

CASE REPORT

SPECT/CT Use as an Indicator of Low-Grade Infection in the Spine: Report of Two Cases

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*Research performed at Department of Orthopedic Surgery, British Hospital of Buenos Aires, Argentina**Received: 11 September 2023**Accepted: 18 October 2023***Abstract**

Low back pain is one of the most common pathologies worldwide. When conservative treatment fails to yield good results, surgery is the recommended approach. Despite spinal fusion, some patients continue to experience persistent low back pain. This is where a series of studies come into play to detect the source of treatment failure. The use of bone scintigraphy with SPECT (single-photon emission computed tomography) in combination with computed tomography (CT) has greatly improved the anatomical localization of abnormalities found in SPECT. While pseudoarthrosis is a significant cause of spinal fusion failure, in recent years, it has been observed that certain low-virulence pathogens are also implicated in persistent low back pain. This is the focus of our study, in which we identified two patients with persistent low back pain after surgery, both of whom tested positive for chronic low-grade infection using SPECT/CT.

Level of evidence: IV**Keywords:** Low-grade infection, Sonication, SPECT/CT, Spinal fusion**Introduction**

Low back pain is a highly prevalent condition both in our local population and globally, with at least 1 out of every 10 patients (9.4%) reporting pain in this region.^{1,2} The management of low back pain varies in different ways, ranging from conservative treatment with analgesics and physiotherapy to more invasive methods, depending on the underlying cause of the condition.³

Unfortunately, in some instances, even after undergoing spinal fusion surgery, a significant number of patients continue to experience or develop low back pain. Studies report a prevalence of reoperation at 14% within 4 years and 19% within 11 years.^{4,5}

Clinical outcomes in patients undergoing surgical reoperation tend to be poorer compared to primary surgery. Therefore, the accurate identification of patients who may benefit from reoperation is crucial.⁶ Loosening of hardware following lumbar fusion can reach up to 65%, affecting bone fusion and segmental stability, which can lead to pain and serve as a potential reason for intervention.⁷

Screw loosening, increasing pain, and subsequent spinal fusion failure could be associated with a significant yet unknown prevalence of chronic low-virulence infection at

the surgical site and implant.⁸⁻¹⁰

The number of previous surgeries appears to be a risk factor for the increase in chronic low-grade infections (29.1%), predominantly caused by *Propionibacterium* spp and *Staphylococcus* in cases of spinal revision.⁹ Both pathogens are commonly found in hair follicles and on the skin, increasing the risk of intraoperative contamination.¹¹

The evaluation of patients with persistent pain after spinal fusion includes clinical examination and imaging, with X-rays and CT scans being the primary modalities.

Conventional images are used to assess changes in material position, loosening, vertebral fusion, vertebral alignment, or possible pseudoarthrosis. Due to the presence of nonspecific postoperative changes and metal-related technique artifacts, the interpretation of tomographic images can sometimes be inconclusive. Consequently, the decision to perform surgical reoperation based solely on imaging studies can be challenging to determine.¹²⁻¹⁴

Bone scintigraphy with SPECT (Single Photon Emission Computed Tomography) is a valuable tool for evaluating patients with persistent low back pain following surgery because it is an imaging study unaffected by metallic

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technique artifacts.¹⁵⁻¹⁷ Additionally, with the advent of hybrid imaging techniques, combining SPECT and CT, the anatomical localization of abnormalities found in SPECT has significantly improved, greatly enhancing its specificity.¹⁸

Today, SPECT/CT is used in some centers for patients who continue to experience low back pain after spinal fusion surgery to detect signs of pseudoarthrosis.¹⁹ However, there are few reports associating radiotracer positivity in SPECT with chronic infection in patients with spinal implants. We present two patients who underwent spinal reintervention due to persistent pain, both of whom exhibited increased radiotracer uptake on SPECT/CT scans, revealing chronic low-grade infection by *Propionibacterium acnes* as the finding

Case Presentation 1

A 69-year-old female patient presented with a history of orthopedic issues. She had previously undergone L3-L4 decompression and fusion at our center due to lumbar stenosis, which required revision the following year, involving hardware replacement and extension to S1. She consulted our service two years later due to one year of bilateral sacroiliac and lumbar pain that did not improve with conservative treatment. On the spine X-ray, the previous osteosynthesis material was observed without sagittal or coronal misalignment [Figure 1]. The axial computed tomography scan showed facet joint arthrosis and signs of instability (facet vacuum phenomenon) [Figure 2]. Additionally, a SPECT/CT scan showed increased radiotracer uptake in the right L4 and L5 regions and the left L5 region [Figure 3]. It was decided to address the condition surgically.



Figure 1. Preoperative (EOS) X-ray showing previous posterior surgery performed at L3-S1

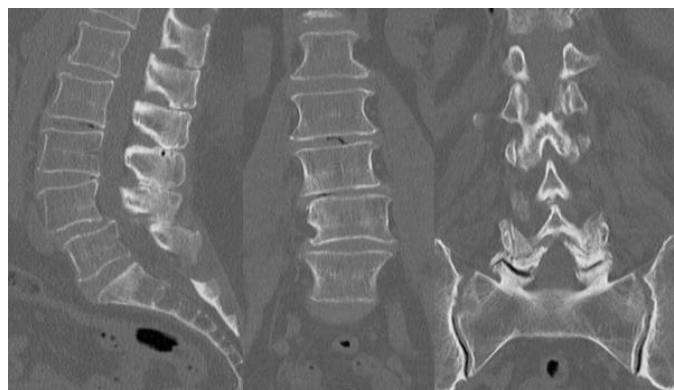


Figure 2. Preoperative CT scans showing signs of instability at L2-L3 and bilateral sacroiliac joints

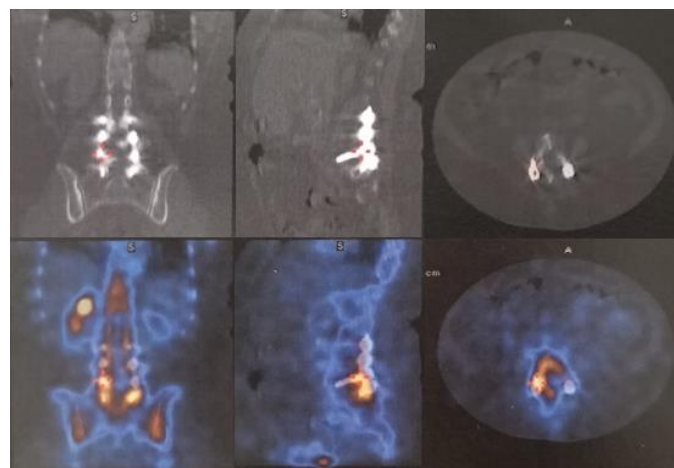


Figure 3. Lumbar SPECT/CT scan. Hypercaptation of the radiotracer is observed in the right pedicle screws of L4 and L5 and in the left pedicle screw of L5

With a posterior approach, the screws and rods from the previous surgery were removed. The right L5 screw was sent for culturing via sonication, and soft tissue samples were also sent for conventional culture. Subsequently, new pedicle screws were placed from L3 to S1, along with bilateral sacroiliac screws [Figure 4].

The patient's pain improved after the intervention, but on the fifth postoperative day, she developed moderate serous drainage from the surgical wound. Laboratory tests showed a white blood cell count of 12,500, ESR of 33, and a CRP level of 1.2. Suspecting a surgical site infection, wound irrigation was performed on the tenth postoperative day. The patient showed significant clinical improvement. On the 15th postoperative day, the screw sample sent for analysis using the sonication method during the first surgery tested positive for *Propionibacterium acnes*. Therefore, the antibiotic treatment was switched to oral minocycline for 8 weeks.

The patient is currently 12 months post her last intervention. She currently has laboratory parameters within the normal range and she carries out her daily

activities as usual without the need for analgesics.

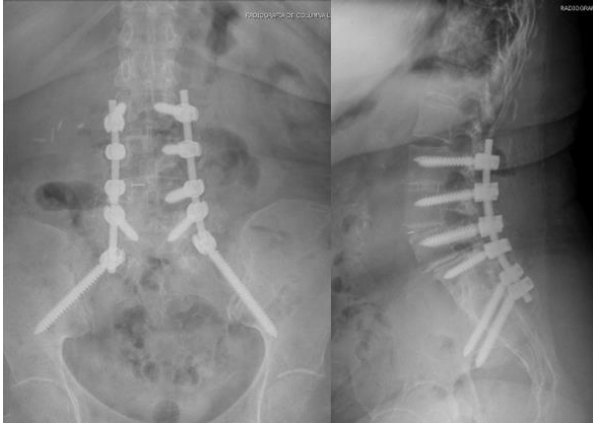


Figure 4. Postoperative X-ray with fusion from L3 to the pelvis

Case Presentation 2

A 70-year-old male patient with a medical history of hypertension and smoking had a surgical history of L3-L5 fusion at our center due to lumbar stenosis. He required two revisions at 3 and 6 years after the initial surgery, performed at another center, due to hardware loosening, with extension from L2 to S1.

The patient presented to us with left paravertebral lumbar pain associated with paresthesias on the right lateral thigh. The CT scan showed signs of instability, with a vacuum phenomenon at L1-L2 [Figure 5]. The SPECT scan revealed increased radiotracer uptake at the L4-L5 level bilaterally [Figure 6]. Given the failure of conservative treatment, it was decided to proceed with surgical treatment.

In the first stage, an anterior fusion was performed via XLIF (Extreme Lateral Interbody Fusion) at the L1-L2 level. Subsequently, in a posterior approach, the previously placed osteosynthesis hardware was removed. Pedicle screws at the S1 level were sent for culture via sonication, and bone and fibrotic tissue were sent for culture by conventional methods. Bilateral pedicle screws at the L1-L2 level were inserted along with rods [Figure 7].

Rescue of *Propionibacterium acnes* from the culture (S1 right screw) via sonication was obtained after 20 days of surgery. Soft tissue culture remained negative. With this rescue, the antibiotic treatment was further adjusted to amoxicillin 1 g every 8 hours for 6 weeks. Currently, 13 months post-surgery, the patient carries out his daily tasks without limitations, without the need for assistance, and without the use of analgesics.

Discussion

SPECT/CT bone imaging is a useful imaging study in patients with persistent lumbar pain following fusion. A study conducted by Al-Riyami et al. demonstrated an 85% positivity rate of the radiotracer in patients with lumbar instrumentation, out of a total of 187 patients.²⁰ Although CT serves as a valuable method for assessing bone bridging, it

has a low positive predictive value for pseudoarthrosis evaluation.²¹

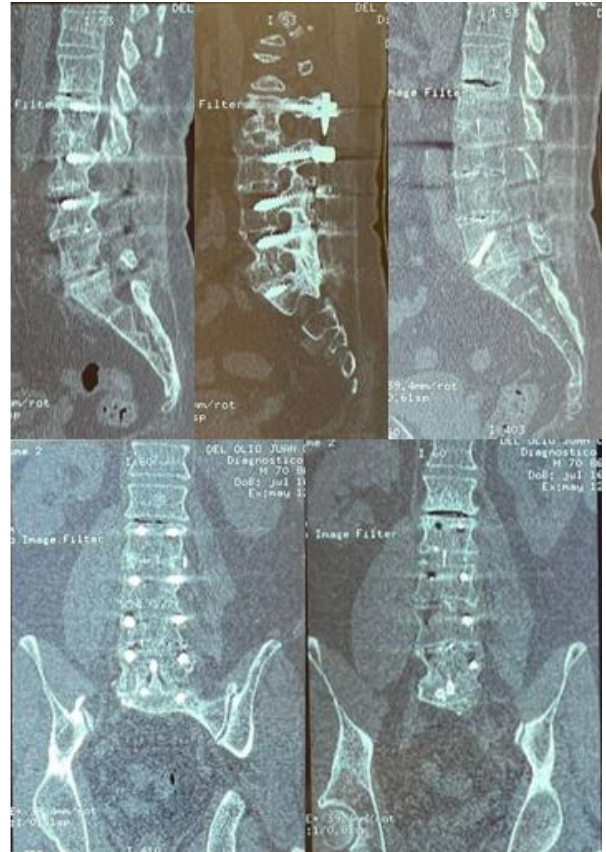


Figure 5. Preoperative CT scan showing signs of neumodisco at L1-L2

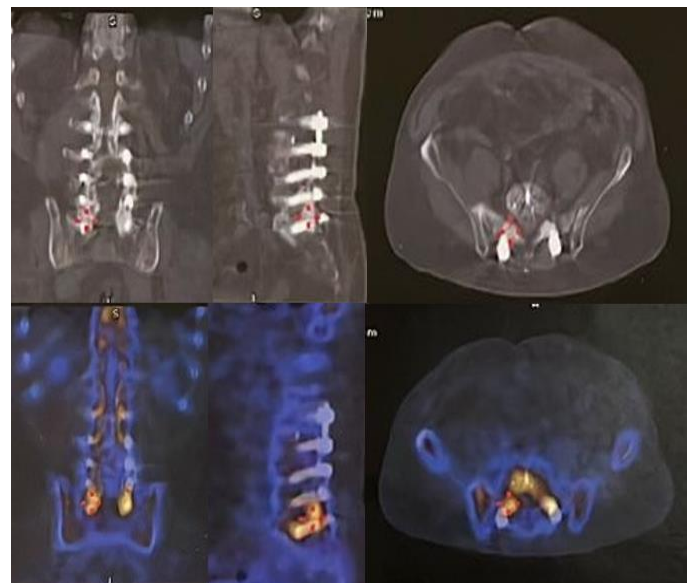


Figure 6. Lumbar SPECT/CT scan with hypercaptation of the radiotracer at bilateral L4-L5 levels



Figure 7. Postoperative X-ray with removal of the previous hardware and fusion at L1-L2

On the other hand, MRI is highly susceptible to poor quality due to technique artifacts or interference from implanted material.²²⁻²⁴ In our patients, SPECT/CT was requested to assess signs suggestive of pseudoarthrosis or hardware loosening.

In the first case, the patient exhibited increased radiotracer uptake in the periprosthetic right sector of L4 and L5 and in the left sector of L5. In the second case, there was increased radiotracer uptake at the bilateral periprosthetic level of S1.

This study has high sensitivity in detecting bone abnormalities that may be potential sources of pain or compromise bone fusion. However, the final determination of the origin of pain should be based on a comprehensive evaluation using various methods. In recent years, it has been discovered that one of the causes of persistent low back pain is the presence of chronic low-grade infection that can lead to hardware loosening, although clinical information on this concept is still limited.²⁵ The formation of a biofilm on the implant that is not penetrable by the immune system or maximum doses of antibiotics during systemic therapy appears to generate a local inflammatory reaction that may

be the cause of osteolysis.^{26,27} Dapunt et al. conducted a study in which they found a 57% positivity rate in implants analyzed using the sonication method in patients operated on for lumbar pseudoarthrosis.²⁸

The most frequently isolated pathogen was *P. acnes*, followed by coagulase-negative *Staphylococcus*.^{29,30} In both of our cases, soft tissue samples were analyzed using conventional methods, while implants were analyzed using the sonication method. The application of ultrasound waves to the retrieved material before culturing disintegrates the biofilm and enhances bacterial growth recovery.³¹ In both cases, soft tissue cultures remained negative, while the screws analyzed via sonication tested positive for *P. acnes*.

What is novel in your analysis is that in both patients, the screws that tested positive were those that showed increased radiotracer uptake in the SPECT/CT. It is important to mention that neither patient had clinical signs of infection nor abnormal laboratory parameters before the revision surgery. This raises a new question about the relationship between radiotracer uptake in SPECT/CT and chronic spinal infections.

Conclusion

SPECT/CT is an excellent tool for assessing implant loosening in patients with persistent low back pain following fixation. Furthermore, it can be crucial in the investigation of low-grade prosthetic infections, allowing for the accurate and precise adjustment of therapeutic management.

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