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Editorial

# Radiological Findings More Important and Reliable in the Diagnosis of Skeletal Fluorosis

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**Abstract**

Skeletal fluorosis is the resultant of prolonged chronic fluoride exposure through fluoride containing water and food and /or industrial fluoride emission. In this disease, due to pathological changes in various bones of the body, many types of physical deformities develop which are more painful and unbearable. These bony deformities remain in man throughout his life. There is no cure available for these fluoride-induced disorders yet. Among these deformities, the most common bone deformities in humans are bending at the waist (kyphosis) and curvature of the lower extremities (genu-varum and genu-valgum). In severe state of skeletal fluorosis, neurological complications such as paraplegia and quadriplegia are also prevalent in human population. In fact, these are the crippling deformities and can be easily recognised by necked eyes. But many times mistakes are made in identifying skeletal fluorosis in its early stages. However, radiological study makes the diagnosis of skeletal fluorosis easier, which is also more important and reliable. Because even mild fluoride-borne effects, such as periosteal exostosis, osteosclerosis, osteoporosis, and osteophytosis can be easily detected in X-rays of diverse bones of skeletal. However, the presence of fluoride-induced calcification of the interosseous membrane between radius and ulna bones of upper limbs or forearms is the most ideal or correct diagnostic feature or sign of skeletal fluorosis. In present editorial, besides the different forms of crippling deformities, various fluoride-induced radiological changes in diverse bones of subjects afflicted with mild to severe skeletal fluorosis have also been focussed which are more important, useful, and reliable in the diagnosis of skeletal fluorosis in humans.

**Keywords:** Bones; Crippling deformities; Fluoride; Genu-valgum; Genu-varum; Kyphosis; Paraplegia; Periosteal exostosis, Osteophytosis; Osteoporosis; Osteosclerosis; Quadriplegia; Radiology; Skeletal fluorosis; X-rays

## Introduction

It is well known that excessive ingestion or inhalation of fluoride for long duration is injurious to health and causes a dreaded fluorosis disease in both humans [1-5] and diverse species of domestic animals [6-13]. The available sources of fluoride to man and animals are: drinking water, vegetation and crops grown on fluorotic soils and water, beverages, rock salts, certain edible marine animals, fluoride rich phosphate feed supplements, mineral mixture, medicines, cosmetics, dust in air and certain industrial processes [1,6]. However, the principal sources of fluoride exposure in human and animals are the fluoridated drinking water and industrial fluoride emission from diverse industrial activities such as zinc smelter, superphosphate fertilizer plants, rock phosphate mining, chemical fertilizer industries, bricks kilns, cement production, etc. Although, perennial surface waters such as ponds, reservoirs, lakes, dams, rivers, streams etc. are also sources of drinking water but these are mostly free from the fluoride contamination or have traces of fluoride or 0.01–0.3 ppm [1,14-16]. In fact, fluorosis develops in humans only when the amount of fluoride in drinking water is found to be more than 1.5 ppm [1].

If fluorosis develops from drinking of fluoridated water, then it is called hydrofluorosis. Similarly, fluorosis caused by industrial fluoride pollution then it is called neighbourhood or industrial fluorosis. But the disorders or anomalies develop in the body caused by these two types of fluorosis are almost the same in both man and animals [17,18].

After the ingestion or inhalation of F from different sources of fluoride exposure, it absorbed by digestive and /or respiratory systems and then finally reaches to various organs through blood circulatory system in the body. More than 50% absorbed F is excreted from the body through excretory products and perspiration, while rest of F is retained in the body where it accumulates gradually in the various organs. However, the maximum bio-accumulation of fluoride occurred in the calcified tissues, bones and teeth as compared to their counter parts. In general, the process of fluoride bio-accumulation is found to be higher in children and immature animals [19-21].

Though, fluoride is not essential element in the process of growth and development in human and animals and is also undesirable substance in animal feed [22,23]. But it has a vital contribution in the formation or mineralization of teeth and dental enamel and prevents the dental caries [1,6]. Nevertheless, the accumulation of fluoride in various organs adversely affects the physiological and metabolic




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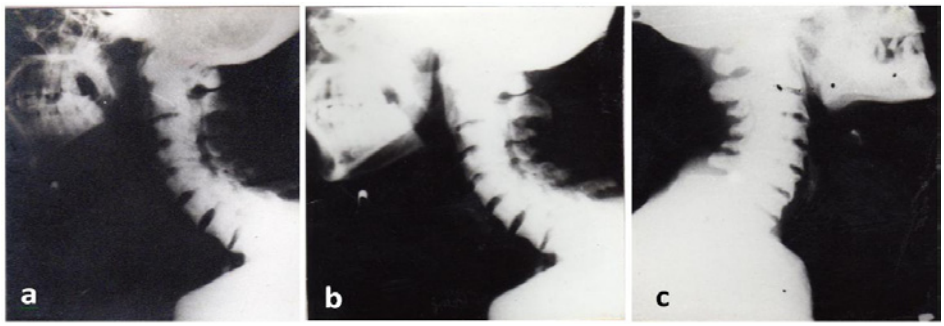


**Figure 1a-c:** Radiographs of cervical spines of subjects having mild (a), moderate (b), and severe (c) skeletal fluorosis showing progressive osteosclerosis, osteophytosis, and calcification of thyroid cartilage.

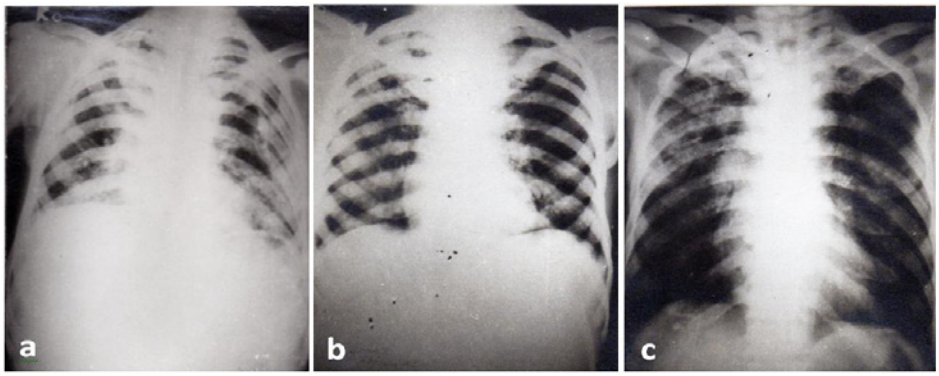


**Figure 2a-c:** Radiographs of chests of subjects having mild (a), moderate (b), and severe (c) skeletal fluorosis showing a peculiar contrast between the chalky-white bony cage and translucent lungs, irregular thickening of ribs and clavicles, and calcification of muscles.

activities, due to which many types of reversible and irreversible pathological changes are developed. These fluoride-induced pathological changes or anomalies are collectively known as fluorosis [1]. Those changes appeared clinically in hard tissues, teeth (dental fluorosis) and bones (skeletal fluorosis) are permanent, irreversible, and untreatable and they could be easily identified visually [1,6]. But other fluoride-induced disorders in soft organs (non-skeletal fluorosis) are however, reversible and disappeared when check the fluoride exposure.

## Skeletal Fluorosis

An excessive fluoride intake alters the equilibrium between the formation and the resorption of bone. This physiological change is accomplished by the involvement of certain regulatory determinants and signalling pathways, thereby leading to various bone or skeletal deformities known as "skeletal fluorosis", which is very painful and more dangerous than other forms of fluorosis in both man and animals. Due to excessive accumulation of fluoride in diverse bones, people suffer with crippling deformities, such as hunch-back (kyphosis) and bow legs (genu-varum), and some are bedridden. In severe state of skeletal fluorosis people also suffer with scissor-shaped knock-knee (genu-valgum) leg deformities and neurological complications, such as paraplegia and quadriplegia [24,25]. In general, these bone abnormalities are easily recognised visually. These crippling deformities are more prevalent or common in the subjects of the higher age groups when in the drinking water fluoride concentration is ≥1.5 ppm [24,25].

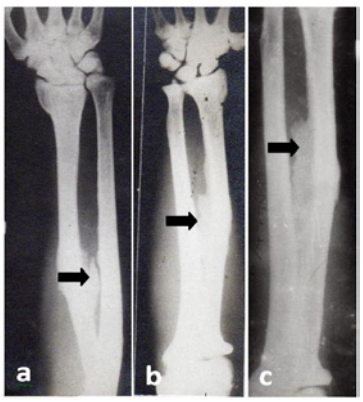


**Figure 3a-c:** Radiographs of radius-ulna bones of forearms of subjects having mild (a), moderate (b), and severe (c) skeletal fluorosis showing progressive osteoporosis, roughening and thickening of periosteal surface, periosteal bone formation along the insertion of tendons, and ligaments. Calcification of interosseous membrane (arrow) between radius and ulna bones indicating skeletal fluorosis.

The excess accumulation of fluoride in muscles also diminishes or restricts movements and the condition leads to becoming disabled including with crippling. As the fluoride concentration in the drinking water increases the skeletal fluorosis becomes more severe and may develop even in children and adolescents as well

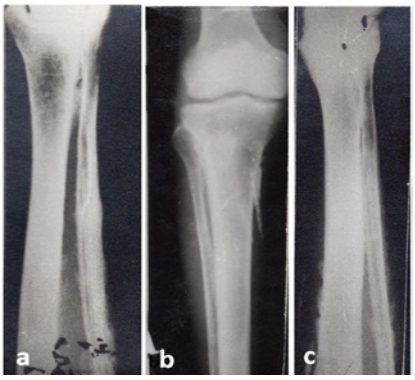


**Figure 4a-c:** Radiographs of tibia-fibula bones of subjects having varying grades of chronic fluoride intoxication (a-c) showing progressive osteoporosis, roughening and thickening of periosteal surface, periosteal bone formation along the insertion of tendons, and ligaments.

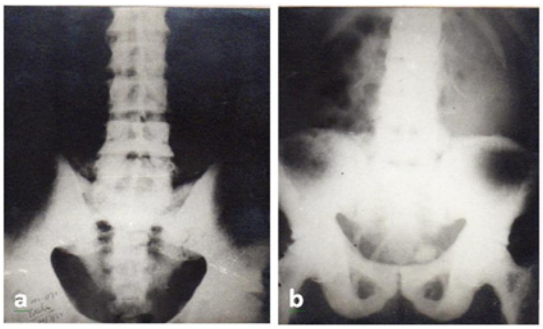


**Figure 5a & b:** Radiographs lumbo-dorsal spines or vertebrae of subjects having moderate (a) and very severe (b) skeletal fluorosis showing diverse progressive changes in spines or vertebrae markedly sclerotic with irregular new bone formation, considerable lipping, and osteophytosis. Interspirous and other spinal ligaments also showed calcification in severe skeletal fluorosis (b).

as in adult individuals. However, severity or magnitude of skeletal fluorosis is much more depend on fluoride concentration in drinking water and its duration and intake frequency or the density if its bio-accumulation in bones [26]. Apart from these chemical constituents in drinking water, food nutrients, ethnic groups, age, sex, individual fluoride susceptibility or tolerance, genetics, etc. are also responsible for the severity of fluorosis [27-33].

## Radiological Findings in the Diagnosis of Skeletal Fluorosis

Skeletal fluorosis is highly significant since it diminishes mobility at a very early age by gradually producing various changes in bones such as periosteal exostosis, osteosclerosis, osteoporosis, and osteophytosis [24,25,34-39]. These changes appear clinically in the form of vague aches and pains in the body and joints and the changes can be seen and identified in the radiographs or X-rays of various bones of skeletal of fluorosed subjects (Figures 1-6). Though, skeletal fluorosis can be identified on the basis of presence of these fluoride-induced radiological changes in diverse bones. But it is not necessary that these changes are present in mild form skeletal fluorosis. Therefore, X-ray of the radius-ulna bones of forearm is more important and helpful for the diagnosis of skeletal fluorosis

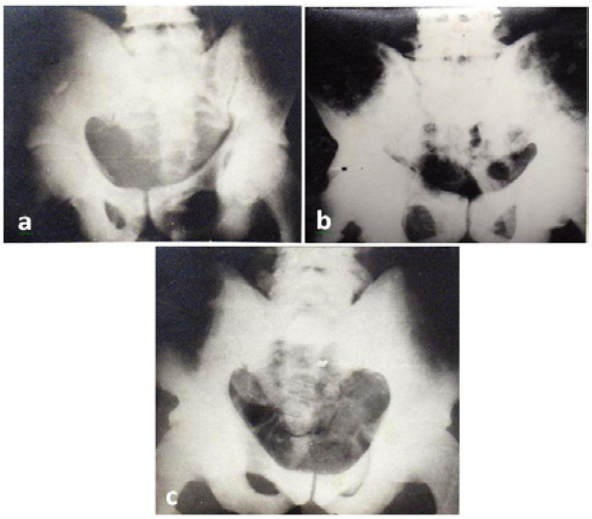


**Figure 6a-c:** Radiographs of pelvic bones subjects having mild (a), moderate (b), severe (c) skeletal fluorosis showing diverse progressive changes as sclerosis of the iliac crests and ischial tuberosities, pelvic bones appeared dense with loss of bone detail, osteophytic changes, ossification of sarco-spinous and sarco-tuberous ligaments.

because interosseous membrane between them is the first to initiate fluoride-induced calcification which can be easily detected on X-ray film (Figure 3). In fact, calcification of interosseous membrane of radius-ulna bones of forearms is the most ideal diagnostic feature for evidence of skeletal fluorosis [40]. Although skeletal fluorosis can be inferred on the basis of crippling deformities, nevertheless, radiological findings are more important, helpful, and reliable for the correct diagnosis of skeletal fluorosis.

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