Radiology of Skeletal Fluorosis: A Review

Nikhil Nair1 and Nikhil Gupta2*

1Department of Radio-Diagnosis, All India institute of Medical Sciences, India
2Department of Clinical Immunology & Rheumatology, Christian medical college, India

Abstract

Fluorosis occurs due to excessive fluorine entry into the body. Dental, skeletal and non-skeletal fluorosis is different types of fluorosis. Endemic skeletal fluorosis is prevalent in many countries including India. Conventional radiographs and more recently MRI are helpful in diagnosis of fluorosis which classically reveals a wide and intriguing spectrum of findings. We review the various radiological findings in a case of fluorosis.

INTRODUCTION

Endemic skeletal fluorosis is an entity presenting with an interesting gamut of radiographic appearances. This disease stems from excessive fluoride consumption and is prevalent in certain regions of South East Asian countries due to naturally occurring high fluoride levels in drinking water. Conventional radiographs and more recently MRI are helpful in diagnosis of fluorosis which classically reveals a wide and intriguing spectrum of findings ascribed to Osteosclerosis (most common), osteomalacia and osteoporosis [1-5].

Excessive fluoride consumption results in increased metabolic turnover and impaired collagen synthesis of the bone [6]. The resulting osteo-condensation leading to osteosclerosis, stress fractures, ligamentous calcification, ossification and mechanical compressive effects often lead to radiculomyelopathy [7-10].

Clinical diagnosis of fluorosis relies on five criteria which include (a) residence in the endemic area for > 10 years; (b) mottled tooth enamel (c) urine fluoride level greater than 10 mg/I (normal, < 1 .5 mg/I); (d) typical symptoms and findings on physical examination and (e) no evidence of other metabolic bone disorders found on review of their medical history or on physical examination [11].

Radiology of fluorosis

Radiological examination is widely considered as the best method for diagnosing fluorosis [12-16], especially when patients are still in the asymptomatic phase [6,17]. Conventional radiographs and MRI are the currently used methods for radiological diagnosis of fluorosis.

Conventional radiographic features of fluorosis include increased bone density, trabecular haziness, compact bone and periosteal thickening and ossification of attachments of tendons, ligaments, and muscles [12,13,18]. Axial skeleton is characteristically involved in fluorosis with the dorsolumbar spine, pelvis, and ribs being the most severely afflicted sites [19-22].

The earliest sign on a plain radiograph is sand like or granular appearance of bone structure owing to bone deposition and thickening at the junctions of trabeculae [11]. In the next stage, trabecular thickening is seen followed by trabecular fusion appearing as focal round densities in the medullary bone [11].

Osteopenia of the long bones is also a common finding reported by many authors [5,17,23]. They also noted that osteosclerosis in the spine and pelvis was always combined with osteopenia of the long bones which was explained as the axial skeleton undergoing a different pathologic process from the appendicular skeleton for many years, until late in the natural history of endemic fluorosis. Krishnamachari described severe osteoporosis of the distal femur, proximal tibia and fibula along with rarefaction of the metacarpal bones as the most striking radiologic features of fluorosis [6].

Osteosclerosis is a common finding in this disorder especially in lumbosacral spine and pelvis. Some authors even suggest that radiographs of the spine (for osteosclerosis) and forearms (for periosteal bone formation and interosseous membrane ossification) are accurate enough for the diagnosis of early skeletal fluorosis in children [17,22,24]. However, osteosclerosis alone is a nonspecific finding seen in many diverse disorders, including metastases, myelofibrosis, Paget’s disease, hemoglobinopathies and renal osteodystrophy among others [1,6].

Vertebral osteophytosis with soft-tissue calcification and ossification is another common but non specific feature of fluorosis. This sign can also be seen in spondylitis deformans, diffuse idiopathic skeletal hyperostosis, ankylosing spondylitis, psoriasis, acromegaly, neuropathy, and alkaptonunia [1,6]. Similarly proliferation at ligament and tendon insertions and


*Corresponding author
Nikhil Gupta, Department of Clinical Immunology & Rheumatology, Christian medical college, India, Tel: +91-9873087879; Email: omnikhil.guptamamc@gmail.com
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periosis are also common but nonspecific findings in fluorosis which can also be seen in diffuse idiopathic skeletal hyperostosis, hyperparathyroidism, X-linked hypophosphatemic osteomalacia, and plasma cell dyscrasia [19]. It is the combination of these above findings on conventional radiographs which is diagnostic of fluorosis [1,6,19].

MRI is another useful imaging modality in fluorosis for early diagnosis and planning of proper surgical intervention in the symptomatic patient as it allows accurate visualization of extent of soft tissue and spinal cord changes and associated abnormalities [25].

Typical MRI findings include sclerotic/dense bones, ossification of posterior longitudinal ligament and ligamentum flavum. Stress fractures, spinal canal and neural foramina narrowing caused by osteophytes in addition to possible presence of meningocele can also be seen [10,26,27].

Osteosclerosis i.e., increased bone density is manifested as low signal intensity on both T1 and T2 weighted images [8,28]. These typical MRI signal changes along with neural foramina narrowing and premature degeneration of vertebrae may be present in many asymptomatic florotic subjects.

MRI is superior over other modalities in demonstrating intraspinal ligaments particularly when they are not calcified [10]. Ligamentum flavum hypertrophy, ossification/calciﬁcation of the posterior longitudinal ligament (PLL) and ligamentum flavum (LF) are also prominent findings in fluorosis [10,27,29,30]. Pseudomeningocele is a commonly reported association [10]. A novel feature of a high frequency of hemangiomas existing with fluorosis was reported for the first time by Ahmed et al., in 2013 [25].

However it is important to remember that MRI is a costly investigation and not feasible for epidemiological studies on endemic population which may be the main reason for paucity of MRI literature on fluorosis [25].

The differential diagnosis of altered marrow signals on MRI are not specific to fluorosis and can also be seen in myelofibrosis, mastocytosis, lymphoma, osteoporosis, osteoblastic metastasis, and Paget’s disease [25]. In endemic regions of fluorosis, patients with compressive myelopathy secondary to ossification of PLL and/or LF, fluorosis should be considered as a possible etiology. MRI may show diffuse low signals on all pulse sequences, and can help in early detection of fluorosis and thus save the patients from serious manifestations like florotic myelopathy which require surgical decompression to resolve and fractures [25].

Grandjean [15] has suggested that characteristic ligament calcifications, a history of long-term heavy exposure to fluoride and high urinary fluoride levels being the most important in the diagnosis of skeletal fluorosis. A history of exposure is essential for early diagnosis [22].

CONCLUSION

Thus to conclude plain radiograph and MRI findings are particularly useful for early and accurate diagnosis of fluorosis, sometimes even in asymptomatic patients.

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