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Case Report

Adjacent Segment Disease of Lumbosacral Spines with Lower Limb Pain and Tightness after Spinal Fusion: Observation from SPECT/CT Scintigraphy

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Abstract

Background: Adjacent segment disease (ASD) commonly happens following spinal fusion surgery, and it can be detected by lateral plain films and magnetic resonance imaging (MRI). Though there are well-established criteria for detecting ASD on MRI, the hybrid image of single-photon emission computed tomography (SPECT) with computed tomography (CT) seems to yield superior sensitivity and more accurately lesioned sites for exact diagnosis.

Case Presentation: A 72-year-old woman visited our rehabilitation clinic due to left lower limb pain and muscle tightness, especially lateral side of leg, for 10 days. She already had lateral X-ray and MRI focusing in spinal areas, and ASD at L2/L3 and L5/S1 levels was suspected, especially L2/L3 level. However, the primary lesioned level was not correlated with her symptoms, and we still needed to confirm ASD. Patient was inspected with skeletal SPECT/CT, and revealed the unambiguous primary degenerative L5/S1 levels of ASD. The patient then received the analgesic, muscle relaxant, as well as therapeutic modalities at the lower back.

Conclusions: We show a case with post-spinal fusion suspected ASD based on findings of X-ray and MRI initially, which is soon accurately confirmed by the hybrid scintigraphies of SPECT/CT. This is concluded that hybrid films of SPECT/CT yield more accurate diagnosis for the ASD in aspect of scintigraphic rehabilitation.

Keywords: Adjacent segment disease; adjacent segment degeneration; spinal fusion; lumbar fusion; spondylolisthesis; single photon emission computed tomography; whole body bone scan.

Introduction

Adjacent segment disease (ASD) is defined as the alterations in the structures adjoining a surgically treated spinal column level that lead to occurrence of pain and disability.[1] Concretely, ASD encompasses a wide range of complications associated with spinal fusion, including disc herniation or degeneration, spondylolisthesis, osteophyte formation, canal stenosis, scoliosis, structural instability, and compression fracture. In certain cases, a second operation may be indicated and deemed necessary.[2]

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ASD is thought to expedite degenerative progress by disrupting the healthy biomechanics of the adjacent non-fused vertebral segments, leading to additional motion, elevated bearing, and higher intra-discal pressure. In cases of lumbar fusion, clinical manifestations, such as lower back pain, leg/thigh pain, neurological symptoms in the lower extremities, pain while walking, or difficulty standing were attributed to an adjoining level after suffers underwent surgical intervention at the pathological levels of the vertebra.

While diagnosing ASD, the use of skeletal scintigraphy with single-photon emission computed tomography (SPECT) is infrequently popular, yet it demonstrates high sensitivity in identifying adjacent level degeneration. With respect to our case, we identified late effects of fusion through the hybrid SPECT/CT image, providing a precise depiction of the location of degenerative levels in the spine.

Case Report

A 72-year-old woman, with past history of lumbar stenosis of L3 to L5 and spondylolisthesis of L3/4 status post total laminectomy of L3 to L4, interspinous dynamic stabilization system, and discectomy of L4/L5 with cage fusion of L4/L5 and transpedicle screws fixation from L3 to L5, had left precordial pain for 3 months due to falling injury. On June 6, 2023, the patient came to our outpatient department of rehabilitation for a consultation regarding radiation pain and muscle tightness of left lower limb, especially lateral side of leg. The onset of her symptoms had been for 10 days. Physical examinations revealed local tenderness of low back and local tightness of left thigh, with Patrick's test and Fortin finger sign positive in the both sides. Owing to previous lateral X-ray and magnetic resonance imaging (MRI) of lumbar spine, completed on May 26, 2023, ASD at L2/L3 and L5/S1 levels was found, especially L2/L3 level. We organized the skeletal scintigraphy with Tc-99m methylene disphosphanate (MDP) whole body bone scan/quantitative sacroiliac scan/SPECT-CT under suspicion of ASD and sacroiliitis, which discloses increased uptake (hot spot) of left 5-6th costochondral junctions, spinal junction of L5-S1, and sacroiliac joint. The hybrid films of SPECT/CT scan exhibit precise lesion sites to each positions, respectively. The diagnosis of ASD of L-S spine, bilateral sacroiliitis, bilateral discitis, and degenerative joint disease of L-S syndrome were confirmed. Then the patient was prescribed non-steroidal anti-inflammatory drug (Relecox cap, 200mg, QD) and muscle relaxant of central nervous system (Chlorzoxazone tab, 250mg, BID) for 12 days, and underwent therapy modalities, for instance, low-level laser therapy and infrared therapy.

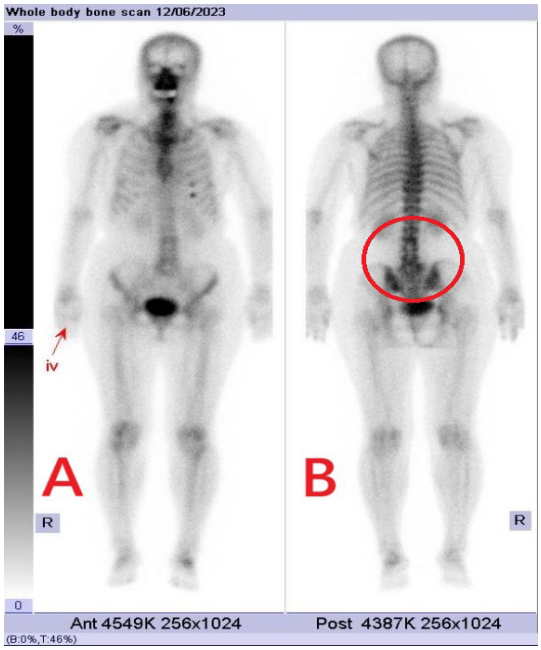

Figure 1. *Whole body bone scan (WBBS) of our case. A, B is the radioactivity image after the Tc-99m MDP was injected intravenously 3 hours later. A is anterior view and B is posterior view. The red circles represent the unusual uptake of the radiotracers, which can be observed at lumbosacral spines and sacroiliac joints.*

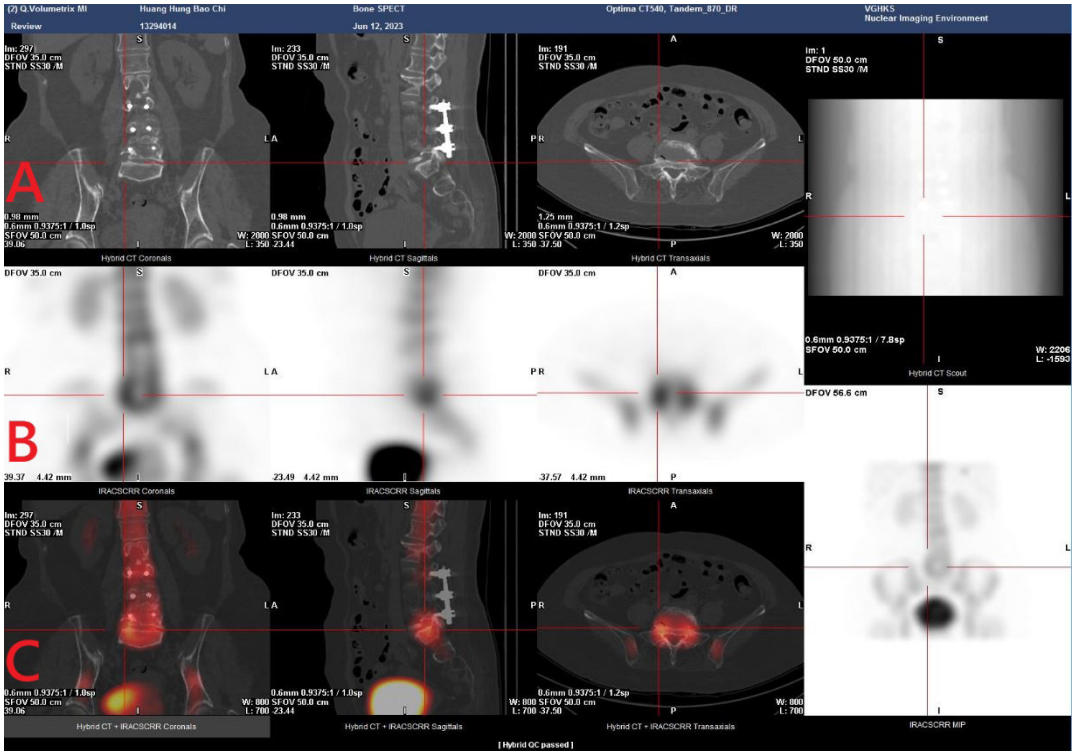

Figure 2. *Skeletal scintigraphy with hybrid images of SPECT/CT of the patient's spine. (A) CT scan films of the pathologic spines and internal fixation in L3-5 vertebras. (B) Bone scan images with noticeable pathologic spine in black. (C) SPECT/CT image of the pathologic L5/S1 junction of spine with a red loci on it.*

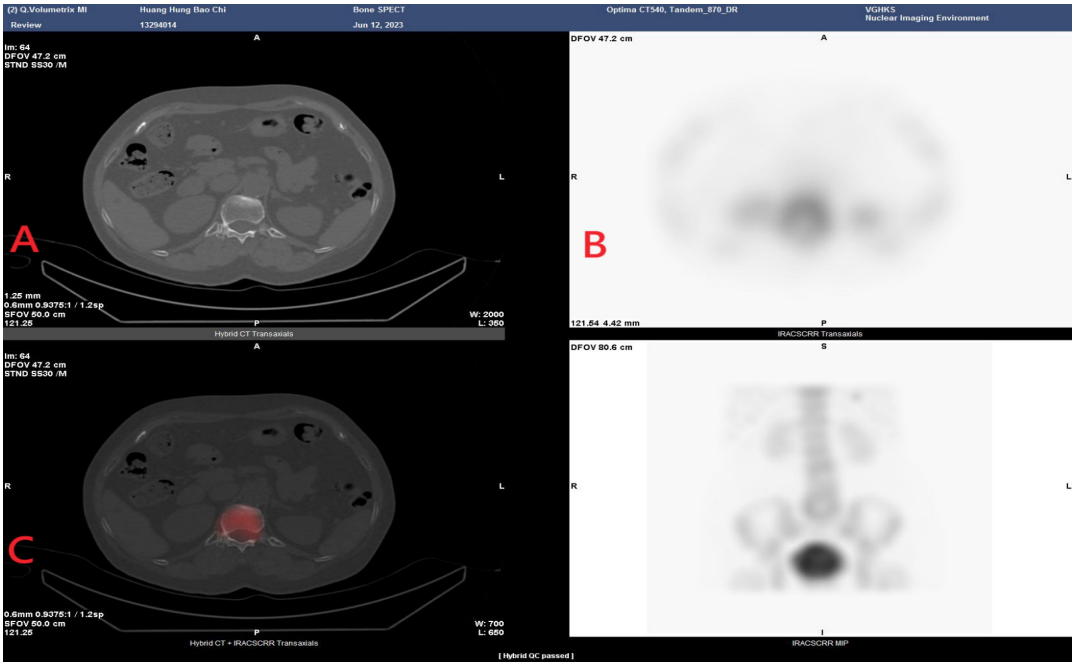

Figure 3. *Skeletal scintigraphy with hybrid image of SPECT-CT of the patient's spine. (A) Axial view of CT scan of the pathologic level of spine. (B) Bone scan image with noticeable pathologic spine in black. (C) Axial view of SPECT-CT image of the pathologic L5/S1 junction of spine with a red loci on it.*

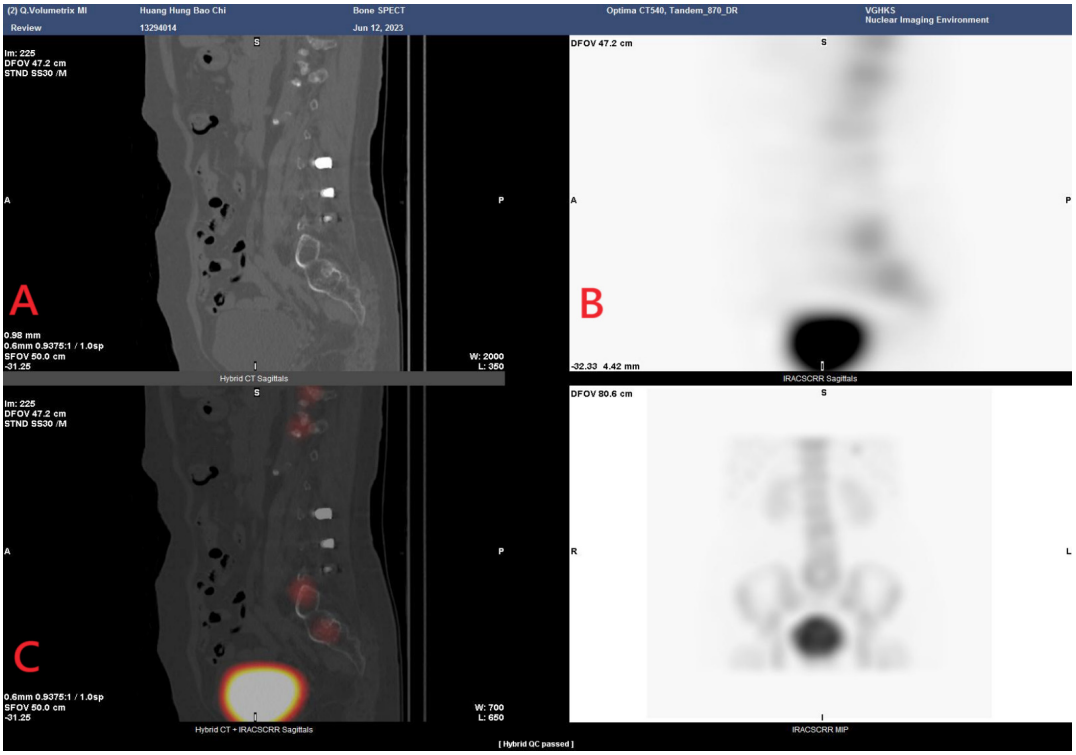

Figure 4. *Skeletal scintigraphy with hybrid image of SPECT-CT of the patient's spine. (A) Sagittal view of CT scan of the pathologic spine. (B) Bone scan image with noticeable pathologic spine in black.(C) Sagittal view of SPECT image of the pathologic L5/S1 junction of spine with a red loci on it.*

Discussion

In this case, while our initial suspicion based on lateral X-ray and MRI led us to consider ASD at L2/L3 and L5/S1 levels, the conclusive diagnosis revealed it to be solely at the L5/S1 disc level through SPECT/CT. The hybrid type of SPECT/CT images provided a definitive diagnosis, as indicated by the high uptake observed in the patient's spine, aligning well with clinical findings. We assert that SPECT/CT may exhibit greater sensitivity and accuracy in detecting ASD of the spine compared to lateral X-ray, irrespective of whether the degenerative process is in its early or late stages.

ASD is a late-stage complication following surgery with spinal fusion. The prevalence of radiographic-based ASD reported approximately 40%, while symptomatic ASD ranges between 5% to 18%.[3] Common symptoms associated with ASD encompass low back pain, referred pain in the lower extremities from the low back, tingling, numbness, or weakness in the lower extremities, pain while walking, and sometimes a diminished ability to stand. In our case, the patient reported experiencing pain and muscle tightness in the left lower limb, particularly on the lateral side of the leg. Although a previous lateral X-ray and MRI suggested ASD at L2/L3 and L5/S1 levels, with a focus on the L2/L3 level, considering our patient's symptoms, we leaned towards L5/S1 levels as the primary source of the issue. This led us to employ a more precise diagnostic tool, SPECT/CT, to accurately locate the lesions.

In most cases of ASD, the diagnosis and treatment plan typically involve X-rays and MRI. Both clinical manifestations and radiographic findings play crucial roles in diagnosing ASD.[4] It is important to note that adjacent segment degeneration (ASDeg) is distinct from adjacent segment disease, abbreviated as ASDis. ASDeg refers to degenerative changes observed radiographically at a vertebral level adjacent to a previously surgically decompressed and/or fusing (or fused) segment, without causing symptoms in those suffers—essentially a kind of radiographic finding. By contrast, ASDis is a kind of radiographic finding with allied clinical symptoms.[4]

In clinical practice, when encountering a new case, suspicion of ASDis is raised based on a history of spinal

fusion, clinical manifestations, and physical findings. Confirmatory image studies are then arranged. Lateral X-ray and MRI are commonly used, and clinical-based classification systems are applied to grade the severity of the degenerative process.[5] However, the challenge arises in cases of adjacent levels of spinal fusion, which often involve upper or lower levels of fixation. Determining how many lesioned levels are correlated with clinical symptoms becomes crucial. In this context, the application of SPECT/CT can enhance accuracy in identifying lesions. SPECT/CT is known for its high sensitivity and better etiological survey, particularly in early or subclinical skeletal lesions. This technique has proven valuable in the early detection of conditions such as neck facet joint arthritis,[6] sternoclavicular arthritis,[7] and meniscus tears in the knee joint,[8]

The hybrid pattern of SPECT/CT images is advantageous for acquiring both anatomical and physiological signals with a high accuracy extent of fusing images. The prototype SPECT/CT device was initially introduced in 1992,[9] and the commercial SPECT/CT became available in 1999, featuring a double-detector multiple-angle camera with mounted a low-dose X-ray tube on the same scaffold.[10] Japanese scientist profitably integrated the hardware modules into a cohesive system and developed algorithms for using CT for correcting SPECT attenuation in 2002.[11] The accuracy of the technique of coregistration has been reported as 3 mm or better in device of SPECT-CT as of 2008.[12] We adopted the technique in many clinical situations.[6-8,13-17]

Since the launch of the first commercial device, numerous SPECT-CT hybrid systems have emerged, featuring distinct CT capabilities ranging slice systems from single to multiple. In general, imaging films obtained from a CT location are useful for structural localization, but anatomical details are better demonstrated by multi-slice diagnostic-type CT, as reported in 2009.[18] This is particularly noteworthy in the bone-joint system, where CT interpretation, rather than position alone, can provide precious supplementary information about the radionuclide loci.

Radiological evaluation of the ASD involves the use of different modalities, including lateral X-ray, CT, and MRI. However, CT is not the primary diagnostic tool of choice. While it has gained preference for evaluating interbody fusion due to its excellent visualization of bony structures and surgical hardware, it is not as sensitive in identifying the actual happening of true fusion as it is in detecting issues such as malunion, non-union and device failure.[19] Indeed, radiography stands out for its wide accessibility, cost-effectiveness, and non-invasiveness. Static radiographs are primarily employed to exclude the possibility of framework failure and to judge the bone consolidation located in the fused slices or any observable peri-implantitis,[20] e.g. haloing surrounding the instrumentation. The prevalence of peri-implantitis has been constantly growing in dental implants, and we believe that the term can be used in describing intervertebral discitis after spinal fusion.[20] Nevertheless, the calculation of faint degrees of motion on hyperflexion/hyperextension films is deemed poor reproducible, primarily due to potential measuring errors of observers.[19] Notably, MRI stands out for its exceptional ability to assess epidural and/or intraspinal tissues in comparison to other image-making modalities. Generally, the ranks of involved spines with compression of dura sac or nerve roots can easily identified based on MRI scan findings. Ou et al.[21] employed the ratio of cerebrospinal fluid-to-rootlet observed in axial T2 weighted images on MR as a radiographic criteria, categorizing it into A, B, C, and D grades. Degeneration at the level neighboring to a prior vertebral fusion procedure was defined by ≥1 grading alterations. Additionally, a comprehensive evaluation of radiological outcomes has been conducted by using lateral dynamic radiographs to look at antero- and retro-listhesis, the Pfirrmann classification to inspect disc degeneration on MRI, and adopting the Modic classification to endplate degeneration.[22] Despite these efforts, there is a recognized need for a better sensitive and vigorous MRI scoring system, as demonstrated by Yu et al.[23], who found Modic changes in 60% of those with relentless degenerative disc disease. It remains unclear whether Modic classification and Pfirrmann grades might earlier distinguish these changes and disc degeneration in the progression of the disease.

Considering the aforementioned limitations of lateral X-ray, CT, and MRI, the potential efficacy of skeletal scintigraphy for the differential diagnosis of lower back pain following lumbar instrumentation becomes apparent. The identification of changes in bony metabolism through technetium-99m (99mTc) MDP skeletal scintigraphy has demonstrated high sensitivity in detecting various bone pathologies.[24] While criticized for its lack of specificity, this modality could prove valuable in revealing pathological changes before they are evident on anatomical imaging

or in situations where numerous anatomical changes complicate the identification of the active pain source.[25]

CONCLUSION

Looking back our case, we examine the patient's spine with SPECT/CT, and came across the ASD at L-S spine. Leveraging the functional signals via SPECT and the anatomical details via CT, the hybrid imaging films of SPECT/CT offer improved correction of attenuation, increased specificity and precise elucidation of the disease's location, including potential involvement of bordering tissues.[9,10,26, 27] This application is very supportive in the realm of scintigraphic rehabilitation.

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Conflicts of interest

The author declare no conflicts of interest.

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