

Appropriateness of Imaging in Patients with Low Back Pain

BY THOMAS J. GILBERT, MD, MPP

INTRODUCTION

Imaging should only be obtained after a focused history and physical examination, and is typically obtained in the context of a specific clinical scenario or concern. It may be obtained to exclude emergent or urgent conditions, to confirm a clinical diagnosis or to guide injection or surgical therapy.

INDICATIONS FOR PLAIN RADIOGRAPHY

Plain radiographs are not indicated for initial evaluation of acute low back pain unless specific indications are present:

- Evaluation for a fracture following significant trauma;
- Clinical suspicion of a fragility fracture (particularly in elderly patients or patients with a history of osteoporosis, prior fragility fracture or chronic steroid use);
- Clinical or laboratory suspicion of neoplasm (particularly in a patient with a known diagnosis of cancer);
- Clinical or laboratory suspicion of infection (including patients with a history of immunosuppression, chronic steroid use, fever, night sweats or elevated inflammatory markers); or
- Failure to respond to conservative therapy at 2-4 weeks.

If initial radiographs are negative in patients with suspected fragility fracture, repeat X-ray should be considered if moderate or severe pain persists at follow-up or reevaluation. Plain radiographs of the sacroiliac joints may be indicated in patients with inflammatory low back pain to evaluate for axial spondyloarthritis, or in patients with recent surgery to evaluate for postoperative complications.

Oblique radiographs have not been shown to add significant information and are not recommended for routine imaging. Lateral flexion-extension radiographs are not recommended for initial evaluation and are generally reserved to evaluate for segmental instability in patients being evaluated for surgery.

INDICATIONS FOR CROSS-SECTIONAL IMAGING (MRI, CT OR BONE SCINTIGRAPHY/SPECT)

Immediate cross-sectional imaging is indicated in patients with emergent conditions, such as cauda equina syndrome and major or progressive neurologic loss. Early cross-sectional imaging is indicated in patients with urgent conditions, such as uncontrolled pain, clinical suspicion of cancer and clinical suspicion of infection.

In the absence of red flags, early imaging has not been shown to be of use or to improve outcomes. Advanced imaging in patients with radiculopathy, lumbar spinal stenosis or non-specific back pain is generally reserved for those who have failed conservative therapy, in anticipation of injection therapy or to evaluate patients for possible surgery.

In most instances, MRI is the cross-sectional imaging procedure of choice, as it allows direct visualization of neurologic structures, has a high sensitivity for infection and neoplasm, and does not utilize ionizing radiation. CT and CT myelography are generally reserved for patients who are unable to undergo MRI, who have failed MRI or who have indeterminate findings on MRI. CT or CT myelography may be needed following MRI for surgical planning. CT is indicated to evaluate the integrity of a lumbar fusion, to characterize fractures or bone lesions and to evaluate areas with increased uptake on bone scan.

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The CDI Quality Institute is a federally qualified Provider Led Entity (PLE) tasked with developing Appropriate Use Criteria (AUC) for the ordering of advanced imaging procedures. The Institute's PLE developed imaging criteria for low back pain in 2017, which is available online at myCDI.com/PLE.

This edition of The Consult summarizes criteria developed by Dr. Gilbert and a panel of subject experts:

- Bruce Bartie, MD; Orthopedic Surgeon, Twin Cities Orthopedics, MN
- David Thorson, MD; Family Practice/Sports Medicine, Entira Family Clinics, MN
- Marjorie Wang, MD, MPH; Professor of Neurosurgery, Medical College of Wisconsin

After development, the criteria was reviewed by an extensive group of medical and other health care professionals.

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CLINICAL SCENARIOS

The strength of recommendations for imaging are indicated as follows:

- Green = indicated
- Yellow = indicated in specific scenarios
- Orange = probably not indicated, with limited exceptions
- Red = not indicated

Cauda equina syndrome	
● Green	MRI
● Yellow	CT myelography in patients unable to undergo MRI, to evaluate equivocal findings on MRI or for surgical planning with or without prior MRI
● Orange	CT without contrast
● Red	Bone scan, PET

CLINICAL NOTES

- Immediate imaging is recommended in patients when features suggest cauda equina syndrome (CES), or for severe or progressive neurologic deficits at one or multiple levels. Timely diagnosis may prevent serious sequelae with these entities (Chou et al., 2011).
- Key signs of cauda equina syndrome include new urine retention/overflow incontinence, saddle anesthesia, fecal incontinence, and bilateral leg weakness/paresthesias. Patients should be examined for decreased anal tone, bilateral leg weakness and perineal numbness (Goertz et al., Institute for Clinical Systems Improvement, 2012; Ahad et al., 2015; Balasubramanian et al., 2010). A combination of signs and symptoms may increase the specificity for CES.
- Urinary retention of more than 500 ml alone, or with bilateral sciatica and rectal incontinence, are more accurate predictors of CES. Pre- and post-void bladder ultrasound could help with the clinical assessment for cauda equina syndrome (Balasubramanian et al., 2010).

Clinical, radiologic or laboratory suspicion of cancer	
● Green	MRI
● Yellow	CT in patients unable to undergo MR or to evaluate equivocal MRI findings
● Yellow	CT as the initial study if plain radiographs show an area of osteolysis or to evaluate an area of increase uptake on bone scan
● Yellow	CT myelography to evaluate for intradural neoplasm or intradural metastases in patients who are unable to undergo MRI
● Yellow	Bone scan to evaluate equivocal or worrisome findings on MRI or CT, or to evaluate for multiple bone lesions which would indicate metastatic disease
● Orange	Bone scan without prior MRI or CT
● Orange	PET, except to evaluate indeterminate lesions on CT or MRI in patients with a diagnosis of cancer sensitive to PET imaging
● Red	Bone scan as a primary diagnostic test to evaluate for lesions in patients with known or suspected multiple myeloma

CLINICAL NOTES

- Emergent imaging is indicated in patients with clinical suspicion of cancer, impending cord impingement and/or a major or progressive neurological deficit.
- Early cross-sectional imaging is indicated in patients with a history of new moderate to severe pain and a “history of cancer.” A history of cancer is the strongest risk factor for spinal neoplasm (Chou et al., 2011; Henscke et al., 2007).
- Imaging might be deferred for several weeks for patients with other risk factors such as age \geq 50 years, unexplained weight loss and failure to improve after one month. These risk factors have positive likelihood ratios of 2.7-3.00, increasing the likelihood of cancer to only 1.2% (Chou et al., 2011).
- MRI could also be reserved for patients with abnormal radiographs and/or erythrocyte sedimentation rate (ESR) \geq 20mm/hour. Abnormalities on plain radiographs or an elevated ESR have a 78% sensitivity and a 67% specificity for neoplasm on MRI (Chou et al., 2007).
- MRI should include fluid sensitive (STIR or T2 fat saturation) sequences, as these can increase the conspicuity and sensitivity of MRI for neoplasm.

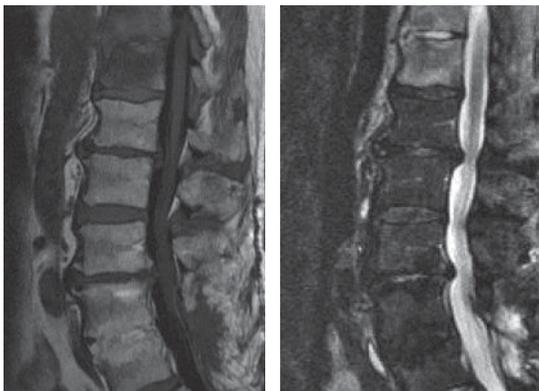


MRI of the lumbar spine with multiple osseous metastases showing low signal intensity on sagittal T1 weighted images (left) and increased signal intensity on sagittal STIR images (right).

Clinical, radiologic or laboratory suspicion of infection	
● Green	MRI
● Yellow	CT in patients unable to undergo MRI and in patients with equivocal findings on MRI (to evaluate for endplate destruction or poorly demarcated endplate erosions)
● Yellow	CT as the initial study (e.g. with evidence of endplate erosions on plain radiographs)
● Orange	Bone scan
● Red	PET

CLINICAL NOTES

- Immediate imaging is recommended in patients when features suggest vertebral infection. Timely diagnosis may prevent serious sequelae with this entity (Chou et al., 2011).
- Clinical features predicting the presence of vertebral infection have not been well studied, but may include back pain with a fever above 38°C (100.4°F) for greater than 48 hours, new moderate or severe pain following an invasive spine procedure (Chou et al., 2007; Institute for Clinical Systems Improvement, 2012; Goertz et al., 2012), and disproportionate back pain (*panel consensus opinion*).
- Risk factors for spinal infection include intravenous drug use, immunosuppression, recent infection, and history of tuberculosis or active tuberculosis (Chou et al., 2007; Institute for Clinical Systems Improvement, 2012; Goertz et al., 2012).
- An ESR and/or C-reactive protein (CRP) can be useful to direct care in patients with equivocal findings on MRI and/or CT. The ESR is elevated in 88-100% of patients with confirmed spine infections and shows a correlation with epidural abscess (Beronius, et al., 2001). The CRP is less sensitive but more specific.
- STIR or T2 fat saturation images are useful to identify marrow edema and paraspinous/epidural edema, phlegmon or abscess.
- Diffusion-weight imaging (the “claw sign”) may help differentiate inflammatory disc degeneration from vertebral spondylodiscitis (Patel et al., ACR, 2016).
- Imaging with IV contrast is useful to differentiate phlegmon from abscess (Patel et al., ACR, 2016).



MRI of the lumbar spine with spondylodiscitis at T11-12. Signal intensity within the abnormal disc and adjacent vertebral marrow spaces is decreased on sagittal T1 weighted images (left) and is increased on sagittal STIR images (right) with adjacent endplate erosions.

Low back pain with suspected fragility fracture in patients with abnormal or indeterminate X-rays	
●	MRI
●	CT in patients unable to undergo MRI, in cases with equivocal findings on MRI, to differentiate benign from pathologic fractures, or to evaluate for vertebroplasty/kyphoplasty
●	CT or MRI in a patient with a normal X-ray. Follow up X-ray in 10-14 days
●	Bone scan (unable to differentiate from degenerative changes)
●	PET

CLINICAL NOTES

- Plain radiography is the initial study of choice to evaluate for a suspected fragility fracture.
- Repeat X-ray should be considered if moderate or severe pain persists at follow-up at 10-14 days.
- MRI is the most appropriate initial imaging modality following plain radiography as the detection of marrow edema is paramount to determining the chronicity of fracture deformities.
- MRI examinations should include fluid sensitive sagittal STIR or T2 fat saturation images.
- Consider inclusion of T1, T2 fat saturation or STIR coronal MRI images through the sacrum to evaluate for sacral insufficiency fractures, which also occur frequently in this patient group.
- CT is indicated for the initial evaluation in patients with significant or high-energy trauma.



MRI of the lumbar spine showing compression fractures at L3 and T12 with marrow edema. Marrow edema shows decreased signal intensity on T1 weighted sagittal images (left) and increased signal intensity on sagittal STIR images (right).

Early low back pain (including patients with uncomplicated radiculopathy and/or stenosis) with no red flags and no conservative therapy

●	MRI, CT, bone scan
●	PET

CLINICAL NOTES

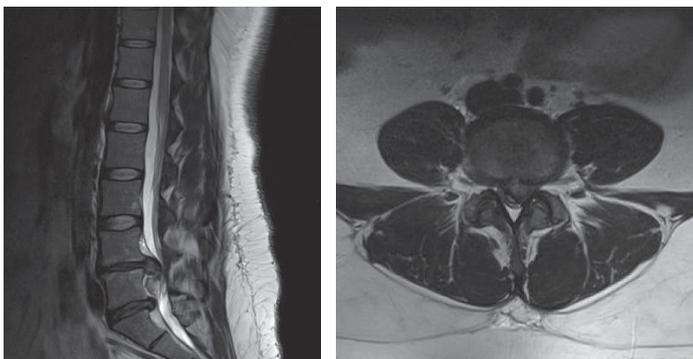
- Red flags include: a clinical or radiographic suspicion of cancer or infection, significant trauma, and major, progressive, or multilevel neurological deficit.
- This does not include patients who are candidates for urgent or immediate surgical intervention.
- Conservative therapy may include manipulation, exercise, physical therapy, pharmacological therapy, or time (if the patient is unable or unwilling to undergo available non-invasive treatments).
- High-quality studies have shown that early imaging does not improve outcome and does not result in psychological benefits. Routine imaging is ineffective because acute low back pain has a favorable natural history and shows significant improvement in most patients in the first 4 weeks (Chou et al., 2011).

- Practitioners should emphasize that acute low back pain is nearly always benign and generally resolves within 1-6 weeks (Institute of Health Economics, 2011). The first-line treatment for low back pain is conservative care (Patel et al., 2016; ACR, 2016).
- Most clinical guidelines recommend an interval of 4-6 weeks of conservative care prior to imaging.

Radiculopathy, moderate to severe pain and/or dysfunction and one or more of the following:	
<ul style="list-style-type: none"> - Failure of conservative therapy - Major or progressive neurologic deficit - Persistent or recurrent symptoms following discectomy - Evaluation for injection therapy or surgery 	
● MRI	
● CT or CT myelography in patients unable to undergo MRI, in patients with discordant MRI findings and symptoms, and in patients undergoing surgical planning following MRI	
● CT as the initial study without contraindications to MRI	
● CT myelography as the initial study without prior MRI and without contraindications to MRI (because of the increased risks with myelography)	
● Bone scan, PET	

CLINICAL NOTES

- The natural history of lumbar disc herniation with radiculopathy in most patients is for improvement in the first 4 weeks with non-invasive therapy.
- Early treatment of radiculopathy is non-invasive and may consist of manipulation, exercise therapy, physical therapy or pharmacologic therapy.
- “Failure of conservative care” is defined as moderate to severe persistent symptoms following an appropriate period of conservative care (typically 4-6 weeks), uncontrolled pain, marked limitation of function, increased pain during conservative care, or inability to participate in noninvasive care after an appropriate period of time.
- Findings on MRI and CT are nonspecific and require strict correlation of symptoms and findings on physical exam to determine the significance.

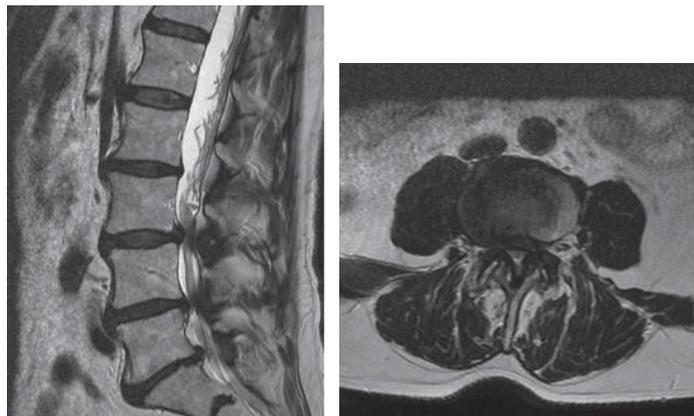


MRI of the lumbar spine showing disc degeneration at L4-5 and L5-S1, and a larger extruded left paracentral disc herniation at L4-5 impinging on the left L5 nerve root.

Lumbar spinal stenosis with neurogenic claudication or moderate or severe standing pain, and/or significant limitations of function with one of the following:	
<ul style="list-style-type: none"> - Unable to perform the activities of daily living - Failure of conservative therapy - Evaluation for injection therapy or surgery 	
● MRI	
● CT/CT myelography in patients unable to undergo MRI, in patients with discordant MRI findings and symptoms, and in patients undergoing surgical planning following MRI	
● CT as the initial study without prior MRI or without contraindications to MRI	
● CT myelography as the initial study without prior MRI and without contraindications to MRI (because of the increased risks with myelography)	
● Bone scan, PET	

CLINICAL NOTES

- “Failure of conservative care” is defined as moderate to severe persistent symptoms following an appropriate period of conservative care (typically 4-6 weeks), uncontrolled pain, marked limitation of function, increased pain during conservative care, or inability to participate in noninvasive care after an appropriate period of time.
- Findings on MRI and CT are nonspecific and require strict correlation of symptoms and findings on physical exam to determine the significance.
- The use of well-defined, articulated and validated criteria for assessing dural sac narrowing on MRI, CT or CT myelography is recommended to improve interobserver and intraobserver reliability (NASS, 2012).



Sagittal (left) and axial (right) T2 imaging showing central canal stenosis at L3-4, L4-5 and L5-S1 with redundancy of nerve roots within the dural sac cephalad to L3-4.

Appropriate Imaging for Low Back Pain

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●	CT without contrast
●	Bone scan, PET

Clinical, radiologic or laboratory suspicion of cancer	
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●	CT as the initial study if plain radiographs show an area of osteolysis or to evaluate an area of increase uptake on bone scan
●	CT myelography to evaluate for intradural neoplasm or intradural metastases in patients who are unable to undergo MRI
●	Bone scan to evaluate equivocal or worrisome findings on MRI or CT, or to evaluate for multiple bone lesions, which would indicate metastatic disease
●	Bone scan without prior MRI or CT
●	PET, except to evaluate indeterminate lesions on CT or MRI in patients with a diagnosis of cancer who are sensitive to PET imaging
●	Bone scan as a primary diagnostic test to evaluate for lesions in patients with known or suspected multiple myeloma

Clinical, radiologic or laboratory suspicion of infection	
●	MRI
●	CT in patients unable to undergo MRI and in patients with equivocal findings on MRI (to evaluate for endplate destruction or poorly demarcated endplate erosions)
●	CT as the initial study (e.g. with evidence of endplate erosions on plain radiographs). Follow-up X-ray in 10-14 days.
●	Bone scan
●	PET

Low back pain with suspected fragility fracture in patients with abnormal or indeterminate X-rays	
●	MRI
●	CT in patients unable to undergo MRI, in cases with equivocal findings on MRI, to differentiate benign from pathologic fractures, or to evaluate for vertebroplasty/kyphoplasty
●	CT or MRI in a patient with a normal X-ray. Follow-up X-ray in 10-14 days.
●	Bone scan (unable to differentiate from degenerative changes)
●	PET

Early low back pain (including patients with uncomplicated radiculopathy and/or stenosis) with no red flags and no conservative therapy	
●	MRI, CT, bone scan
●	PET

Radiculopathy, moderate to severe pain and/or dysfunction and one or more of the following: - Failure of conservative therapy - Major or progressive neurologic deficit - Persistent or recurrent symptoms following discectomy - Evaluation for injection therapy or surgery	
●	MRI
●	CT or CT myelography in patients unable to undergo MRI, in patients with discordant MRI findings and symptoms, and in patients undergoing surgical planning following MRI
●	CT as the initial study without contraindications to MRI
●	CT myelography as the initial study without prior MRI and without contraindications to MRI (because of the increased risks with myelography)
●	Bone scan, PET

Lumbar spinal stenosis with neurogenic claudication or moderate to severe standing pain, and/or significant limitations of function with one of the following: - Unable to perform the activities of daily living - Failure of conservative therapy - Evaluation for injection therapy or surgery	
●	MRI
●	CT/CT myelography in patients unable to undergo MRI, in patients with discordant MRI findings and symptoms, and in patients undergoing surgical planning following MRI
●	CT as the initial study without prior MRI or without contraindications to MRI
●	CT myelography as the initial study without prior MRI and without contraindications to MRI (because of the increased risks with myelography)
●	Bone scan, PET

Nonspecific moderate to severe low back pain with significant limitation of function and one or more of the following: - Failure of conservative therapy - Evaluation for injection therapy or surgery	
●	MRI
●	CT in patients unable to undergo MRI and in patients undergoing surgical planning following MRI
●	CT as the initial study without contraindications to MRI
●	CT in patients with a history of spinal fusion with or without prior MRI
●	Bone scan, except for patients with indeterminate lesions on MRI or CT scans
●	CT myelography without neurogenic claudication and/or radiculopathy
●	PET

Nonspecific moderate or severe low back pain with significant limitation of function and one or more of the following:

- Failure of conservative therapy
- Evaluation for injection therapy or surgery

	MRI
	CT in patients unable to undergo MRI and in patients undergoing surgical planning following MRI
	CT as the initial study without contraindications to MRI
	CT in patients with a history of spinal fusion with or without prior MRI
	Bone scan except for patients with indeterminate lesions on MRI or CT scans
	CT myelography without neurogenic claudication and/or radiculopathy
	PET

CLINICAL NOTES

- Practitioners should emphasize that acute low back pain is nearly always benign and generally resolves within 1-6 weeks (Institute of Health Economics, 2011). The first-line treatment for low back pain is conservative care (Patel et al., ACR 2016).
- Conservative care may consist of spinal manipulation, exercise therapy, physical therapy, cognitive behavioral therapy, intensive interdisciplinary rehabilitation, massage therapy, acupuncture, yoga, pharmacologic therapy, progressive relaxation, or time (for patients unable or unwilling to undergo available non-invasive treatments) (Chou et al., 2007).
- “Failure of conservative care” is defined as moderate to severe persistent symptoms following an appropriate period of conservative care (typically 4-6 weeks), uncontrolled pain, marked limitation of function, increased pain during conservative care, or inability to participate in noninvasive care after an appropriate period of time.
- In referring patients with non-specific low back pain who have failed non-invasive therapies, other published guidelines suggest referring patients to a spine specialist after 3 months (Chou et al., 2007).

CONCLUSION

This material on advanced imaging was developed by the CDI Quality Institute’s Provider Led Entity (PLE) and its Spine Subject Expert Panel. The PLE is federally qualified to develop Appropriate Use Criteria for advanced imaging studies. These AUC recommendations were finalized in March of 2017 and are available on the CDI Quality Institute’s PLE site at: myCDI.com/PLE. They do not address imaging following acute trauma.

REFERENCES

Complete references as well as evidence tables can be found on the CDI Quality Institute web site at myCDI.com/PLE.

In June of 2016, Centers for Medicare & Medicaid Services (CMS) named 11 qualified Provider Led Entities and additional PLEs were named in June of 2017. These entities are charged with determining appropriate use criteria in medical imaging:

- American College of Cardiology Foundation
- American College of Radiology
- Banner University Medical Group-Tucson University of AZ
- **CDI Quality Institute**
- Cedars-Sinai Health System
- Intermountain Healthcare
- Massachusetts General Hospital, Dept. of Radiology
- Medical Guidelines Institute
- Memorial Sloan Kettering Cancer Center
- National Comprehensive Cancer Network
- Sage Evidence-based Medicine & Practice Institute
- Society for Nuclear Medicine and Molecular Imaging
- University of California Medical Campuses
- University of Utah Health
- University of Washington Physicians
- Virginia Mason Medical Center
- Weill Cornell Medicine Physicians Organization

The CDI Quality Institute is devoted to continuous quality improvement and quality advocacy. The Institute works through its national network of affiliated radiologists to define, measure and communicate quality indicators for medical imaging and related services. This is done through a Radiologist Quality and Mentoring Program, ongoing clinical education and an active Medical Directors’ Council. The Institute also provides public policy leadership and advocacy at the federal and state levels.

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