	50 (1.8)		8 (2.0)	
Cases of paraplegia,	No (%)	8 (0.3)		3 (0.7)	
Before and after intervention:		Before	After	Before	After
Drinking water Fluoride,	mg/L	3.7	0.18	3.81	0.04
Urinary F,	mg/L	6.7 ±2.18	4.0 ±1.83**	7.13 ±2.0	4.6 ±2.8*
Serum Ca,	mg/L	1.00 ±0.06	1.01 ±0.03	0.88 ±0.02	0.98 ±0.021*
Serum P,	mg/L	0.54 ±0.04	0.53 ±0.03	0.28 ±0.05	0.33 ±0.03
Alkaline P,	KA units/L	684 ±204	735 ±247	275 ±154	297 ±183

* Significance for P <0.05. ** Significance for P<0.01

In the present study, the people are equally affected in village A and village B. It is known that malnutrition modifying the clinical profile of fluorosis in developing countries had been suggested by the high rate of crippling deformities among poor individuals residing in fluorotic areas [11, 12, 13]. Thus poor nutrition, including calcium deficiency and hard manual labour seem to play in additional role [12, 14]. Calcium deficiency may result in a secondary hyperparathyrodism[14]. The occurrence of such deformities only in fluorotic areas but not in similar socio-economic communities of non-fluorotic areas directly involves fluoride toxicity in modifying the formation of bone matrix [6].

Neurological sequelae, usually in the form of cervical radiculomyelopathy, results from the mechanical compression of the spinal cord and nerve roots due to ossification of soft tissue ligaments like posterior longitudinal ligament and ligamentaum flavum. Stiffness and weakness in lower and upper limbs, paraesthesia and numbness of whole body, inability in gripping of articles and they were unable to move and get up. These complications occur at a later stage of the disease. In the present study there are 8 cases of cervical radiculomyelopathy were found (age between 40 to 55 years) which clearly shows that 3 to 4 mg/L fluoride exposure for 40 to 55 years can develops cervical radiculomyelopathy.

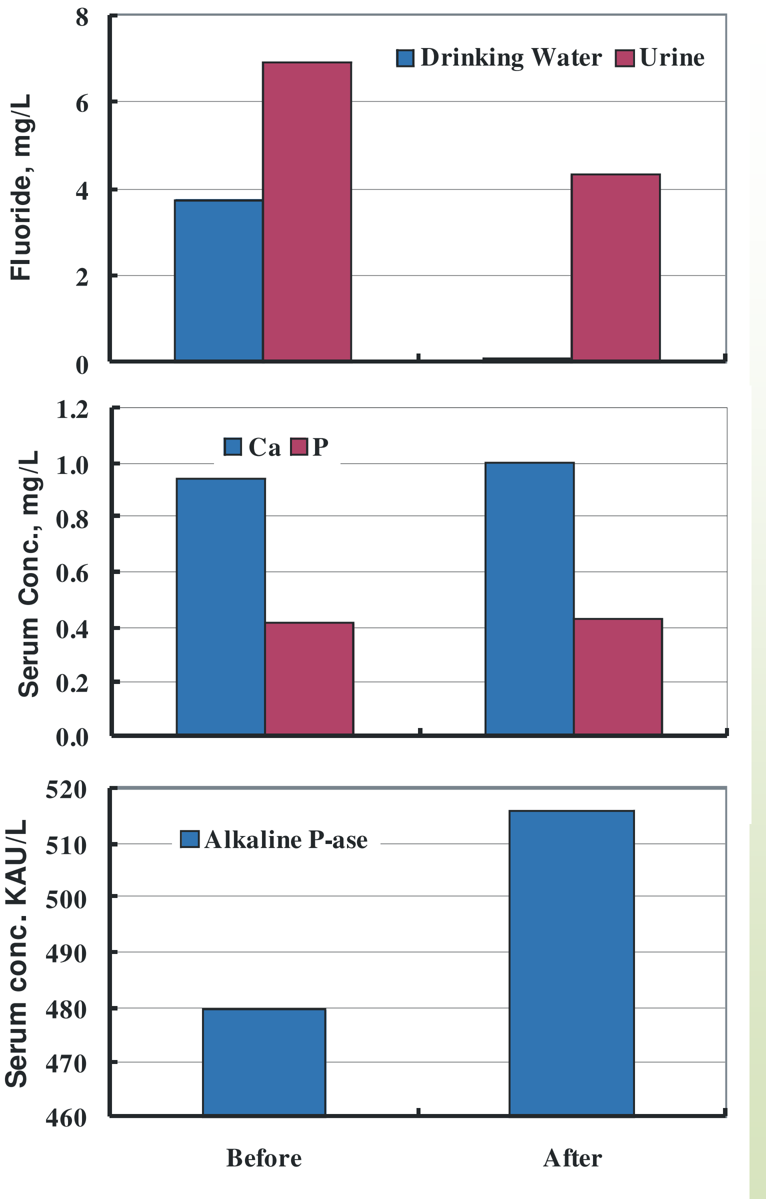

FIGURE 2. Concentrations of fluoride calcium, phosphorus in water and serum before and after the intervention.

Supply of bone char defluoridator to the village made significant change in the users health status and technology is being adopted in neighbouring villages too. The rainwater harvesting tanks are constructed in village B and people's acceptability is very high, though the rain is seasonal. The difficulty with this technique is that it required rooftop home. Experimental trials are on to harvest rainwater even from thatched house roofs.

Decrease in urinary fluoride, increase in serum calcium in children and increase in alkaline phosphatase in children and adults is observed after consumption of the low fluoride water obtained from the bone char defluoridators and the rain harvesting systems introduced in village A and B. Thus the results show clearly, both clinically and from the biochemical indicators that the health status was improved along with the intervention.

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