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ORIGINAL PAPER

Back Pain in Children and Diagnostic Value of ^{99m}Tc MDP Bone Scintigraphy

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ABSTRACT

Aim: The aim of our study is to assess the diagnostic value of Technitium-99m-Methyle diphosphonate (^{99m}Tc-MDP) Bone scintigraphy in the assessment of children with back pain. **Methods:** Included in this retrospective study were 68 child referred to us complaining of back pain (mean age of 13± 2). There were 45 boys and 23 girls. All children have been investigated with conventional x-ray which revealed normal or inconclusive result. All underwent bone scintigraphy after the injection of ^{99m}Tc-MDP with calculated doses according to there body weights. **Results:** Bone scintigraphy revealed 17 (25%) abnormal scans in 11 boys and 6 girls. Scans findings were suggestive of spondylolysis (n=4); malignancy including primary tumors and metastases (n=3); infection including osteomyelitis and discitis (n=3); sacroiliitis (n=2); benign tumors (n=2); pseudo fractures in ribs (n=1); necrosis in femoral head epiphysis(n=1) and nonskeletal- renal retention due to hydronephrosis (n=1). Sensitivity, specificity and accuracy of bone scan in detecting gross skeletal abnormality as a cause for back pain were 94% and 100% and 99% respectively. **Conclusion:** Bone isotope scan is a sensitive imaging modality in the assessment of pediatric patients with back pain. It is a reliable modality to detect and role out most benign and aggressive serious etiologies.

Key words: Bone scan; back pain; pediatric; ^{99m}Tc-MDP.

1. INTRODUCTION

Back pain is relatively less common in children than in adults (1-2). Most cases of back pain in children clear up in a few days without medical attention. In few cases the symptoms will persist for a longer time which may indicate underlying serious problem more than just a simple backache. Causes can range from serious malignant causes to just benign lesions (1-3). Therefore, it is important to start with sensitive and cost effective imaging modality that is capable of distinguishing simple back pain from serious underlying diseases.

A variety of imaging techniques has been used to confirm the cause of back pain. A conventional x-ray is often the first imaging technique which has been used (1). Unfortunately; this technique suffers from low sensitivity, and can miss most causes of back pain including serious pathologies. On the other hand, advanced imaging modalities like computerized tomography (CT scan) and magnetic resonance imaging (MRI) can be ordered (4-5). However, such modalities are not cost effective, and not used routinely to image the whole body.

Bone scintigraphy (BS) has been used in the diagnostic work-up of unexplained bone pain (6-8). The technique is sensitive and allows visualization of the whole skeleton in a short time. This modality is more sensitive than x-rays, since early or non-aggressive lesions generally cannot be seen on radiographs until significant bone mineral matrix has been lost (9-10).

Our study will assess the diagnostic value of BS in children presented with back pain. We will try to emphasize on efficiency of this modality in localizing many pathologies that

would have been missed by conventional x-ray study. Also, we will make an overview for scan findings in some lesions encountered during our study

2. PATIENTS AND METHODS

Included in this retrospective study were 68 children with ages ranging from 4 to 15 years (mean age of 11± 3). There were 45 boys and 23 girls. All children presented with back pain of 7 to 88 days duration with a mean value of 18±5 days. All children underwent BS for assessment of back pain. There initial laboratories and conventional radiological investigation failed to define or localize any possible etiology. All patients underwent ^{99m}Tc MDP BS which has been carried out two hours after intravenous administration of radioisotope tracer with calculated dose according to body weights by the formula: Pediatric dose = age (in years)/age+12 x adult dose (20 mCi).

Whole body BS was performed, using G.E Millennium dual head gamma camera with low energy high resolution collimators. Matrix set for 128 x 128 and time set for 30 minutes. For better assessment of any suspected or equivocal abnormality in the whole body scans, all children had additional static views by 500,000 counts performed after whole body scans, and additional SPECT images for the spine.

All scans were reported by two nuclear medicine specialists. The abnormal scan finding was defined as either single or multiple foci of increase or reduced tracer uptake in the spine or pelvic area; or any extra skeletal soft issue activity within chest or abdomen that can explain the etiology of back pain.

Final diagnosis was established using histopathology and

other imaging modalities (MRI and CT scan). Patients with normal scans had clinical follow up for 6 months to 1 year, or until relieve of symptoms.

3. RESULTS

Bone scintigraphy revealed 17 (25%) abnormal scans in 11 boys and 6 girls. Abnormal scans were described according to anatomical sites which were congruent with the site of pathology in all cases. Table 1 shows anatomical distribution of scan abnormalities in 17 abnormal scans. Scans findings were

No.	Anatomical site	No of Patients
1	Spine	7
2	Pelvic bone	4
3	Sacroiliac joint	3
4	Hip joint	1
5	ribs	1
6	extra skeletal(renal retention)	1
	Total	17

Table 1. Anatomical distribution of bone scans abnormalities

Case no.	Bone scan finding	diagnosis
1	Unilateral focal activity in L4	spondylolysis
2	Unilateral focal activity in L4	spondylolysis
3	Bilateral focal activity in L4	spondylolysis
4	Unilateral focal activity in L5	spondylolysis
5	Prominent increase activity in right iliac bone	osteomyelitis
6	Prominent increase activity in right iliac bone	osteomyelitis
7	Increased tracer uptake within IVD and adjacent vertebrae	Discitis
8	Increased tracer uptake in sacroiliac joint	sacroiliitis
9	Increased tracer uptake in sacroiliac joint	sacroiliitis
10	Increased tracer uptake in both sacroiliac joints	Bilateral sacroiliitis
11	Multiple focal increased radiotracer uptake in the spine	Bone metastasis
12	Abnormal increased radiotracer uptake in the iliac bone and sacrum	Ewing sarcoma
13	Focal increased radiotracer uptake in lower thoracic spine	Osteoid ostioma
14	Focal increased radiotracer uptake in lower thoracic spine	Osteoblastoma
15	Multiple focal areas with increased radiotracer uptake involving multiple ribs and both tibia	(pseudofractures)
16	Focal reduced radiotracer uptake within femoral epiphysis	Perth's disease
17	Radiotracer retention within right kidney	hydronephrosis

Table 2. Bone scintigraphy findings and diagnosis in 17 abnormal scans

suggestive of spondylolysis (n=4); malignancy including primary tumors and metastases (n=3); sacroiliitis (n=2); infection including osteomyelitis and discitis (n=3); benign tumors (n=2); pseudofracture (ribs) (n=1); necrosis in femoral head epiphysis (n=1) and nonskeletal (renal) (n=1). Table 2 shows BS findings and diagnosis in 17 abnormal scans encountered during our study. BS failed to detect one case of disc herniation.

Sensitivity, specificity and accuracy of bone scan in detecting gross skeletal abnormality as a cause for back pain were 94% and 100% and 99% respectively. Positive predictive

value (PPV) and negative predictive value (NPV) were found to be 100% and 98% respectively.

4. DISCUSSION

Back pain is uncommon in children younger than 3 years, increasing its frequency with age until reaching a plateau during early adolescence (1). Most often, back pain is benign and self-limited. However, it is occasionally the presenting symptom of systemic diseases as cancer or infection. Thus, the major diagnostic task is to distinguish the patients with simple back pain from those with serious underlying diseases.

Low cost and availability make plain radiography the most common spinal imaging test. Conventional x-ray is often the first imaging technique which has been used (1). Unfortunately, the interpretation of spine X-ray in children is more difficult than in adults due to the presence of epiphyseal and apophyseal growth center. Also conventional x-ray is lack the sensitivity and would miss most causes of back pain including serious pathologies (1). The limitation of plain radiography was obvious in our study group, in which most x-ray studies were negative or inconclusive.

In our study, bone scintigraphy was able to detect many benign and malignant conditions in 25% of children (Table 2). Our results for scintigraphy with ^{99m}Tc-MDP showed an overall sensitivity, specificity values of 94%, 100% respectively.

Skeletal scintigraphy is highly sensitive for detecting stress-induced changes in bone and is an important part in the evaluation of the young athlete with low back pain (11). Spondy-

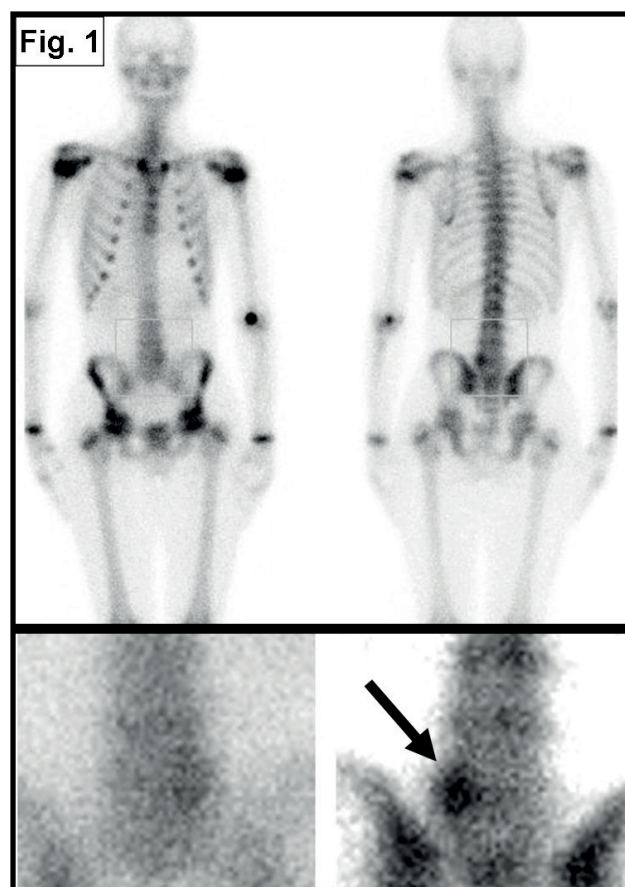


Figure 1. Whole body scan in 14 years old male boy with LBP of 3 weeks duration; scan showed focus with abnormal activity at L5 level (arrow); finding was suggestive of spondylolysis.

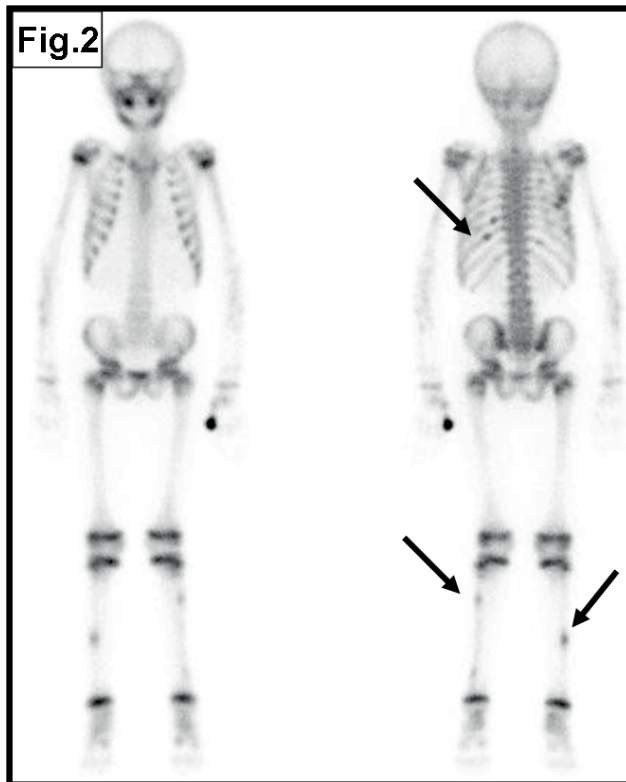


Figure 2. 10 years old male child with multiple pseudofractures involving multiple ribs and lower tibiae.

lolyolysis is an osseous defect of the pars interarticularis, thought to be a developmental or acquired stress fracture secondary to chronic low-grade trauma (12-13). Most patients with spondylolysis present with either acute or chronic pain. It can be found in as many as 47% of adolescent athletes with low back

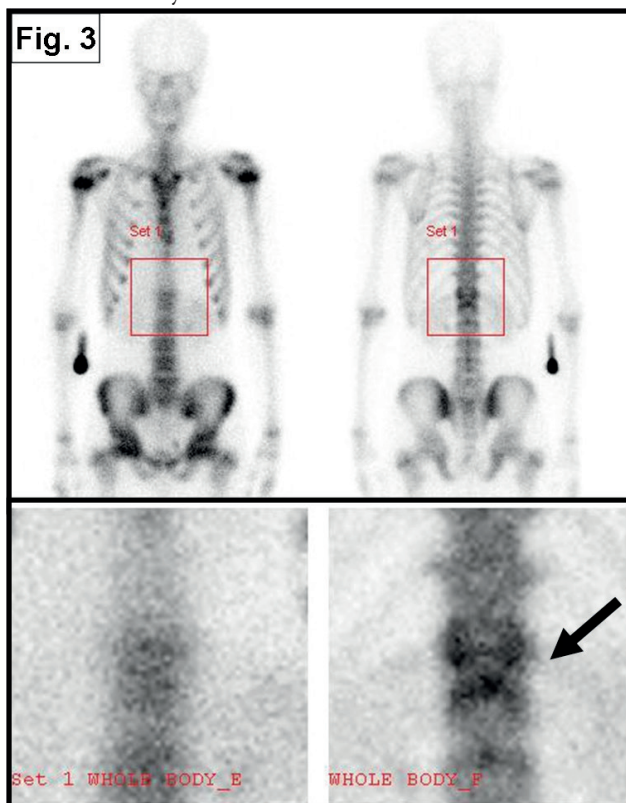


Figure 3. 14 years old girl with back pain; bone scan revealed intervertebral disc activity at level of T12-L1 extending to adjacent vertebral end plates (arrow). Finding was consistent with discitis.

pain (14). Most of pars defects (90%) occur at the L5 level and unilateral defect found in 30% of cases (14). Spondylolysis will show focal tracer accumulation in the region of the pars interarticularis during delayed BS (Figure 1). SPECT BS is more sensitive than planar images and can detect abnormalities in about one third of individuals with normal planar exams (15).

Also, BS is a very sensitive exam for the detection of acute bone fractures (16), and it does have increased sensitivity for the detection of rib fractures compared to plain radiographs. BS can be the modality of choice in the assessment of suspected child abuse cases (17). Also, findings can sometimes draw attention to possible underlying metabolic bone disease (Figure 2).

Other causes of low back pain in children like Spinal process apophysitis, Lumbosacral transitional vertebra, Facet Syndrome, Schuermann's Disease and disc herniation can have nonspecific findings during BS. For instant; spinal process apophysitis produces uptake of tracer along the lumbar spinous process and is due to a hyperextension overuse injury. A lumbosacral transitional vertebra is a common anomaly characterized by a large transverse process that follows the contour of the sacral ala and forms a non-ossified articulation with the sacrum (18). Bertolotti syndrome refers to increased tracer uptake along the transverse process pseudoarthrosis of a transitional vertebrae which is indicative of stress change (18). This finding can be seen in about 80% of patients with a transitional vertebra and low back pain (18).

Facet Syndrome can produce both local and radiating pain. SPECT BS will usually detect an abnormality (sensitivity 100%), but with poor specificity (70%). However, a normal exam can rule out facet syndrome (19).

Schuermann's Disease is relatively uncommon disorder, occurring in 3 to 5% of adolescents (15). The diagnosis is established when the radiographs demonstrate anterior wedging greater than 5 degrees with involvement of 3 or more contiguous vertebral bodies and a structural kyphosis of greater than 40 degrees plate (15).

An acute herniated nucleus pulposus may not have any changes on BS until there has been excessive stress placed on the adjacent vertebrae. When this occurs, mild increased activity can be seen in the end-plates of the vertebral bodies on either side of the disc. In our study BS failed to detect any abnormalities in one case of disc herniation.

Early stage of Perth's disease has a characteristic appearance during BS with photopenic defect within femoral epiphysis. On the other hand; slipped Capital Femoral Epiphysis in the absence of avascular necrosis the bone scan findings is nonspecific and consist of mildly increased activity about the hip and widening and blurring of the growth plate activity.

^{99m}Tc-MDP BS can detect osteomyelitis one to two weeks before radiologic changes (20). For the detection of osteomyelitis in non-violated bone, the 3 phase bone scan has a reported sensitivity of 90-100% and a specificity of 70-95% (20-21). Osteomyelitis has characteristic appearance in 3 phase BS with abnormal increase in flow, blood pool and delayed radiotracer uptake.

There is a higher incidence of discitis in children with peaks seen between the ages of 1 to 4, and 12 to 15 years (15). In young children, the higher incidence is felt to be related to the vascular supply of the spine. In children subchondral vessels

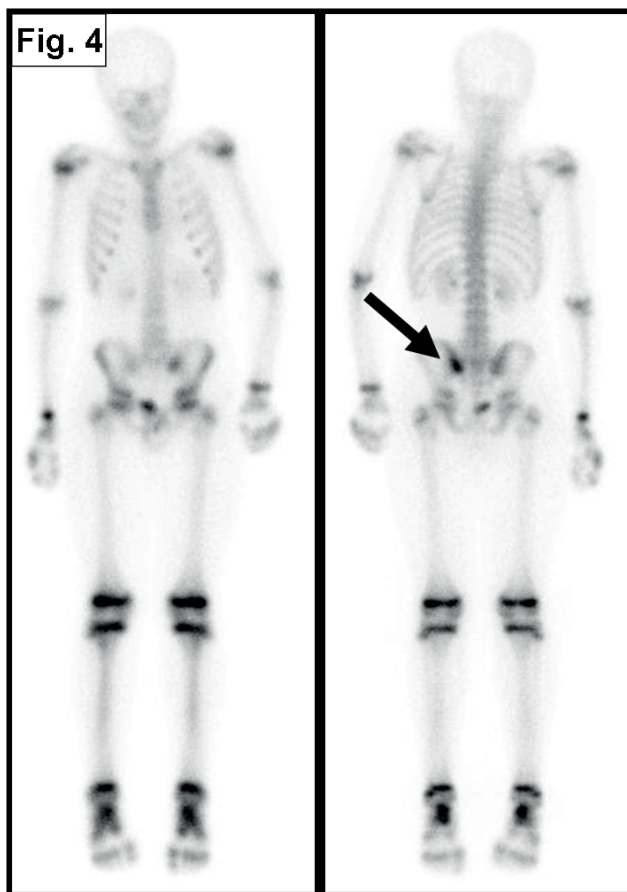


Figure 4. 15 years old boy with low back pain of one month duration. Bone scan revealed prominent activity in both SIJs which is more prominent in the left side. Finding was consistent with sacroiliitis.

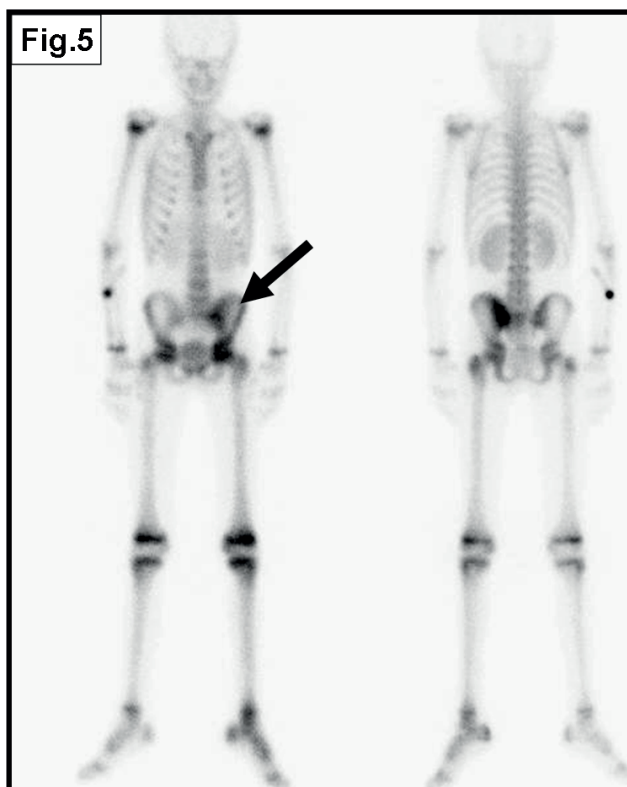


Figure 5. 13 years old child with low back pain of 2 months duration; bone scan revealed prominent activity within left iliac bone suggestive of aggressive bone pathology. Biopsy revealed primary malignant Ewing sarcoma.

are present until age of 8 and supply the disc, and may persist until teenage years (15). During BS delayed images; discitis will show increased tracer activity in the disc space and the contiguous vertebral bodies (Figure 3).

^{99m}Tc -MDP BS can detect synovial inflammations of rheumatoid arthritis and ankylosing spondylitis. Sacroiliitis can have prominent unilateral or bilateral uptake within sacroiliac joints (Figure 4). However; bilateral sacroiliitis, can be difficult to detect due to the normal increased activity within the SI joints. SI joint to sacrum (SIJ index) of greater than 1.35 can have value in this case (22).

^{99m}Tc -MDP BS is 50 to 80% more sensitive than radiographs in detecting skeletal metastases. This is probably because about 30-75% of the bone mineral content must be lost before a metastasis is evident on a radiograph (23). In contrast, as little as a 5-10% change is required to detect an abnormality on BS (23). The sensitivity for BS in detecting bone metastases is between 62%–100% (23). About 90% of patients with skeletal metastases present with multiple lesions which increase its specificity of this modality. Nearly 80% of all metastatic lesions are in the axial skeleton (24). Multiplicity of active lesions can help to define metastatic bone lesions and tracer uptake involving both the vertebral body and pedicles is usually indicative of metastatic disease (24).

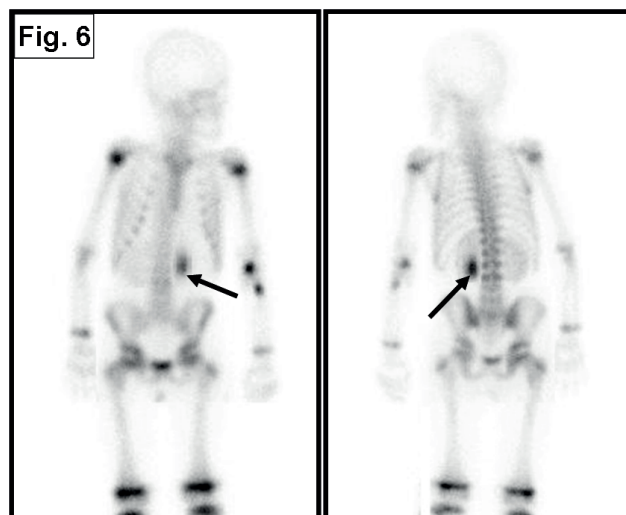


Figure 6. 6 years old girl with back pain; scan revealed radiotracer retention within left kidney. Finding was suggestive of hydronephrosis-PUJ stenosis.

Primary bone tumors also can present with back pain in children since more than 80% of the Ewing's sarcomas occur in patients under 20 years of age (25). The tumor usually arises in the diaphysis of a long bone, but 20% arise in the pelvis (25). Bone scan can show gross abnormality during the three phases of bone scan; and hardly differentiated from osteomyelitis in some cases (Figure 5).

Benign lesions like osteblastomas and osteoid osteoma can involve the posterior elements of the spine and they have characteristic appearance during 3 phase bone scan, osteblastomas and osteoid osteomas will be hot on both blood pool and delayed images (26). Osteblastomas are typically larger than 2 cm and possess both sclerotic and lytic features (26). Osteoid osteoma may occur in the spine (10-20% of cases), it most commonly involves the lumbar spine, nearly always occurs in the posterior elements (50%); only 10% of lesions involve the vertebral body, and is frequently associated with

a painful scoliosis with the convexity of the curve oriented away from the side of the lesion (27).

^{99m}Tc-MDP B.S showed nonskeletal abnormalities that would have been missed by conventional imaging. Retention of tracer in the kidney due to Hydronephrosis is frequently encountered (28), which can draw attention to presence of obstructive uropathy as a possible etiology (Figure 6).

Finally we believe that plain x-ray can miss serious pathologies in pediatric patients with back pain, causing delay and unnecessary radiation exposure to this group of patients. Bone isotope scan has high negative predictive value in this study (98%), and consequently it can be safe to proceed into clinical follow up and maybe symptomatic management without the need to do any advanced investigations. We do not recommend the use bone isotope scan in each child with back pain, but when we have clinical data suggestive of an underlying bony pathology, bone isotope scan should be the first line of radiological investigation, before proceeding to CT or MRI. Also, Bone scintigraphy SPECT/CT which includes optimized CT as part of the study, provide improved diagnostic accuracy for back pain and oncology compared to routine BS, which may decrease the number of studies an individual child may need. This imaging modality, however, must be tailored on an individual basis as the addition of the CT study can increase exposure to the child and should only be performed after appropriate justification and with adherence to optimized low dose pediatric protocols.

5. CONCLUSION

Bone isotope scan is a non-invasive, highly sensitive and reliable imaging modality in the assessment of pediatric patients with back pain and in detecting most possible bony pathologies. We recommend this investigation as first imaging procedure to avoid any delay in the diagnosis and to avoid unnecessary investigations.

CONFLICT OF INTEREST: NONE DECLARED.

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