PAIN MEDICINE CASE REPORTS

ISSN 2768-5152

Volume 9, Number 2, pp. 131-135

IMAGING CONSIDERATIONS FOR PATIENTS WITH CHRONIC LOW BACK PAIN: A CASE REPORT

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Background: The incidence of low back pain, a leading cause of global disability, has increased significantly. Spinal cord stimulation (SCS) is US Food and Drug Administration-approved for treating intractable back pain, particularly in patients with prior surgical interventions.

Case Report: A 43-year-old woman was referred for SCS implantation following 3 prior lumbar spinal surgeries with continued, right-sided radicular back pain. Additional diagnostic imaging was obtained, and a magnetic resonance imaging with and without contrast revealed a recurrent disc despite 3 lumbar microdiscectomies. The patient was then referred for lumbar spinal fusion, specifically anterior lumbar interbody fusion.

Conclusions: This case underscores the importance of comprehensive imaging and clinical assessment to identify structural abnormalities that may mimic or exacerbate pain. It highlights the need for tailored evaluations to determine SCS candidacy and advocates for careful consideration of imaging modalities in managing chronic low back pain, particularly in patients with a history of failed back surgery.

Key words: Spinal cord stimulation, lumbar spinal fusion, chronic back pain, imaging for low back pain

BACKGROUND

Low back pain is the leading cause of disability worldwide (1). Up to 85% of adults will experience low back pain in their lifespan, and the disease burden contributes to significant patient morbidity as well as health care costs (2). Treatment options are numerous and depend on the severity and etiology of the disease process. Neuromodulation, specifically with the use of spinal cord stimulation (SCS), has grown in popularity to treat intractable lower back pain especially when a neuropathic component is present. Seventy percent of SCS are performed among patients who have undergone prior back surgery (e.g., failed back surgery syndrome/postlaminectomy pain syndrome). However, appropriate candidacy for SCS implantation is one of the most difficult aspects in the decision-making process as it is not appropriate for all patients.

Understanding the patient's clinical history, diagnostic imaging, and physical exam is paramount in providing an appropriate treatment plan for the patient. Furthermore, a pain physician should have knowledge of different diagnostic exams for further evaluation. Most spine patients will have a magnetic resonance imaging (MRI) without contrast. An MRI provides excellent visualization of the spinal cord, surrounding muscles and ligaments, and osseous structures. Further, understanding of MRI technology, need for contrast, and available sequences are necessary to delineate disease processes and evaluate anatomy correctly. This case report describes a patient with chronic low back pain following multiple back surgeries who was referred for SCS. The patient's clinical presentation and lack of adequate imaging required further workup where the patient was found to have a recurrent disc herniation

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Disclaimer: There was no external funding in the preparation of this manuscript.
Conflict of interest: Each author certifies that he or she, or a member of his or her immediate family, has no commercial association (i.e., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted manuscript.
Patient consent for publication: Consent obtained directly from patient(s).
This case report adheres to CARE Guidelines and the CARE Checklist has been provided to the journal editor.
Accepted: 2025-02-03, Published: 2025-04-30

that required further surgical intervention rather than neuromodulation.

CASE PRESENTATION

A 49-year-old woman presented to our interventional pain clinic as a referral for SCS following multiple lumbar spine surgeries. Informed consent was obtained per institutional policy. Her symptoms included right-sided, lumbar back pain with radicular symptoms in the L5 distribution consistently over a 2-year time period. After 3 lumbar microdiscectomies within the past 2 years at an outside facility, her radicular pain persisted with minimal to no relief. Given her persistent pain after multiple lumbar surgeries, her primary surgical team referred to our clinic for SCS given MRI findings showed scar tissue vs recurrent disc herniation at her right L5/S1 nerve. However, given high suspicion by her primary team for scar tissue, no further surgical intervention was recommended. Rather than proceeding directly with the SCS trial, we obtained an MRI with and without contrast that showed a distinction of recurrent disc herniation. These findings were consistent with the patient's radicular pain symptoms in the L5 distribution. A diagnostic and therapeutic transforaminal epidural steroid injection was performed with 0.25% bupivacaine and 10 mg of dexamethasone with > 70% improvement in radicular pain immediately, which would be consistent with a positive diagnostic response. However, the pain relief lasted for 6 to 8 hours consistent with the duration of action of bupivacaine. Given the recurrent disc and the response to a diagnostic epidural steroid injection, the patient was referred to a surgery colleague for evaluation. She was scheduled for anterior lumbar interbody fusion at the L5/S1 level.

DISCUSSION

Incorporation of neuromodulation into the treatment algorithm for patients with chronic low back pain, specifically postlaminectomy pain syndrome, has led to exciting improvements in outcomes as well as technological innovations. However, case-by-case evaluations of each patient referred for SCS are important, and adequate review and understanding of spine imaging is imperative. As important as it is to understand when patients are great candidates for SCS, it is just as important to know when SCS would not be an effective tool for a patient's chronic pain.

Indications for SCS

When determining which patients are appropriate candidates for SCS, the decision quickly becomes multifactorial. First, social factors are a large contributor. Follow-up capability, reprogramming and device understanding, and wound management are all social factors that must be considered. Medical conditions, which have received US Food and Drug Administration approval for SCS implantation, include failed back surgery syndrome (postlaminectomy syndrome), complex regional pain syndrome types I and II, and intractable low back pain and leg pain which may be related to the following: radicular pain syndrome, radiculopathies related to failed back syndrome or herniated disc disease, epidural fibrosis, degenerative disc disease, and arachnoiditis (3). Patients referred for SCS have often failed conservative therapy consisting of physical therapy, oral medications, psychotherapy, or chiropractic manipulation. Prior to permanent implantation, a thorough review of patient imaging, psychosocial factors, and shared decision-making is needed prior to trial implantation. Trial success, defined as over 50% pain reduction, increased activity level, and/or decreased medication use during this time, suggests appropriateness for permanent implantation.

Contraindications to SCS

Contraindications to SCS implantation include infection at the site, aberrant anatomy inhibiting safe implantation, systemic illness, or severe coagulopathy. Poor outcomes have been noted among patients who have active, untreated mental illness, somatization, and poor coping skills (4).

Imaging Considerations

Compared to computed tomography (CT) and conventional radiographs, an MRI is best for evaluation of soft tissue pathologies and is the only imaging modality of the 3 to image the spinal cord directly. In addition, an MRI is a good adjunct to CT scans in the evaluation of bony structures as it includes sequences specific for evaluation of bone marrow as well as additional information of tumors (via fat suppression), bone bruising, and undetected fractures. An MRI is the imaging modality of choice for confirming lumbar disc herniation, nerve root entrapment, and spinal cord stenosis (5). Our patient had lumbar spine pathology, which is where we chose to focus our discussion.

In lumbar spine imaging, it is important to determine if the imaging seen is correlated to patient symptoms. Abnormal lumbar imaging is relatively common with patients over age 60 who were asymptomatic revealing 36%

with herniated discs, 21% with spinal stenosis, and > 90% having degenerated or bulging discs (6). Additionally, a randomized control trial (6,7), which assigned patients with back pain to either conventional radiographs or rapid MRI for further evaluation, documented higher rates of specialist consultations, health care service costs, 3-fold higher rate of surgical intervention, less physical therapy referrals, and no difference in functional status or pain relief in the rapid MRI group. All imaging findings should be paired carefully with clinical examination and symptom correlation as relying on imaging alone can result in false positive results that incur substantial health care costs and unnecessary procedures.

Decision-making for lower back pain imaging should include guidelines put forth by the American College of Radiology (ACR) regarding chronic back pain appropriateness criteria. In a meta-analysis by Jenkins et al (8) with a total of 1.2 million patients, over 34% of lumbar spine imaging was deemed inappropriate when using criteria guidelines. Emphasis on a focused history and physical, reassurance pharmacotherapy if deemed necessary by the provider, and conservative management, such as physical therapy without routine imaging, is suggested in patients with nonspecific lower back pain. Among patients with no neurologic compromise and minor risk factors for medical conditions, including stenosis, cancer, compression fractures, or inflammatory back diseases, initial imaging with traditional radiography should be postponed until a trial of therapy is completed (9).

ACR appropriateness criteria for low back pain was updated in 2021 (12). The guidelines for imaging of the low back include an appropriateness scale defined by a score from 1 to 9 that falls into the following categories: usually appropriate, may be appropriate, may be appropriate (disagreement), and usually not appropriate. Situations in which neither an MRI without contrast nor an MRI with and without contrast is indicated include Variants 1 and 2 (Table 1). MRI lumbar spine without contrast is usually appropriate in patients with Variants 3, 4, 5, 6, and 7. An MRI with and without intravenous (IV) contrast is only deemed "usually appropriate" by the ACR with Variants 4, 5, and 7. In Variants 3 and 6, MRI lumbar spine with and without contrast may be appropriate and should be analyzed on a case-by-case basis with physician judgment and positive predictive value of ordering imaging steering the final decision.

With Variants 1 and 2, patients do not have red flag symptoms, no prior imaging has been obtained, and the likelihood of imaging being diagnostic with either variant is very low. Patients in both of these subgroups often have inconclusive imaging results, and studies (7,10,11) have shown that imaging yields no clinical benefit and increased health care-associated costs. Management of these subgroups should include conservative therapy.

Patients with Variant 3, who have failed at least 6 weeks of conservative therapy should be imaged if the practitioner believes the patient could benefit from surgical or procedural intervention (12). MRI lumbar spine is therefore the modality of choice in these patients. An MRI is valuable in this situation to evaluate vertebral discs, neural anatomy, and signs of nerve root compression from spinal stenosis or other pathologies. Contrast is not typically needed in evaluation of surgical or procedural candidates but can be useful with noncontrast MRI if it is nondiagnostic or indeterminate. Notably, the ACR recognizes the ability of an MRI with and without contrast in this situation to differentiate between residual or recurrent disc from fibrosis and scarring in postoperative patients (12).

Table 1. Variants of low back pain according to the ACR.

Variants of Low Back Pain According to the ACR	
Variant Class	**Description**
Variant 1	Acute low back pain with or without radiculopathy. No red flag prior management. Initial imaging.
Variant 2	Subacute or chronic low back pain with or without radiculopathy. No red flags. No prior management. Initial imaging.
Variant 3	Surgery or intervention candidate with persistent or progressive low back pain during or following 6 weeks of optimal medical management.
Variant 4	Low back pain with suspected CES.
Variant 5	Low back pain with history of prior lumbar surgery and with or without radiculopathy. New or progressing symptoms or clinical findings. Initial imaging.
Variant 6	Low back pain with or without radiculopathy. One or more of the following: low-velocity trauma, osteoporosis, elderly individual, or chronic steroid use. Initial imaging.
Variant 7	Low back pain with or without radiculopathy. One or more of the following: suspicion of cancer, infection, or immunosuppression. Initial imaging.

Abbreviations: ACR, American College of Radiology; CES, cauda equina syndrome.

Variant 4 includes patients with suspected cauda equina syndrome (CES). While CES is rare, it is emergent and proper steps need to be taken to ensure appropriate timing of intervention. Most commonly, CES is seen at the L4-L5 or L5-S1 level with symptoms ranging from nerve root compression with resulting limb weakness or numbness, bowel and bladder dysfunction, impaired sexual function, and perianal or saddle numbness. An MRI without contrast is the preferred imaging modality of choice; however, an MRI with and without contrast is helpful among patients where cancer, infection, or inflammation is the driver of symptoms.

Variant 5 is defined by patients with low back pain with history of prior lumbar surgery with or without radicular symptoms who have new or progressing clinical findings. Back pain following surgery consists of a wide differential diagnosis with pathology ranging from scar formation, recurrent herniation or protrusion of a disc, bone fragments, or surgical graft or fusion failure. In this variant of patients, an MRI with and without contrast is most useful as its ability to delineate scars from recurrent disc phenomena (12). Challenges may arise in patients with surgical hardware and distorted anatomy, in which CT myelography of the lumbar spine is a good adjunct to MRI findings to assess nerve root compression (12). CT myelography risks and benefits must be weighed as it does require lumbar puncture as well as intrathecal contrast injection. Notably, an MRI without contrast alone will not differentiate between scar and recurrent disc herniation and will not accurately depict the extent of infectious etiologies when compared to an MRI with and without contrast.

Variants 6 and 7 include special subgroups of the population in which medical conditions must be carefully analyzed (Variant 6: low-velocity trauma, osteoporosis, elderly individuals, or chronic steroid use; Variant 7: patients with high suspicion of cancer, infection, or inflammation is likely). As these subgroups did not apply to our patient, we felt it was outside of the scope of this case report to discuss these variants in greater detail.

Contrast and MRI Sequences

Generally, MRI technology functions by producing a reaction between mobile, tissue hydrogen ions, and a main, static magnetic field by using radiofrequency waves at specific frequencies. Commonly used sequences in MRI scans are T1- and T2-weighted images. These sequences differ based on different echo times (TEs) (time between the radiofrequency pulses and signal reception) and repetition times (TRs) (time between radiofrequency pulses). T1-weighted images typically have short TR and TE times, which accounts for their ability to highlight fat. T2-weight images have longer TR and TE times and are characterized by brightness of fat- and water-based tissues.

As mentioned above, contrast is not needed for every patient undergoing an MRI. However, if needed, the most common agent is gadolinium. IV gadolinium is given, most often, and produces a high signal in T1. Within the spine, different disease processes can be differentiated with the appropriate use of MRI sequencing and contrast.

For our patient specifically, the use of contrast was needed to differentiate between scar and herniation. Failed back syndrome is an indication for contrast during lumbar MRI spine due to the scar that can form in the epidural space following laminectomy that will appear dark on T1-weighted images, but bright on T2 imaging due to granulation. Notably, even after time passes and other structures in the body would lose vascularity surrounding scar tissue, the epidural space will maintain vascularity and thus will maintain visibility on contrast imaging. This is differentiated from recurrent disc herniation as the nucleus pulposus is an avascular structure that will not enhance with contrast on imaging. Again, the differentiation of scar tissue and recurrent disc herniation is the presence of blood supply within the scar tissue while disc material would not have this feature.

Hueftle et al (13) were able to successfully demonstrate the ability of MRI lumbar spine with and without contrast to differentiate between these 2 conditions 100% of the time and a later study by Ross et al (14) was 96% successful. Some technical factors must be taken into consideration as well when performing imaging with contrast. Obtaining imaging directly after contrast administration is imperative in clarifying these diagnoses. After only 30 minutes, gadolinium will diffuse into the avascular disc fragment making disc herniation vs scar virtually impossible to differentiate (14,15). Additionally, after surgery, nerve root sheaths may be enlarged or distorted from scar formation, which will lead to subsequent enhancement of the nerve roots within the nerve sheath on imaging from compression and ischemia previously (15). Lastly, following discectomy, there may be annular remnants that were not fully dissected, which may extend to the anterior epidural space and be mistaken for disc material (14).

In the acute postoperative period, MRI imaging should be analyzed carefully. Fluid can replace the space in which the herniated disc fragment was previously located, leading to a mistaken diagnosis of recurrent disc involvement (13). This space may continue to house fluid for months, which is later taken over by scar formation. This is an important clinical consideration when ordering imaging in the months following lumbar spine surgery to differentiate between scar formation and recurrent disc disease.

For our patient, the patient had 3 prior lumbar surgeries, and it was assumed that the disc was adequately removed and formation of scar tissue was present. It is possible to evaluate scar tissue vs recurrent disc with an MRI without contrast by evaluating displacement of nerve root and comparing presurgery MRI to postsurgery MRI. However, as mentioned above, an MRI with and without contrast would be the gold standard to differentiate with much more certainty.

CONCLUSIONS

This case highlights 2 pivotal issues in the interventional management of chronic low back pain. First is identifying when providers should or should not offer interventional procedures to patients. Second is establishing what level of evidence is sufficient to deem that a patient would be a candidate for an interventional procedure, such as neuromodulation via SCS trial/implant. Imaging is a key aspect of the patient workup when managing chronic low back pain. However, clinical correlation with patient symptomatology and the appropriate choice of modality are both essential for utilizing imaging studies in a useful context.

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