Skeletal Fluorosis

A Report of Two Cases

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ABSTRACT: Two illustrative cases of patients with skeletal fluorosis and classic radiographic changes are presented. One patient demonstrated a progressive paraparesis, while the other was diagnosed incidentally on routine radiographs. A review of the literature, treatment, and histologic findings are presented.

Introduction

Skeletal fluorosis is an uncommon condition in the United States, yet endemic in some parts of the world.[1-5] The therapeutic uses of fluoride compounds in the prevention of dental caries and the treatment of osteoporosis are widely known, however, the nonspecific symptoms and classic radiographic presentation of fluoride toxicity are less familiar.[6-13] The following cases are presented to familiarize orthopedic surgeons with the skeletal and soft tissue findings of fluorosis.

Case Report

Case 1

A 65-year-old Hispanic female presented with a 1- to 2-month history of progressive lower extremity weakness and intermittent urinary incontinence. Approximately 1 week prior to presentation, her legs had become so weak she was no longer able to ambulate. She reported an aching pain in her back and chest, and parasthesias in both legs. There was no history of trauma nor previous problems with her neck or back. The patient was a Mexican citizen who had no reported occupational fluoride exposure, although she drank well water in Mexico most of her life.

The medical history was significant only for untreated hypertension. Her physical examination demonstrated markedly decreased muscle strength in both lower extremities. Deep tendon reflexes were absent at the ankles and moderately hyperreflexic at the knees. Rectal tone was good with intact bulbocavernosus reflex. Light touch, proprioception, and pain sensations were intact in the lower extremities. Neurologic testing in the upper extremities was within normal limits.

Radiographs of the chest and abdomen revealed increased radiodensity throughout (Fig. 1, 2). Considering the patient's age and medical presentation, a working diagnosis of metastatic disease of unknown etiology was made. An emergent myelogram demonstrated a partial spinal block at the second and third thoracic levels (Fig. 3). Radiation therapy to her thoracic spine was begun along with a workup for a primary malignancy. An iliac crest bone biopsy (Fig. 4) showed a striking osteoblastic process, although it showed no evidence of malignancy. Prompted, in part, by a lack of significant response from the radiation therapy, additional workup, including a skeletal survey and a spinal CT, was obtained (Fig. 5, 6).

Due to the patient's persistent neurologic deficits and documented spinal cord compression from bony impingement, a posterior decompressive laminectomy was performed from the first to the fourth thoracic vertebrae. At surgery, the laminae were noted to be essentially fused with the bone being very soft and chalk-like in consistency.

A fluoride level on the bone removed at surgery measured 1,900 nanograms (ng) per liter (the normal

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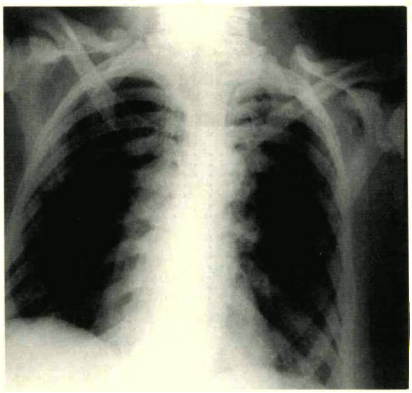

Fig. 1: Slightly overpenetrated chest radiograph demonstrating diffuse dense symmetrical sclerosis of bony thorax.

level is less than 140 ng). A urine fluoride level taken after surgery measured 3.39 mg/L, (normal, 0.2 mg/L to 1.0 mg/L). The patient's neurologic status remained about the same with short-term follow up.

Case 2

A 68-year-old white male was being followed in a medical clinic for end-stage renal disease. He was without symptoms relevant to his back or extremities. His medical history was significant for hypertension, adult onset diabetes, and end stage renal disease of unknown etiology. His medications contained no fluoride compounds and his physical examination was within normal limits. He had no history of occupational fluoride exposure, although he had worked on a ranch.

Routine radiographs revealed diffuse osteosclersosis throughout the spine and pelvis. Calcification of ligaments in the pelvis was also noted (Fig. 7). With these radiographic changes and a subsequent iliac crest bone biopsy (Fig. 8), a diagnosis of skeletal fluorosis was made. He required no specific treatment for this condition and subsequently died of his renal disease.

Discussion

The beneficial effects of fluoride in the prevention of dental caries, and more recently in the treatment

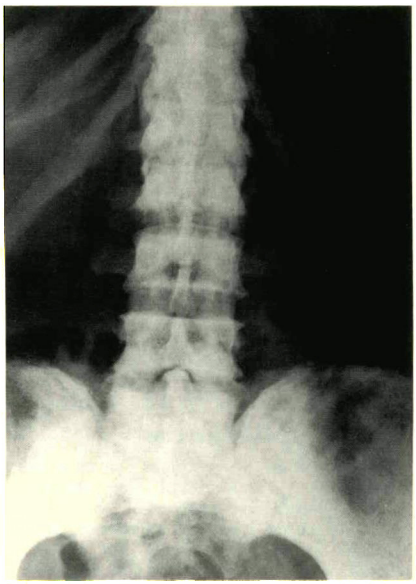

Fig. 2: Anteroposterior view of the lumbosacral spine with fairly uniform diffuse dense sclerosis.

of osteoporosis, are well recognized. The soft tissue and skeletal manifestations of fluoride toxicity are uncommon. The most frequently reported cause of skeletal fluorosis is from the ingestion of water containing high concentrations of fluoride. Most reports of this disease originate from parts of Africa and Asia where fluorosis from drinking water is endemic.[1-5,14] Occasionally, skeletal fluorosis may be caused by occupational exposure.[9,15] Iatrogenic skeletal fluorosis is being increasingly reported with the use of fluoride in the treatment of multiple myeloma, osteopenic conditions, or the use of niflumic acid in the treatment of inflammatory conditions.[8,16-18]

Most researchers agree that concentrations of fluoride in drinking water of one part per million can be helpful in the prevention of dental caries.[6,8,10,13] However, there is disagreement over the dose and effect that fluoride has on subsequent bone strength

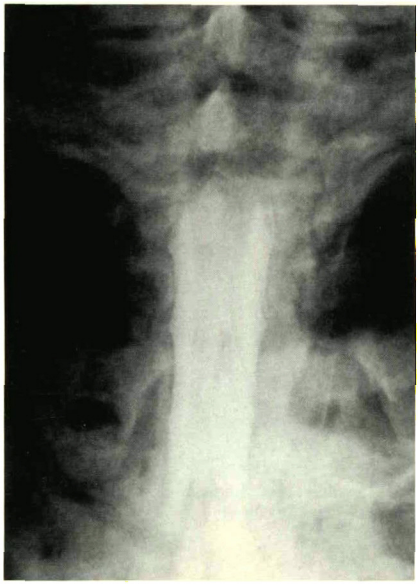

Fig. 3: Posteroanterior view of the cervicothoracic junction in head down position following subarachnoid introduction of Pantopaque. There is a subtotal block at the superior margin of T3. A very small amount of contrast agent passed this area.

in the treatment of osteopenic conditions such as osteoporosis. Fluoride has been documented to increase bone mass in treated subjects, although a consistent increase in bone strength has not been demonstrated.[12,19,20] Human studies have generally been limited to those specimens obtained from areas of endemic fluorosis. They have shown the modulus of elasticity and tensile strength of fluorotic bone was consistently reduced. Compression testing, however, showed increased strength in these bones as compared to controls.[2,9] The differences may be due to the varying effects of fluoride treatment relevant to the subject's nutritional status, vitamin D level, magnesium level, or calcium level at the time of fluoride administration.[2,4,8,9,12,14,20,21]

In those areas of endemic fluorosis, pain, as seen

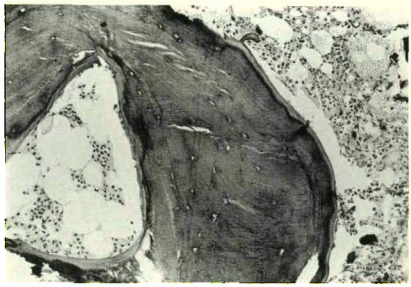

Fig. 4: Trabecular bone almost entirely surrounded by osteoid seam (original hematoxylin and eosin, ×100).

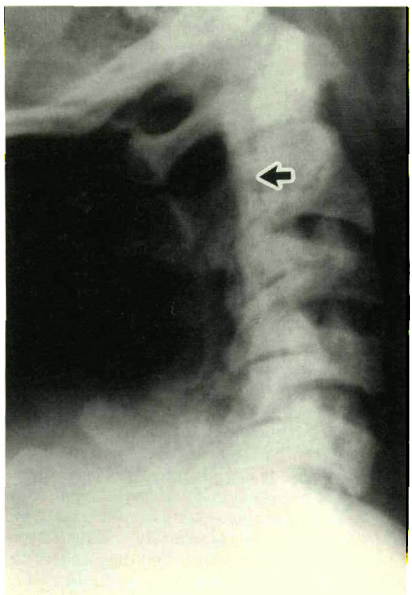

Fig. 5: Lateral view of the cervical spine with diffuse bony sclerosis and heavy calcification of the posterior longitudinal ligament (arrow).

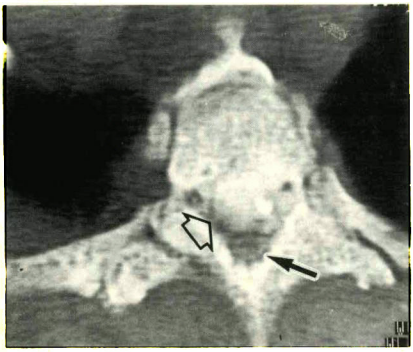

Fig. 6: Axial CT scan of the superior thoracic level. Note the large amount of calcification in the region of the posterior longitudinal ligament (open arrow) and the compressed cord and opacified subarachnoid space (arrow). There is a small amount of residual Pantopaque.

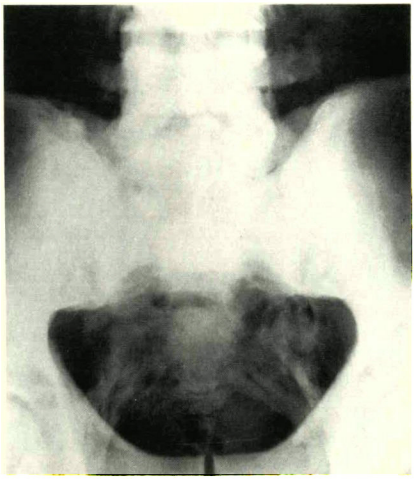

Fig. 7: Anteroposterior radiograph of the pelvis. There is heavy calcification of the sacrospinous ligaments.

in the first case, is a frequent symptom.[1] Physical findings include an increased incidence of genu valgum and varum, kyphosis, and decreased spine mobility.[1,3,5]

The radiologic features of skeletal fluorosis have been well described. Initially, the pelvis and vertebrae are affected and become roughened, with blurring of normal trabecular pattern. With continued fluoride exposure, further blurring and merging of the bony trabeculae occurs. Finally, diffuse osteosclerosis of the central bones occurs while irregular periosteal thickening and ligamentous calcification occur in the extremities and spine.[1,3-5,8,15,18,22] The attachments of tendons, muscles, and ligaments to bone become progressively calcified throughout the body relevant to the severity of the process.[21] The skull is usually spared except in the most severe cases.[15] The changes in the vertebral column, as in the two cases presented, are generally among the most conspicuous radiographically. Calcification of the various intervertebral ligaments (ligamentum flavuum, anterior and posterior longitudinal ligaments), and the enlargement of the posterior elements can markedly narrow the spinal canal as demonstrated in the first case.[1,16,21]

The radiographic similarities between fluorosis and the far more common osteoblastic metastatic processes can cause a delay in diagnosis and treatment.[15] Prostatic and breast carcinoma are common sources of diffuse osteosclerosis in the elderly and should be excluded early. This is well demonstrated in the first case presented where the diagnosis did not become apparent until after the iliac crest bone biopsy. The presumed diagnosis of fluorosis was confirmed with the histologic findings following and fluoride levels from bone and urine.

Additional disease processes which can present a radiographic appearance of diffuse osteosclerosis are Paget's disease, myelosclerosis, and sickle cell anemia. Paget's disease is a more expansile process in which diffuse bony involvement is rare. Sickle cell anemia, myelosclerosis, and Paget's disease lack ligamentous calcification which may be seen in fluorosis.

Histologically, there is a tremendous increase in periosteal new bone formation. The lamellar bone, though, is of increased density, and disordered and irregular. The haversian systems of lamellar bone are

also inconsistently formed.[5,8,12,15,18,21] The trabeculae are increasingly dense with thickened osteoid seams, similar to that seen in Paget's disease.[1]

Treatment in cases of fluoride toxicity secondary to chronic exposure is aimed at the identification and elimination of the source. In these cases, normal renal excretion of fluoride will usually halt progression of the process. Hemodialysis has also been used effectively in cases of acute fluoride poisoning, although its usefulness in chronic cases has not been documented. Due to the hypocalcemia seen, close cardiac monitoring and calcium replacement is also advised during treatment.[23,24]

The cases presented demonstrate several typical features of skeletal fluorosis. By recognizing this entity early, extensive and costly studies may be avoided and the fluoride source eliminated to prevent further progression and sequelae.

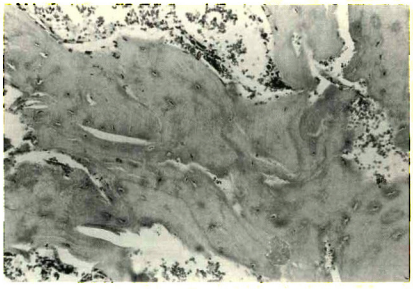

Fig. 8: Iliac crest biopsy demonstrating numerous cement lines in trabecular bone (original hematoxylin and eosin, ×100).

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