ACR Appropriateness Criteria® on Low Back Pain

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Acute low back pain with or without radiculopathy is one of the most common health problems in the United States, with high annual costs of evaluation and treatment, not including lost productivity. Multiple reports show that uncomplicated acute low back pain or radiculopathy is a benign, self-limited condition that does not warrant any imaging studies. Guidelines for recognition of patients with more complicated status can be used to identify those who require further evaluation for suspicion of more serious problems and contribute to appropriate imaging utilization.

Key Words: Appropriateness Criteria®, low back pain, lumbar spine CT, lumbar spine MR, utilization, radiculopathy

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SUMMARY OF LITERATURE REVIEW

Acute low back pain (LBP) with or without radiculopathy is one of the most common health problems in the United States and is the leading cause of disability for persons aged <45 years. The cost of evaluating and treating acute LBP runs into billions of dollars annually, not including time lost from work [1].

Because of the high prevalence and high cost of dealing with this problem, government agencies have sponsored extensive studies that are now part of the growing body of literature on this subject. One of the earlier comprehensive studies was carried out in Quebec and was reported in *Spine* in 1987 [2]. The US Department of Health and Human Services convened a 23-member multidisciplinary panel of experts to review all of the literature on this subject, grade it, and develop a clinical practice guideline, which was published in December 1994 [3]. States have also convened similar panels in recent years, largely because of the rapidly rising workers' compensation claim burden being imposed on state budgets by LBP management [4].

It is now clear from these studies and others that uncomplicated acute LBP or radiculopathy is a benign, self-limited condition that does not warrant any imaging studies [5-8]. The vast majority of these patients are back to their usual activities within 30 days [1-3]. The challenge for clinicians, therefore, is to distinguish that small segment of patients within this large population who should be evaluated further because of suspicion of more serious problems (see Variants 1-6).

Indications of a more complicated status, often termed "red flags," include the following [2,9]:

- recent significant trauma or milder trauma at age > 50 years;
- unexplained weight loss;
- unexplained fever;
- immunosuppression;

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Variant 1. Uncomplicated acute low back pain and/or radiculopathy, nonsurgical presentation; no red flags (red flags defined in text)

Radiologic Procedure	Rating	Comments	RRL
MRI lumbar spine without contrast	2		None
X-ray lumbar spine	2		Medium
Myelography and postmyelography CT lumbar spine	2	In some cases, postinjection CT may be done without myelography.	High
X-ray myelography lumbar spine	2		Medium
NUC Tc-99m bone scan with SPECT spine	2		Medium
CT lumbar spine without contrast	2		Medium
MRI lumbar spine without and with contrast	2		None

Note: Rating scale: 1 = least appropriate, 9 = most appropriate. CT = computed tomography; MRI = magnetic resonance imaging; NUC = nuclear medicine; RRL = relative radiation level; SPECT = single photon-emission CT; Tc-99m = ^{99m}technetium.

- history of cancer;
- intravenous drug use;
- prolonged use of corticosteroids or osteoporosis;
- age > 70 years;
- focal neurologic deficit with progressive or disabling symptoms; and
- duration > 6 weeks.

Radiography

Radiography is recommended when any of the red flags are present [3,4]. Lumbar radiography may be sufficient for the initial evaluation of the following red flags [3,4], with further imaging indicated for treatment planning if findings are abnormal or inconclusive:

- recent significant trauma (at any age),
- osteoporosis, and
- age > 70 years.

The initial evaluation of patients with LBP may also require further imaging if other red flags, such as suspicion of cancer or infection, are present [3,4].

Isotope Bone Scanning

The role of isotope bone scanning in patients with acute LBP has changed in recent years with the wide availability of magnetic resonance imaging (MRI), especially contrast-enhanced MRI. Bone scanning is a moderately sensitive test for detecting the presence of tumors, infection, or occult fractures of the vertebrae but not for specifying the diagnosis [3,4]. For spondylolysis or stress fracture in athletes, bone scintigraphy with single photon-emission computed tomography (CT), followed by limited CT if results on scintigraphy are positive, is more sensitive than MRI [10]. Bone scintigraphy with single photon-emission CT can be useful to identify symptomatic facet disease in patients treated with facet injection [11].

High-resolution isotope imaging, including single photon-emission CT, may localize the source of pain in patients with articular facet osteoarthritis before therapeutic facet injection [12]. Similar scans may be helpful in detecting and localizing the site of painful pseudoarthrosis after lumbar spinal fusion [13]. The test is contraindicated during pregnancy.

Variant 2. Low-velocity trauma, osteoporosis, and/or age > 70 years

Radiologic Procedure	Rating	Comments	RRL
MRI lumbar spine without contrast	8		None
CT lumbar spine without contrast	6	MRI preferred. CT useful if MRI is contraindicated or unavailable, and for problem solving.	Medium
X-ray lumbar spine	6		Medium
NUC Tc-99m bone scan with SPECT spine	4		Medium
MRI lumbar spine without and with contrast	3		None
Myelography and postmyelography CT lumbar spine	1	In some cases, postinjection CT may be done without myelography.	High
X-ray myelography lumbar spine	1		Medium

Note: Rating scale: 1 = least appropriate, 9 = most appropriate. CT = computed tomography; MRI = magnetic resonance imaging; NUC = nuclear medicine; RRL = relative radiation level; SPECT = single photon-emission CT; Tc-99m = ^{99m}technetium.

Variant 3. Suspicion of cancer, infection, or immunosuppression			
Radiologic Procedure	**Rating**	**Comments**	**RRL**
MRI lumbar spine without and with contrast	8	See comments regarding contrast in text under "Anticipated Exceptions."	None
CT lumbar spine without contrast	6	MRI preferred. CT useful if MRI is contraindicated or unavailable, and for problem solving.	Medium
X-ray lumbar spine	5		Medium
NUC Tc-99m bone scan whole body with optional targeted SPECT spine	5		Medium
X-ray myelography lumbar spine	2		Medium
Myelography and postmyelography CT lumbar spine	2	In some cases, postinjection CT may be done without myelography.	High

Note: Rating scale: 1 = least appropriate, 9 = most appropriate. CT = computed tomography; MRI = magnetic resonance imaging; NUC = nuclear medicine; RRL = relative radiation level; SPECT = single photon-emission CT; Tc-99m = ^{99m}technetium.

Plain and contrast-enhanced MRI has the ability to demonstrate inflammatory, neoplastic, and most traumatic lesions as well as to show anatomic detail not available on isotope studies [14]. Gadolinium-enhanced MRI reliably shows the presence and extent of spinal infection and is useful in assessing therapy [15]. Magnetic resonance imaging has therefore taken over the role of isotope scanning in many cases in which the locations of lesions are known. Isotope scanning remains invaluable when a survey of the entire skeleton is indicated (eg, for metastatic disease).

MRI, CT, Myelography, and Myelography/MRI, CT

Uncomplicated acute LBP and/or radiculopathy (no red flags) do not warrant the use of any of these imaging studies [2-4]. The early indiscriminate use of expensive imaging procedures in this common clinical setting has caused large increases in workers' compensation costs and in some cases has led to the perception that CT and MRI of the lumbar spine are not worth the cost [7,14,16]. Adding to this controversy is the fact that nonspecific lumbar disc abnormalities are common and can be demonstrated readily on myelography, CT, and MRI, even in asymptomatic patients [17-20].

The appropriate use of these imaging procedures is an important challenge that has been extensively addressed in the major reviews referenced herein [2-4]. For example, LBP complicated by red flags suggesting infection or tumor may justify the early use of CT or MRI, even if radiographic results are negative [3]. The most common indication for the use of these imaging procedures, how-

Variant 4. Low back pain or radiculopathy, surgery and/or intervention candidate			
Radiologic Procedure	**Rating**	**Comments**	**RRL**
MRI lumbar spine without contrast	8		None
CT lumbar spine without contrast	5	MRI preferred. CT useful if MRI is contraindicated or unavailable, and for problem solving.	Medium
MRI lumbar spine without and with contrast	5	Indicated if noncontrast MRI is nondiagnostic or indeterminate. See comments regarding contrast in text under "Anticipated Exceptions."	None
Myelography and postmyelography CT lumbar spine	5	MRI preferred. May be indicated if MRI is contraindicated or nondiagnostic. In some cases, postinjection CT may be done without myelography.	High
X-ray lumbar spine	4	Usually not sufficient for decision making without MRI or CT.	Medium
NUC Tc-99m bone scan with SPECT spine	4	May be particularly useful for facet arthropathy, stress fracture, and spondylolysis.	Medium
X-ray myelography lumbar spine	2		Medium

Note: Rating scale: 1 = least appropriate, 9 = most appropriate. CT = computed tomography; MRI = magnetic resonance imaging; NUC = nuclear medicine; RRL = relative radiation level; SPECT = single photon-emission CT; Tc-99m = ^{99m}technetium.

Variant 5. Prior lumbar surgery

Radiologic Procedure	Rating	Comments	RRL
MRI lumbar spine without and with contrast	8	Differentiate disc from scar. See comments regarding contrast in text under "Anticipated Exceptions."	None
CT lumbar spine without contrast	6	Most useful in postfusion patients or when MRI is contraindicated or indeterminate.	Medium
MRI lumbar spine without contrast	6	Contrast often necessary.	None
Myelography and postmyelography CT lumbar spine	5	In some cases, postinjection CT may be done without myelography.	High
X-ray lumbar spine	5	Flex/extension may be useful.	Medium
NUC Tc-99m bone scan with SPECT spine	5	Helps detect and localize painful pseudoarthrosis.	Medium
X-ray myelography lumbar spine	2		Medium

Note: Rating scale: 1 = least appropriate, 9 = most appropriate. CT = computed tomography; MRI = magnetic resonance imaging; NUC = nuclear medicine; RRL = relative radiation level; SPECT = single photon-emission CT; Tc-99m = ^{99m}technetium.

ever, is the clinical setting of LBP complicated by radiating pain (radiculopathy, sciatica) or cauda equina syndrome (bilateral leg weakness, urinary retention, saddle anesthesia), usually due to herniated disc or canal stenosis.

MRI. Magnetic resonance imaging of the lumbar spine has become the initial imaging modality of choice in complicated LBP, displacing myelography and CT in recent years. Multidisciplinary agreement on terminology facilitates the reporting of MRI findings [21]. Although disc abnormalities are common on MRI in asymptomatic persons, acute back pain with radiculopathy suggests the presence of demonstrable nerve root compression on MRI [22]. Magnetic resonance imaging findings of Modic endplate change [23], anterolisthesis, or disc extrusion are more strongly associated with LBP than disc degeneration without endplate change [24-28]. A randomized, controlled trial showed that the depiction of stenosis or nerve-root compression on MRI in the first 48 hours after the onset of acute back pain or radiculopathy did not affect outcomes after 6 weeks of conservative management [8]. Magnetic resonance imaging is particularly efficacious for detecting red-flag diagnoses, particularly using the short tau inversion recovery and fat-

Variant 6. Cauda equina syndrome

Radiologic Procedure	Rating	Comments	RRL
MRI lumbar spine without contrast	9	Use of contrast depends on clinical circumstances.	None
MRI lumbar spine without and with contrast	8	Use of contrast depends on clinical circumstances. See comments regarding contrast in text under "Anticipated Exceptions."	None
Myelography and postmyelography CT lumbar spine	6	Useful if MRI is nondiagnostic or contraindicated. In some cases, postinjection CT may be done without myelography.	High
CT lumbar spine with or without contrast	5	May be indicated if MRI is confusing or contraindicated and myelography is not feasible. Use of contrast depends on clinical circumstances.	Medium
X-ray lumbar spine	4		Medium
NUC Tc-99m bone scan with SPECT spine	2		Medium
X-ray myelography lumbar spine	2		Medium

Note: Rating scale: 1 = least appropriate, 9 = most appropriate. CT = computed tomography; MRI = magnetic resonance imaging; NUC = nuclear medicine; RRL = relative radiation level; SPECT = single photon-emission CT; Tc-99m = ^{99m}technetium.

saturated T2 fast spin-echo sequences. Magnetic resonance imaging with contrast is useful for suspected infection and neoplasia. In postoperative patients, enhanced MRI allows distinction between disc and scar when tissue extends beyond the interspace.

CT. Computed tomographic scans provide superior bone detail but are not quite as useful in depicting disc protrusions compared with multiplanar MRI. With the added value associated with high-quality reformatted sagittal and coronal plane images, CT is useful for depicting spondylolysis, pseudoarthrosis, scoliosis, and for the postsurgical evaluation of bone graft integrity, surgical fusion, and instrumentation [29].

Myelography/CT. "Plain" myelography was the mainstay of a lumbar herniated disc diagnosis for decades. It is now usually combined with postmyelography CT. The combined study is complementary to plain CT or MRI and occasionally more accurate in diagnosing disc herniation, but it suffers the disadvantage of requiring lumbar puncture and contrast injection [30-33]. It may also be useful in surgical planning.

Thermography, Discography, and Computed Tomographic Discography

Expert panels have agreed that these imaging modalities are either too nonspecific (thermography) or carry additional risk (discography) that is not warranted in view of the efficacy of other less invasive imaging procedures [3,4]. When other studies fail to localize the cause of pain, discography may occasionally be helpful. Although the images often depict nonspecific aging or degenerative changes, the injection itself may reproduce a patient's pain, which may have diagnostic value [34].

Anticipated Exceptions

Nephrogenic systemic fibrosis (NSF), also known as nephrogenic fibrosing dermopathy, was first identified in 1997 and has recently generated substantial concern among radiologists, referring doctors, and lay people. Until the past few years, gadolinium-based magnetic resonance contrast agents were widely believed to be almost universally well tolerated, extremely safe, and not nephrotoxic, even when used in patients with impaired renal function. All available experience suggests that these agents remain generally very safe, but recently, some patients with renal failure who have been exposed to gadolinium contrast agents (the percentage is unclear) have developed NSF [35-37], a syndrome that can be fatal. Further studies are necessary to determine what the exact relationships are between gadolinium-containing contrast agents, their specific components and stoichiometry, patient renal function, and NSF. Current theory links the development of NSF to the administration of relatively high doses (eg, >0.2 mmol/L/kg) and to agents in which the gadolinium is least strongly chelated. The US Food and Drug Administration has recently issued a "black box" warning concerning these contrast agents [38].

This warning recommends that until further information is available, gadolinium contrast agents should not be administered to patients with either acute or significant chronic kidney disease (estimated glomerular filtration rate < 30 mL/min/1.73 m^2), recent liver or kidney transplantation, or hepatorenal syndrome, unless a risk-benefit assessment suggests that the benefit of administration in a particular patient clearly outweighs the potential risk(s) [36].

RELATIVE RADIATION LEVEL INFORMATION

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level indication has been included for each imaging examination. The relative radiation levels are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure (Table 1). Additional information regarding radiation dose assessment for imaging examinations can be found in *ACR Appropriateness Criteria®: Radiation Dose Assessment Introduction* [39].

Disclaimer: *The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for the diagnosis and treatment of specified medical conditions. These criteria are intended to guide radiologists, radiation oncologists, and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treat-*

Table 1. Relative radiation level designations

Relative Radiation Level	Effective Dose Estimate Range (mSv)
None	0
Minimal	<0.1
Low	0.1-1
Medium	1-10
High	10-100

ments. Only those examinations generally used for the evaluation of a patient's condition are ranked. Other imaging studies necessary to evaluate other coexistent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the US Food and Drug Administration have not been considered in developing these criteria, but the study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

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APPENDIX

Definitions

Acute low back pain	Lumbosacral pain of less than 6-weeks duration or with progressive or disabling symptoms.
Radiculopathy	Dysfunction of a nerve root, usually caused by compression or irritation of the root.
Spinal stenosis	Narrow bony canal that may cause radiculopathy or cauda equina syndrome.
Herniated disc	Herniation of the disc material beyond the confines of the interspace.
Sciatica	Pain radiating down the leg(s) below the knee along the distribution of the sciatic nerve, usually due to mechanical pressure and/or inflammation of lumbosacral nerve root(s).
Cauda equina syndrome	Compression of multiple nerve roots, often resulting in bilateral motor weakness (legs), urine retention, and saddle anesthesia.