Correlative Imaging in Skeletal Tuberculosis with Special emphasis on Radionuclide Bone Scintigraphy: A Pictorial Essay

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Abstract:

Tuberculosis can affect virtually any bone in the body, but it most commonly affects the spine. Radionuclide imaging holds a promising place in the evaluation of skeletal tuberculosis. Its ability to scan the entire skeleton and the physiologic dimension it provides are virtually exclusive to this specialty. Although conventional modes of imaging such as radiography, computer tomography and magnetic resonance imaging have their own place and provide explicit structural details, nuclear medicine is the only modality that targets skeletal physiology. This is a pictorial assay which describes the scintigraphic patterns of skeletal tubercular lesions using Tc-99m MDP bone scanning and their correlation with other imaging modalities like MRI, CT scans in seven patients.

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Introduction:

Tubercular involvement of the bone is a common phenomenon encountered in day-to-day clinical practice in the Indian subcontinent. With the incidence of immunodeficiency disease on the rise, there is also a concomitant rising trend in tuberculosis. Such cases usually present in adulthood, (although not very uncommon in childhood) with regional, and with or without constitutional symptoms. There may also be additional systemic involvement such as that of respiratory, gastrointestinal or nervous systems.

Skeletal scintigraphy with Tc-99m MDP (Technetium-99m- Methylene Diphosphonate) helps in early detection and localization of the disease. The other advantage of this test is its capability to scan the entire skeleton, which helps to document or rule out involvement of multiple sites.

Although histology remains the mainstay for arriving at the final diagnosis, there are certain clinical and radiological features, which help in suspecting the disease. This is especially useful in those situations where the lesion is precarious and empirical treatment is contemplated.

Material and method:

Bone scintigraphy was performed in all patients with 15 to 25 mCi of Tc-99m MDP, administered intravenously. Three phase bone scans were performed wherever indicated. The first phase comprised of the perfusion images acquired at the rate of 2 seconds per frame. The second phase was acquired between five and ten minutes using 256 x 256 matrix size. The third phase was acquired at three hours. Imaging was performed using either a Siemens single head E-Cam or GE Millennium gamma camera coupled with high-resolution low energy collimator. Both whole body as well as spot view images were obtained. Regional spot views were acquired with cumulated counts of 800 to 1000 kilo counts in 256 x 256 matrix.

All patients also underwent radiographic studies of the respective regions with plain radiograph and Magnetic resonance imaging.

Finally biopsies were performed on the skeletal lesions. The final diagnosis of skeletal tuberculosis was obtained on the basis of histopatological examination results.

Case - 1

A forty years old female presented with pain in the left hip region in the preceding months, which was progressive in intensity. The pain was ill localized. There was no history of fever or weight loss. Plain radiograph (Figure 1A) revealed no abnormality in the pelvic bones. An MRI of the lumbar spine (1B) ruled out any disc lesion. A Tc-99m MDP bone scan (1C, 1D) revealed increased and inhomogeneous tracer uptake in the left acetabulum and adjoining ileum. Aspiration cytology smear using Leishman stain and H&E stain revealed epithelioid granuloma. (1E, F)

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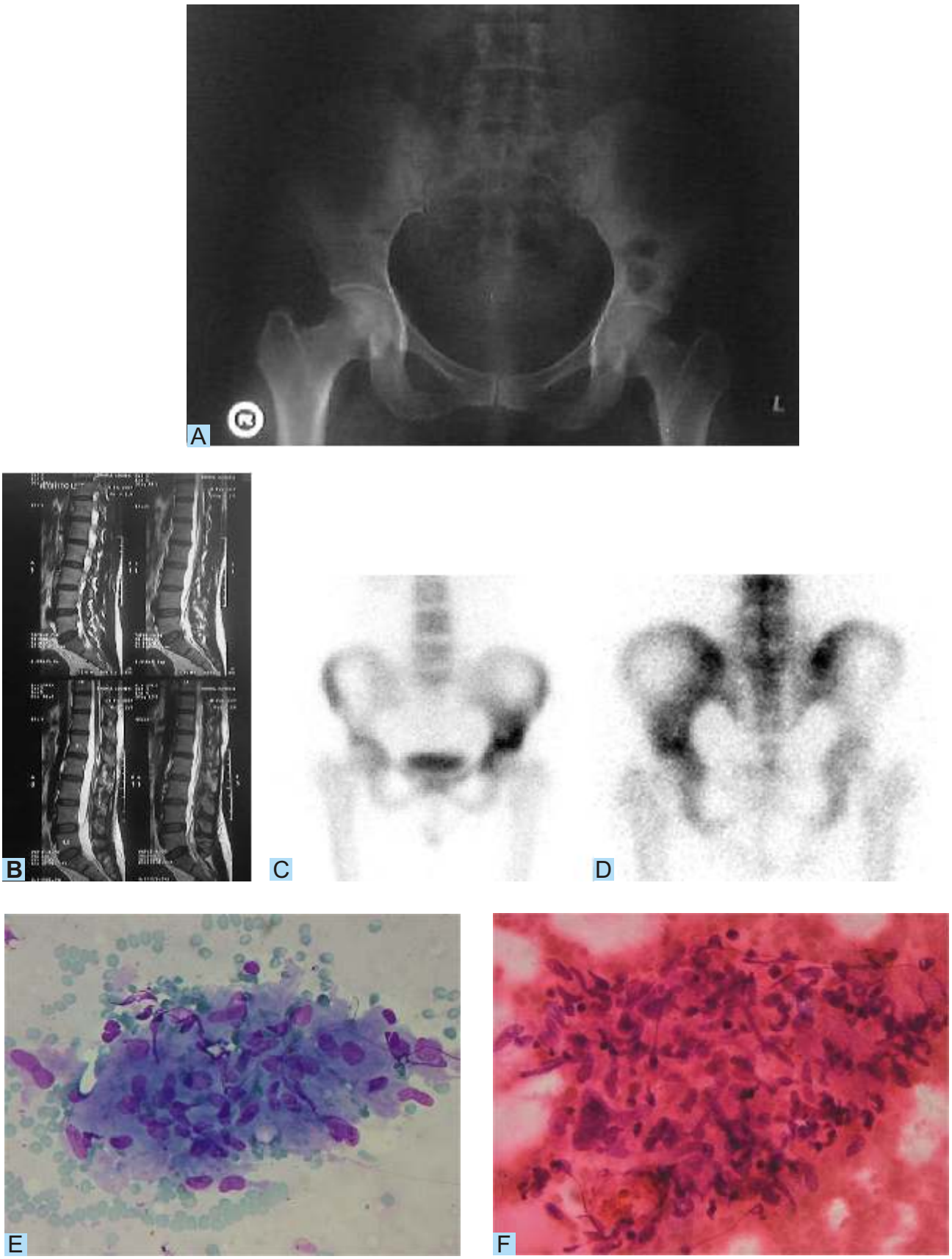

Figure 1. Plain x-ray of bony pelvis (A) revealed no abnormality. MRI scan of the lumbar vertebrae (B) ruled out any disc lesion. Tc-99m MDP bone scan, anterior (C) and posterior (D) spot views of the pelvis revealed increased and inhomogeneous tracer uptake in the left acetabulum and adjoining ileum. Aspiration from the ileac lesion and subsequent cytological examination using Leishman stain (E) and H&E stain (F) revealed epithelioid granuloma.

Case - 2

A 19 years old lady presented with weight loss, evening rise in temperature and back pain lasting several weeks. Clinical examination revealed restricted movements of the spine. Plain radiograph (2A) was normal. Three-phase bone scan (2B) revealed a focal lesion at right sacro-iliac joint in the phase-3 static images. This lesion appeared hypervascular in nature as evidenced by positive phase-1 (increased blood flow) and phase-2 (increased blood pool) images. A MRI (2C) scan revealed evidence of an abscess in the right iliacus. The abscess was aspirated, and microbiological examinations demonstrated infection with acid-fast bacilli.

Case - 3

A 54 years old lady complained of backache and left shoulder pain for several weeks. Plain radiograph (3A) showed an osteolytic lesion in the left scapula. MRI (3B, 3C) confirmed the lesion in the left scapula, which was suspected as neoplastic. A bone scan (3D, 3E) was requested to look for involvement of distant skeleton. This showed localized pathology to the medial margin and spine of left scapula. Histological evaluation confirmed the diagnosis of skeletal tuberculosis. The patient responded well to anti-tubercular treatment.

Case - 4

A 26 years old gentleman complained of occipital headache and back pain for which MRI was requested. The MRI study of brain was normal, but that of the spine (4A, 4B) showed abnormal signals. Whole body bone scan (4C) and spot views (4D) revealed multiple lesions in the vertebrae, sternum, ribs and right scapula. Routine chest radiograph (4E) was normal. Biopsy from the rib lesion confirmed the diagnosis of tuberculosis.

Case - 5

Forty years old gentleman was clinically thought to be having inflammatory arthritis in view of complains of right shoulder pain and backache. A whole body bone scan was requested to localize and document any focal abnormality. The radionuclide bone scans (5A, 5B) revealed two distinct lesions one in the medial margin of right scapula and the other in fourth lumbar vertebra. In view of absence of known malignancy, a gallium scan was suggested to document any infective process such as tuberculosis. The gallium scan (5C) showed congruent and increased tracer uptake at the two abnormal sites noted on the bone scan. A MRI (5D 5E) was also performed to look at the structure of these bones. Histology (5F, 5G) revealed Langhan's giant cells and tubercular granuloma.

Case - 6

A 28 years old gentleman complained of pain in the right shoulder lasting three months. Plain radiograph (6A) revealed osteopenia in the right humerus. MRI (6B, 6C) showed infective lesion in the right shoulder joint. A bone scan was requested to look for evidence of avascular necrosis of head of right humerus. The three-phase bone scan (6D, 6E) showed increased perfusion, high blood pooling and corresponding increased tracer localization in the delayed image. Whole body scan (6E) did not reveal involvement of any other part of the skeletal system. A gallium scan (6F) showed congruent and increased tracer localization in the right shoulder joint. Histology (6G, 6H) revealed characteristic tubercular granuloma confirming the diagnosis of tuberculosis.

Case - 7

A 73 years old gentleman complained of excruciating pain in the back. Clinically there was a gluteus abscess. Plain X ray (7A, 7B) of the lumbar vertebrae was normal. MRI (7C, 7D) revealed abnormal signals in L4, L5 vertebrae. Bone scan (7E) revealed abnormal tracer localization in L4 and L5 vertebrae with no evidence of involvement of distant skeleton. An aspirate from the lesion revealed pink colored acid-fast bacilli on Zeil-Nelson stain. (7F)

Discussion:

Skeletal tuberculosis can affect one or multiple bones as seen in the cases described above. Radionuclide bone scanning provides important clues to the diagnosis and especially in Indian subcontinent; the index of suspicion for this entity should be high. Tuberculosis can affect virtually any bone in the body, though the involvement of vertebrae is by far the most common (1). Skeletal tuberculosis accounts for 1 to 5% of all tubercular infections. The spine is known to be involved in 50% of such cases. About 30% have disease in the hip or knee, and 20% have affection of other bones such as ribs, pelvis, shoulder and sacroiliac joint.(2)

Mycobacterium tuberculosis lodges in the bones via haematogeneous spread from previously acquired disease in the lungs, gut or nodes. It may also invade the bones directly from the para-aortic lymph nodes. Tubercle bacilli initially destroy the cancellous bone and then extend to the cortex.

Other conditions, which may mimic skeletal tuberculosis, are pyogenic infection, fungal osteomyelitis, multiple myeloma, eosinophilic granuloma and bone metastasis. There are certain features of skeletal tuberculosis, which differentiate it from pyogenic osteomyelitis. Sequestration, which is the feature of pyogenic osteomyelitis, is not seen in tubercular osteomyelitis. Periosteal reaction is commonly seen is pyogenic osteomyelitis and not in tubercular. Reactive new bone formation is less pronounced in tuberculosis. Intervertebral disc is destroyed earlier in pyogenic infection and later in tuberculosis (3). Tuberculosis affecting the joints may first lodge in the synovium or the bone. Early radiological signs in such cases are usually osteoporosis and synovial effusion. Comprehensive evaluation of the lesion is done when bone

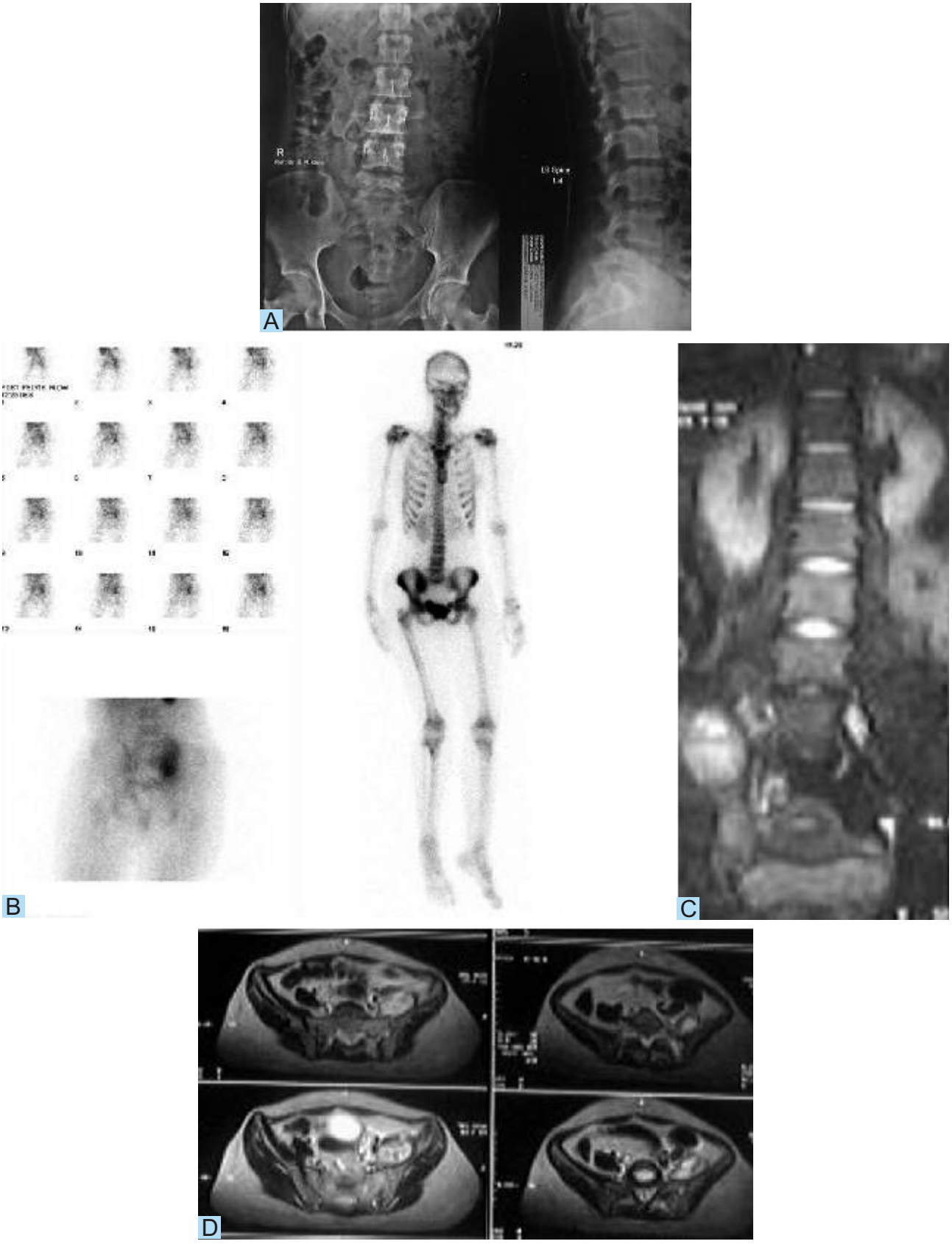

Figure 2. Plain radiographs of bony pelvis and lumbar spine (A) revealed evidence of scoliosis, but no sinister pathology. Three-phase bone scan (B) revealed a focal lesion at right sacro-iliac joint in the phase-3 static image. This lesion appears to be hypervascularity as evidenced in the first pass (increased blood flow) and blood pool images. The MRI scans (C, D) revealed altered signal intensity appearing hyperintense on T2 weighted images in the right sacral ala and the adjoining ilium, minimal fluid is seen in the right sacroiliac joint. The right iliacus muscle appears bulky and shows heterogeneous hyperintense signal with hypointense rim suggestive of an abscess.

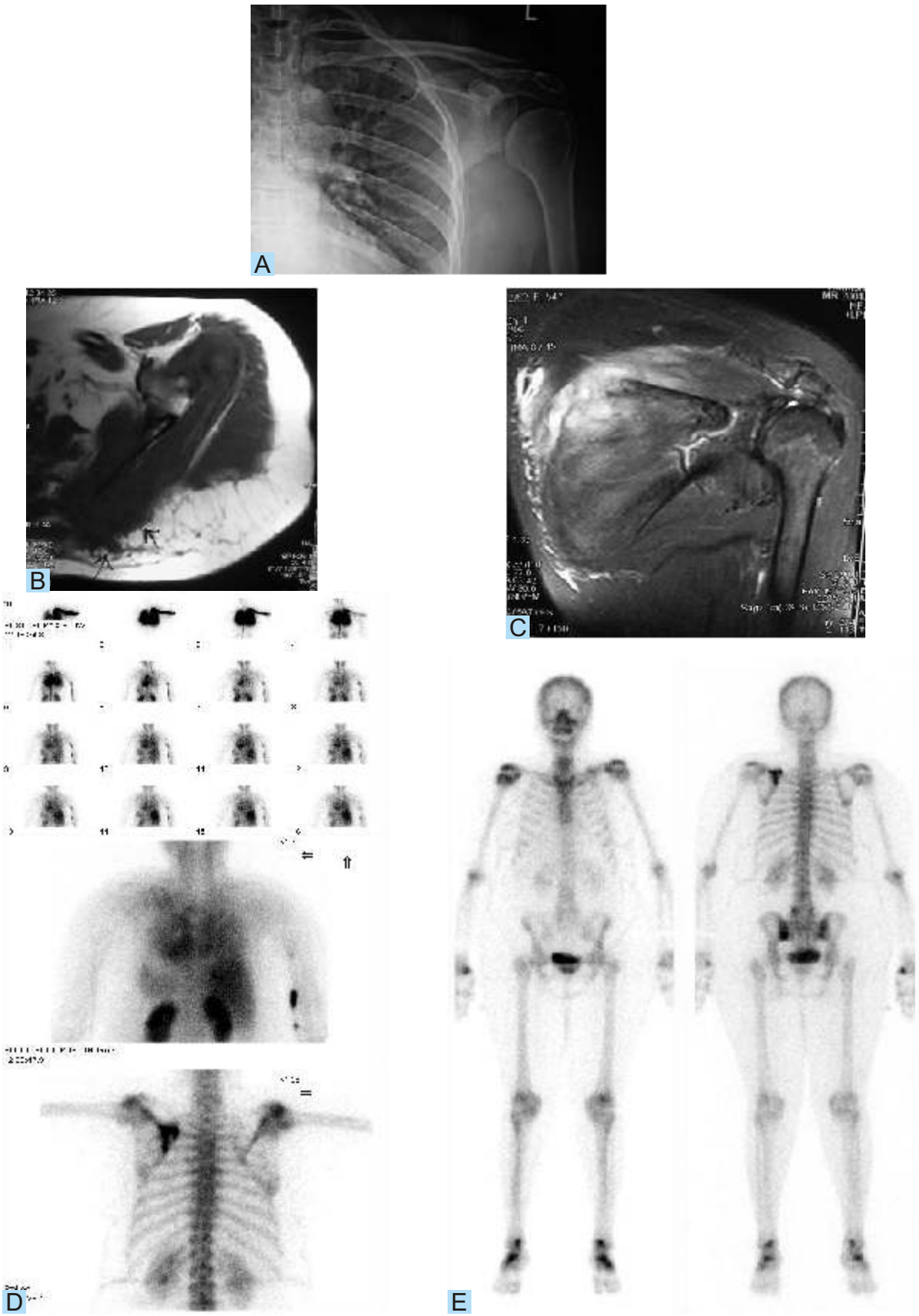

Figure 3. Plain radiograph of the thorax (A) revealed an osteolytic lesion in the left scapula along the medial margin just inferior to the scapular spine. The MRI study (B, C) confirmed the lesion in the left scapula, which was suspected as neoplastic. The MRI also revealed ill-defined altered signal as hyperintense on FAT SAT (Fat saturation) and hypointense on T1 weighted images in the supra and infraspinatus muscles medially. A three phase bone scan localized the pathology to the medial margin and spine of left scapula (D,E). Histological evaluation confirmed the diagnosis of skeletal tuberculosis.

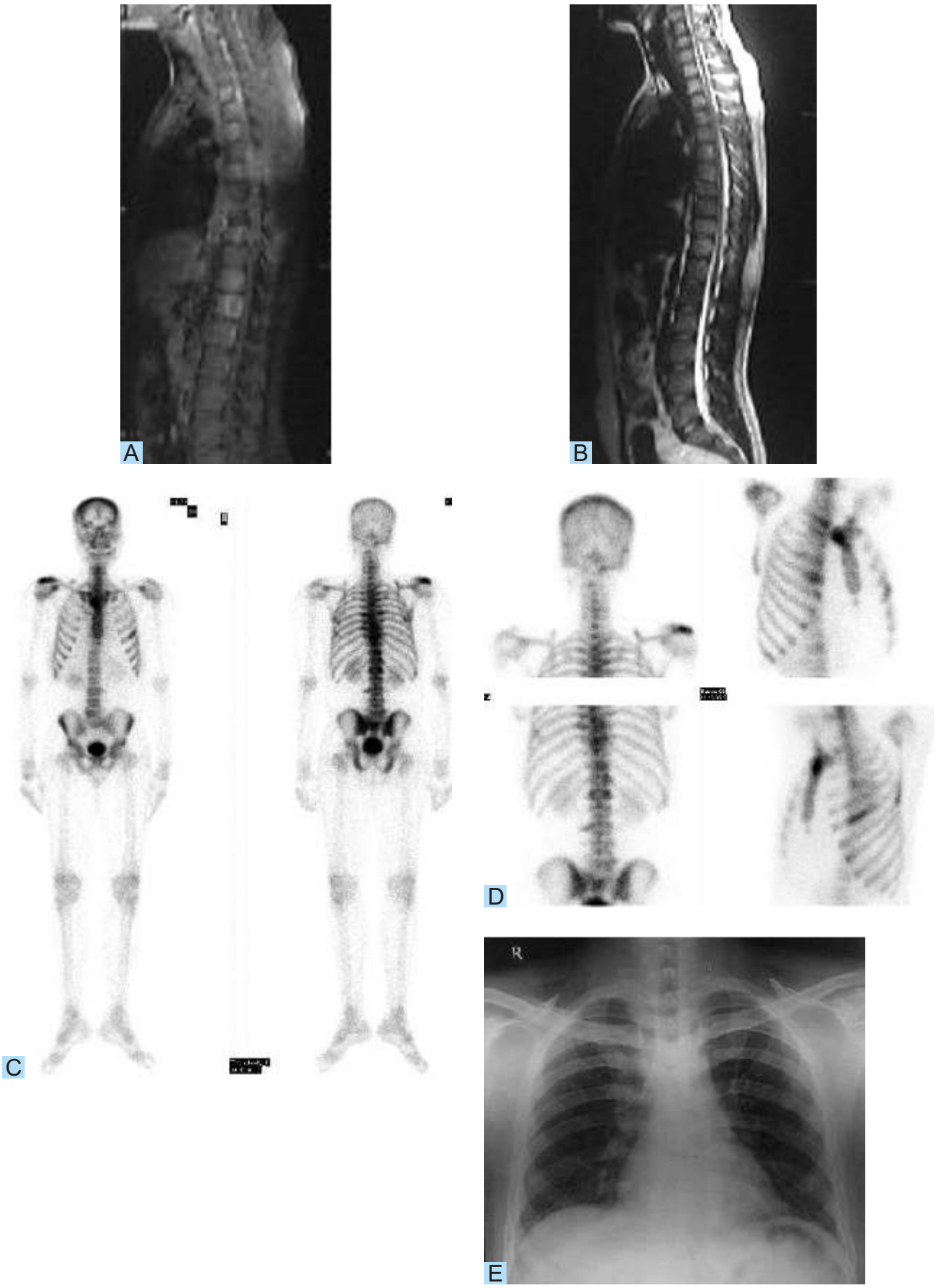

Figure 4. The MRI scans of the spine (A, B) revealed abnormal signals in multiple vertebrae and discs on both T1 and T2 weighted images. Tc-99m MDP whole body bone scans (C) and spot views (D) revealed multiple focal bone lesions involving the entire vertebral spine, sternum, multiple ribs and right scapula. Routine planar chest x-ray was normal (E).

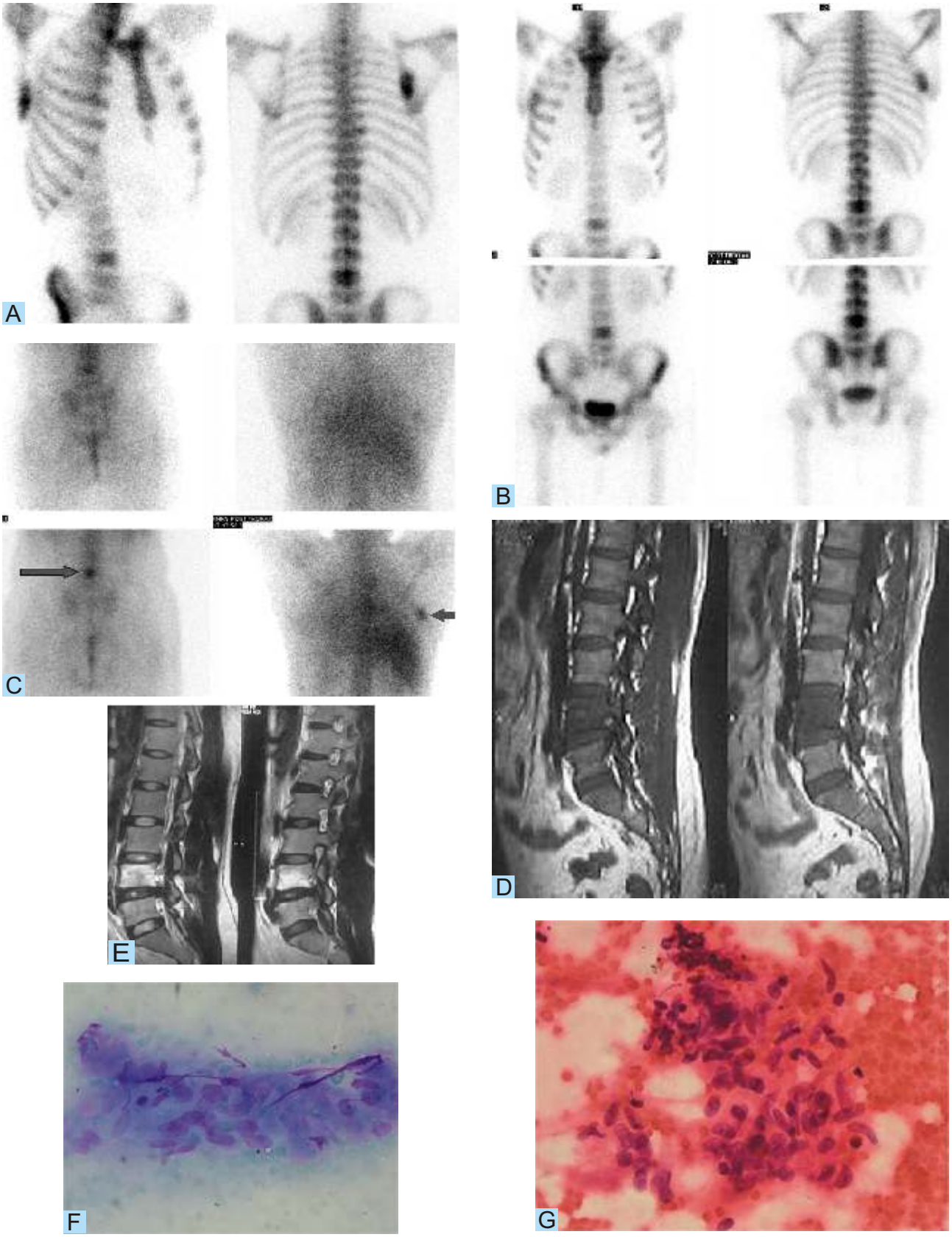

Figure-5. Spot views of Tc-99m MDP bone scan (A, B) revealed two discrete focal lesions showing increased radiotracer uptake: one in the medial margin of right scapula and the other in the body of fourth lumbar vertebra. A correlative Gallium-67 scan (C) showed congruent and increased tracer uptake at the corresponding two sites of abnormality noted in the bone scan (Red Arrows). A subsequent MRI study (D, E) revealed ill-defined hyper-intense signals in L4 vertebral body and the posterior elements on T2 weighted images (D). This appears hypo-intense on T1 weighted images (E). Histology of the bone lesions revealed Langhan's giant cells (F) and tubercular granuloma (G).

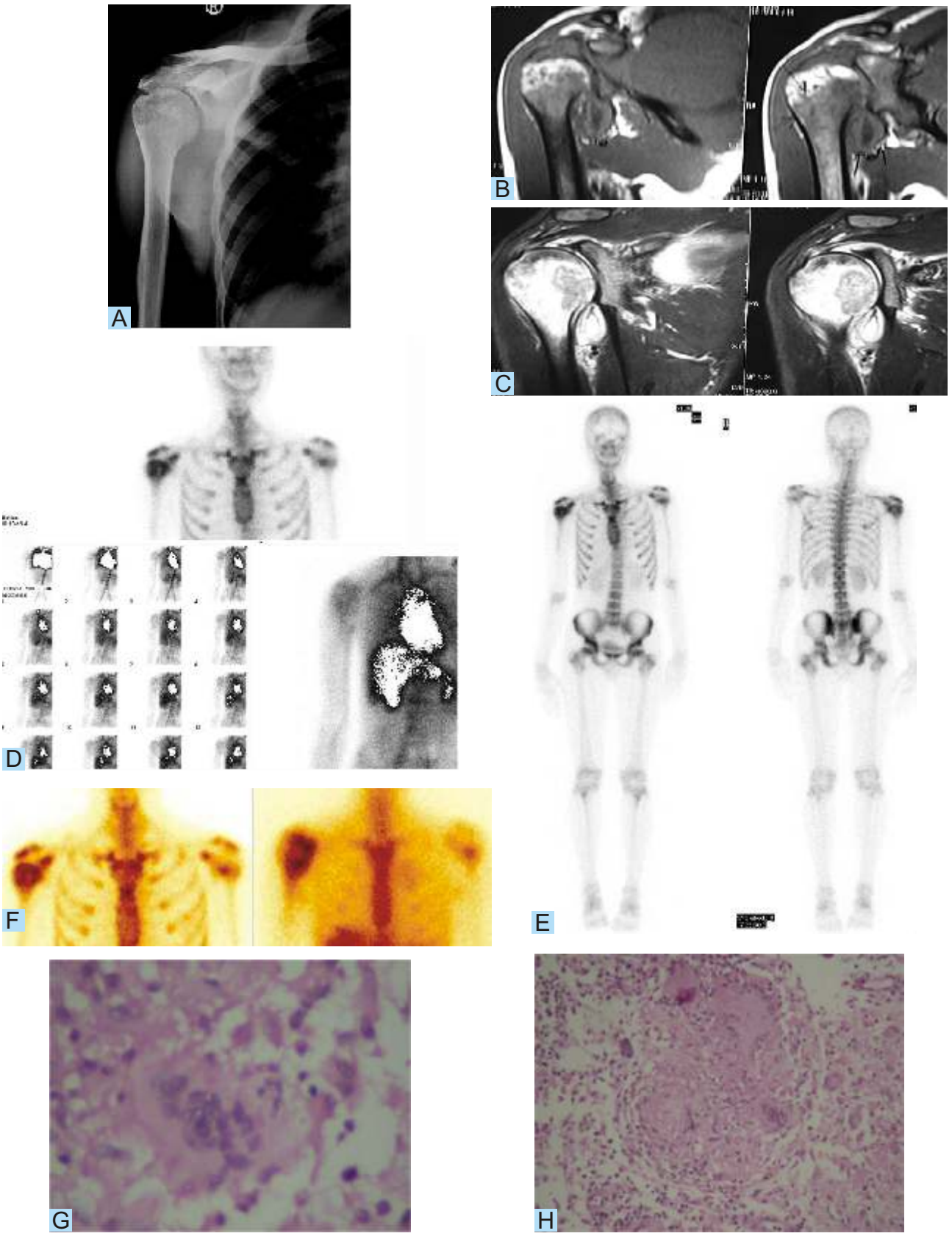

Figure 6. Plain x-ray of right shoulder region (A) revealed osteopenia in the right humerus near the greater tuberosity. MRI study (B, C) showed heterogeneous hypo-intense signal on T1 (B) and hyper-intense signal on T2 weighted images (C) in the head of right humerus and greater tuberosity. The surrounding muscles also show abnormal signals. Minimal fluid is also noted in the right shoulder joint. Three-phase bone scan (D, E) revealed a focal lesion at the head of right humerus in the static images, while the earlier first-pass and blood pool images revealed evidence of hyper-vascularity in the first pass and blood pool images. A Gallium-67 scan (F) showed congruent and increased tracer localization in the right shoulder joint. Histopathology of the bone lesion revealed characteristic tubercular granuloma (G, H).

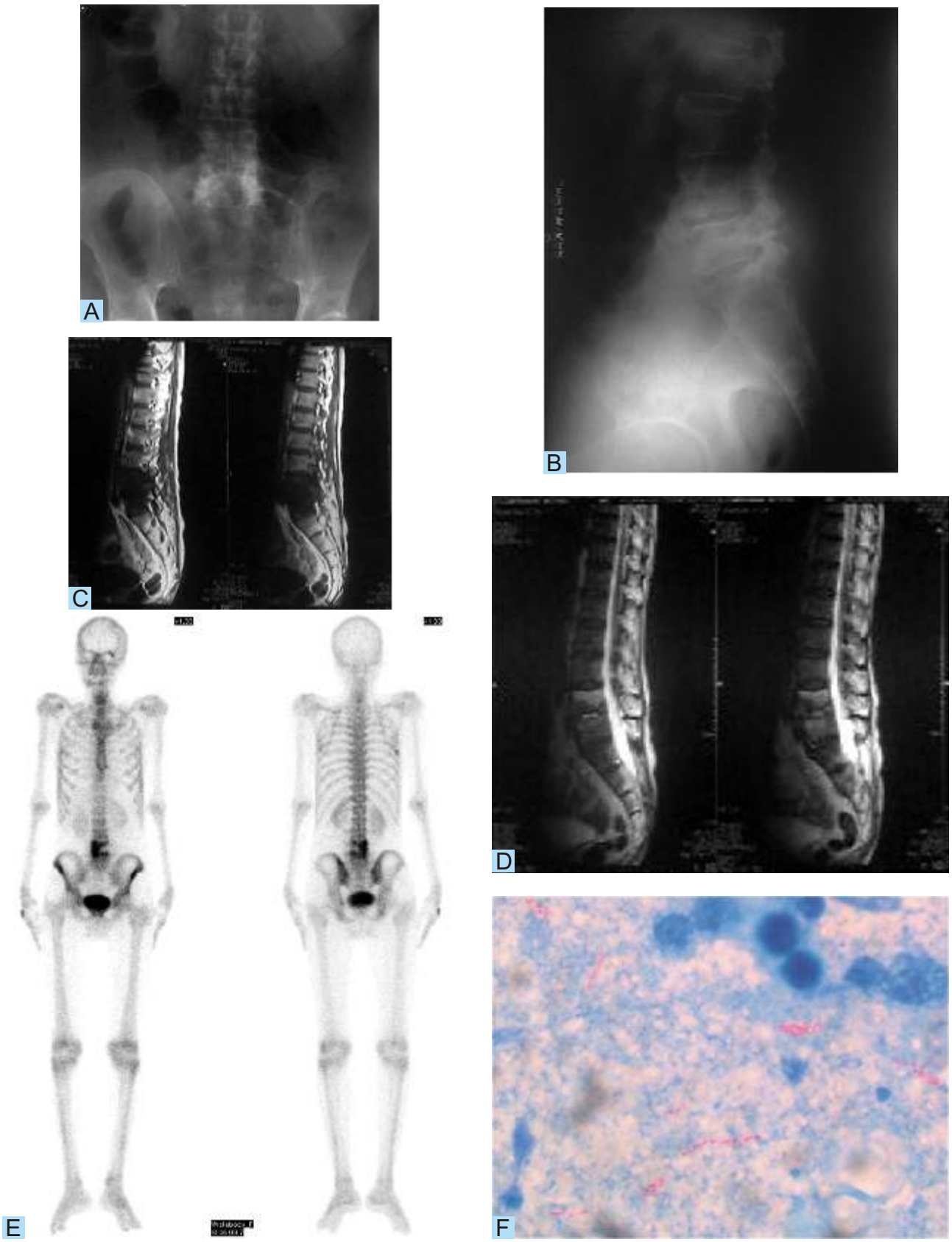

Figure 7. Plain x ray (A, B) of the lumbar vertebrae shows sclerosis of L4 and L5 vertebral bodies with reduction in the intervening disc height. The MRI study (C, D) revealed abnormal signals in the L4 and L5 vertebrae appearing hypointense on T1 WI (C) and hyperintense on T2 WI (D). The L4/5 disc also shows altered signal. Minimal prevertebral soft tissue is seen at these levels. The Tc-99m MDP whole body bone scan (E) revealed abnormal foci of increased radio tracer uptake at L4 and L5 vertebrae, with no evidence of involvement of any other bones elsewhere in the skeleton. An aspirate from the vertebral lesion revealed pink colored acid-fast bacilli on Zeil-Nelson stain (F).

scan is clubbed with MRI as the later provides useful details of the surrounding soft tissues.

Relative merits of different imaging modalities have been evaluated. Plain radiography gives an overview and may be normal in the early phase of the disease. In tuberculosis of the spine, the plain radiograph will show abnormality in as many as 90% of cases with advanced disease (4,5). Paraspinal abscesses may be visible as soft tissue swelling on plain radiograph. The presence of calcification within the abscess is virtually diagnostic of tuberculosis. Certain unusual forms of spinal tuberculosis have also been reported. These include cases where the disease is confined to the neural arch with sparing of the vertebral body as well as the intervertebral disc (6). CT scan demonstrates abnormality earlier than plain radiography. The patterns include fragmentary destruction in 47% cases, osteolysis in 34%, localized sclerosis in 10% and sub-periosteal sclerosis in 10% cases (7). CT is also useful in demonstrating para-spinal abscess, calcification within the abscess, epidural lesions containing bone fragments. It is an ideal tool for guiding percutaneous diagnostic needle aspiration cytology. (8)

MRI is more sensitive and specific than plain radiograph and CT scan in the diagnosis of skeletal tuberculosis. The anatomical details including the soft tissue and disc involvement yield greater specificity (9). MRI can also provide diagnosis of tuberculosis of spine 4 to 6 months earlier than the conventional imaging methods (10).

Histology remains the final investigation of choice for making the diagnosis of skeletal tuberculosis because neoplasm and other infections cannot be ruled out based on imaging studies alone.

In the seven cases presented here it has been demonstrated that tuberculosis may affect any bone or joint in the body including spine, pelvis, scapulae, sacro-iliac and shoulder joints.

Tuberculosis of the shoulder joint affects 1-2% of all the skeletal tuberculosis. Its presentation may be insidious in adults and could be fulminating in children. Our patient had presented with slow onset of symptoms with little evidence of involvement on plain radiograph. MRI as well as bone scan had revealed features of infection. Gallium scan was also performed which revealed congruent and increased tracer uptake at the affected bones as in the bone scan.

It has been shown that combined Tc-99m MDP scintigraphy and Gallium scans have a sensitivity of 90%, specificity of 78% and accuracy of 86% in the diagnosis of skeletal tuberculosis (11,12). The present pictorial assay above cases have demonstrated the effectiveness of nuclear medicine in the documentation of symptomatic, as well as asymptomatic sites of involvement of the skeleton tuberculosis. Combining this technique with a structural modality largely helps to arrive at the diagnosis. Histology remains the final tool to demonstrate the disease but acid-fast bacilli may not be seen in all the cases and one may have to rely on circumstantial evidence, which includes demonstration of granulomas and therapeutic trial to arrive at a final diagnosis.

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