Imaging of the Failed Back Surgery Patient: A Practical Approach for Radiologists

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Introduction

Persistent or recurrent pain after lumbar spine surgery is common and challenging. The traditional term failed back surgery syndrome (FBSS) describes persistent, recurrent or new low-back pain and/or radicular symptoms following spinal surgery. Increasingly, the term persistent spinal pain syndrome after surgery is preferred because “failed surgery” may incorrectly imply that the operation itself was technically unsuccessful.

For radiologists, the postoperative lumbar spine is particularly demanding. Normal postoperative changes can mimic disease, metallic implants may degrade image quality, and several abnormalities frequently coexist. The fundamental question is therefore not simply: “What looks abnormal after surgery?” but rather: “Which imaging finding can plausibly explain the patient's new or persistent symptoms?” This distinction is essential because postoperative abnormalities are common even in asymptomatic patients.

Before looking at the images: know what operation was performed

Interpretation should begin with the surgical history. Was the patient treated by microdiscectomy, laminectomy, decompression, interbody fusion, posterolateral fusion or instrumented fixation? Which levels were operated on? When was surgery performed? Were implants or bone grafts used?

Timing is particularly important. An MRI performed three days after surgery has a completely different spectrum of expected findings from one obtained three years later. Early postoperative imaging is dominated by edema, hemorrhage, fluid collections and inflammatory enhancement. Late imaging should focus more on recurrent disc herniation, fibrosis, stenosis, instability, nonunion, hardware failure and adjacent-segment degeneration. A useful rule is: Never interpret the postoperative spine without knowing what was done and when it was done.

Radiographs: still useful after fusion

Although MRI dominates the investigation of postoperative pain, conventional radiographs remain valuable, particularly after instrumented fusion. Standing radiographs

demonstrate alignment, hardware position and gross implant failure. Comparison with previous examinations can reveal progressive deformity or migration. Flexion-extension radiographs may provide additional information when instability or pseudarthrosis is suspected, although interpretation can be difficult and absence of visible motion does not necessarily prove solid fusion Radiographs may be limited in the assessment of the intervertebral fusion.

CT: the examination of bone, fusion and hardware

CT is particularly useful in the instrumented postoperative spine. It provides excellent assessment of screw position, cage location, bone graft incorporation and fusion. Thin-section acquisition with multiplanar reconstructions is essential. CT is often the most useful modality for suspected pseudarthrosis. Persistent lucency through the intended fusion mass, lack of bridging trabecular bone, hardware loosening or breakage and gas/vacuum within the fusion region may support the diagnosis.

Pedicle screw loosening may manifest as a circumferential lucent halo around the screw, particularly when progressive on serial examinations. Coronal reformats may nicely depict this sign or persistent micromobility. However, lucency may persist after vertebral fusion. CT also allows assessment of cage subsidence, migration and endplate changes. Modern metal-artifact reduction and dual-energy or spectral techniques can substantially improve visualization around implants. However, CT findings should still be interpreted in clinical context. Not every peri-screw lucency represents symptomatic loosening, and not every imperfect-looking fusion is the cause of pain.

MRI: the central examination for recurrent neurological symptoms

MRI remains the most comprehensive technique for evaluating patients with recurrent radicular pain or neurological symptoms. It assesses the spinal canal, neural foramina, nerve roots, discs, bone marrow and postoperative soft tissues. Metallic hardware can substantially degrade image quality. Techniques that reduce artifact include high receiver bandwidth, thin sections, fast spin-echo imaging and dedicated metal-artifact reduction sequences such as SEMAC or MAVRIC-type techniques when available.

The goal is not to obtain aesthetically perfect images but to answer the clinically relevant question: Is there persistent or recurrent neural compression? Recurrent disc herniation versus postoperative fibrosis

One of the classic postoperative imaging problems is distinguishing recurrent disc herniation from epidural fibrosis after discectomy.

Recurrent disc material usually demonstrates signal characteristics similar to the parent disc and typically shows no central enhancement, although peripheral enhancement related to granulation tissue may occur. Postoperative epidural fibrosis generally enhances more homogeneously because scar tissue is vascularized. Contrast-enhanced MRI can therefore be useful when this distinction is clinically important, particularly in the appropriate postoperative interval. However, morphology should be considered together with enhancement. Scar tissue frequently surrounds nerve roots without causing symptoms. The key finding is not simply the presence of fibrosis but whether there is convincing anatomical correlation with the symptomatic nerve root.

Residual versus recurrent stenosis

Persistent symptoms shortly after surgery may result from inadequate decompression or unrecognized multilevel disease. Later symptoms may reflect recurrent stenosis caused by progressive facet arthropathy, ligamentous hypertrophy, disc degeneration or postoperative instability.

The radiologist should separately evaluate the central canal, lateral recesses and neural foramina. Foraminal stenosis is particularly important because it may be underestimated on routine axial images. Sagittal and dedicated oblique assessment can improve evaluation. When symptoms recur after an initial period of improvement, ask whether the same level has become stenotic again or whether disease has developed elsewhere.

Arachnoiditis: recognize the pattern

Adhesive arachnoiditis is a potential cause of persistent neurological symptoms after surgery, infection, hemorrhage or previous intrathecal procedures. MRI findings include abnormal clumping and adhesion of the cauda equina nerve roots. Several patterns may occur: centrally clustered roots, peripheral adherence producing an “empty sac” appearance, or a more severe irregular soft-tissue mass containing adherent nerve roots.

These appearances can be striking, but imaging severity does not always correlate with symptoms. The diagnosis should therefore be made morphologically without automatically attributing all pain to the arachnoiditis.

Postoperative collections: not every fluid collection is an abscess

Fluid collections are common after lumbar surgery. The differential diagnosis includes seroma, hematoma, cerebrospinal fluid collection and abscess. Timing, location and clinical information are essential.

- A postoperative hematoma can produce significant neural compression, particularly during the early postoperative period.
- A CSF leak or pseudomeningocele may communicate with the thecal sac. MR myelography or CT myelography can occasionally help identify the communication when conventional MRI is inconclusive.
- The diagnosis of abscess requires integration of morphology, surrounding inflammatory changes and clinical findings. Peripheral enhancement around a postoperative collection does not automatically indicate infection because postoperative granulation tissue commonly enhances.

Infection: look beyond enhancement

Postoperative infection may involve the disc space, vertebral bodies, epidural space, paraspinal tissues or instrumentation. MRI is the preferred examination for suspected spondylodiscitis and epidural infection. However, postoperative marrow edema and enhancement can persist and mimic infection, particularly early after surgery.

Features raising concern include progressive endplate destruction, abnormal disc signal and enhancement, paravertebral or epidural collections and extensive inflammatory soft-tissue changes. Diffusion-weighted imaging may provide additional information in selected cases but should not be interpreted in isolation. Again, the temporal evolution on serial imaging may be more informative than a single examination.

Pseudarthrosis: a mechanical cause of persistent pain

Failure of fusion is an important cause of persistent or recurrent pain. Pseudarthrosis may be associated with mechanical back pain, implant loosening or hardware failure. CT is generally the most useful modality for demonstrating absence of osseous bridging. Indirect signs include screw loosening, rod or screw fracture, cage migration and persistent motion on dynamic radiographs. Vacuum phenomenon within the intended fusion region may also suggest persistent mobility.

However, the radiologist should distinguish radiological nonunion from symptomatic pseudarthrosis. Imaging can demonstrate failure of fusion, but clinical correlation determines whether it explains the patient's symptoms.

Adjacent-segment disease: degeneration or consequence?

After fusion, increased mechanical stress may occur at levels adjacent to the fused segment. Imaging may demonstrate progressive disc degeneration, facet arthropathy, listhesis, stenosis or instability above or below the fusion. However, adjacent-level degeneration is also common as part of normal aging.

The radiologist should therefore avoid automatically attributing any adjacent disc degeneration to the previous fusion. Comparison with preoperative and earlier postoperative examinations is particularly valuable. The important question is whether there has been new or accelerated structural deterioration associated with neural compression or instability.

Hardware complications: look systematically

Instrumentation should be assessed component by component. Check pedicle screws for malposition, loosening and fracture. Assess rods and connectors for discontinuity. Evaluate interbody cages for migration, subsidence or displacement. Look for endplate erosion and the relationship between implants and neural structures. A technically abnormal screw does not necessarily cause symptoms. Conversely, a subtle implant complication may become clinically important when it affects a nerve root. Whenever possible, describe the anatomical consequence rather than simply stating that hardware is abnormal.

The danger of incidental abnormalities

Postoperative imaging contains numerous abnormalities. Disc degeneration, facet arthropathy, scar tissue, mild foraminal narrowing and hardware-related changes are common. The temptation is to select one visible abnormality and designate it as the cause of pain. This is particularly problematic because pain is a clinical phenomenon, not an imaging finding.

The most valuable reports distinguish three categories:

expected postoperative findings,

structural abnormalities of uncertain clinical relevance,

abnormalities that plausibly correlate with the patient's symptoms.

This hierarchy is far more useful than a long undifferentiated list of findings.

A structured approach improves postoperative spine interpretation.

- First, identify the exact surgical procedure, treated levels and interval since surgery.

- Second, assess alignment and compare with previous examinations.
- Third, evaluate the spinal canal, lateral recesses and foramina for residual or recurrent compression.
- Fourth, inspect the operated disc level for recurrent herniation and postoperative fibrosis.
- Fifth, assess fusion and instrumentation for pseudarthrosis, loosening, migration or fracture.
- Sixth, search for complications including infection, hematoma, CSF leak and arachnoiditis.
- Seventh, examine adjacent segments.

The final question should always be:

Which of these abnormalities actually matches the patient's clinical syndrome? The imaging of persistent pain after lumbar surgery is difficult because abnormal postoperative anatomy is expected.

Three principles are especially useful:

> Know the operation and the postoperative interval before interpreting the images.
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> An abnormal postoperative finding is not automatically the cause of pain.
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> Persistent symptoms may arise from the operated level, another spinal level—or outside the spine altogether.

The radiologist's most important contribution is therefore not to produce the longest possible list of postoperative abnormalities. It is to distinguish expected change from complication and, among the genuine abnormalities, identify those that can reasonably explain the patient's symptoms. In the postoperative spine, perhaps more than anywhere else in musculoskeletal imaging, clinical relevance is more important than imaging conspicuity.