American College of Radiology
ACR Appropriateness Criteria®
Low Back Pain

Variant 1: **Acute low back pain with or without radiculopathy. No red flags. No prior management. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
Radiography lumbar spine	Usually Not Appropriate	☢☢☢
MRI lumbar spine with IV contrast	Usually Not Appropriate	O
MRI lumbar spine without and with IV contrast	Usually Not Appropriate	O
MRI lumbar spine without IV contrast	Usually Not Appropriate	O
Bone scan whole body with SPECT or SPECT/CT complete spine	Usually Not Appropriate	☢☢☢
CT lumbar spine with IV contrast	Usually Not Appropriate	☢☢☢
CT lumbar spine without IV contrast	Usually Not Appropriate	☢☢☢
Discography and post-discography CT lumbar spine	Usually Not Appropriate	☢☢☢
CT lumbar spine without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT myelography lumbar spine	Usually Not Appropriate	☢☢☢☢
FDG-PET/CT whole body	Usually Not Appropriate	☢☢☢☢

Variant 2: **Subacute or chronic low back pain with or without radiculopathy. No red flags. No prior management. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
Radiography lumbar spine	Usually Not Appropriate	☢☢☢
MRI lumbar spine with IV contrast	Usually Not Appropriate	O
MRI lumbar spine without and with IV contrast	Usually Not Appropriate	O
MRI lumbar spine without IV contrast	Usually Not Appropriate	O
Bone scan whole body with SPECT or SPECT/CT complete spine	Usually Not Appropriate	☢☢☢
CT lumbar spine with IV contrast	Usually Not Appropriate	☢☢☢
CT lumbar spine without IV contrast	Usually Not Appropriate	☢☢☢
Discography and post-discography CT lumbar spine	Usually Not Appropriate	☢☢☢
CT lumbar spine without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT myelography lumbar spine	Usually Not Appropriate	☢☢☢☢
FDG-PET/CT whole body	Usually Not Appropriate	☢☢☢☢

Variant 3: **Subacute or chronic low back pain with or without radiculopathy. Surgery or intervention candidate with persistent or progressive symptoms during or following 6 weeks of optimal medical management. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI lumbar spine without IV contrast	Usually Appropriate	O
Radiography lumbar spine	May Be Appropriate	☢☢☢
MRI lumbar spine without and with IV contrast	May Be Appropriate	O
Bone scan whole body with SPECT or SPECT/CT complete spine	May Be Appropriate	☢☢☢
CT lumbar spine without IV contrast	May Be Appropriate	☢☢☢
CT myelography lumbar spine	May Be Appropriate	☢☢☢☢
MRI lumbar spine with IV contrast	Usually Not Appropriate	O
CT lumbar spine with IV contrast	Usually Not Appropriate	☢☢☢
Discography and post-discography CT lumbar spine	Usually Not Appropriate	☢☢☢
CT lumbar spine without and with IV contrast	Usually Not Appropriate	☢☢☢☢
FDG-PET/CT whole body	Usually Not Appropriate	☢☢☢☢

Variant 4: **Low back pain with suspected cauda equina syndrome. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI lumbar spine without and with IV contrast	Usually Appropriate	O
MRI lumbar spine without IV contrast	Usually Appropriate	O
CT lumbar spine without IV contrast	May Be Appropriate	☢☢☢
CT myelography lumbar spine	May Be Appropriate	☢☢☢☢
Radiography lumbar spine	Usually Not Appropriate	☢☢☢
MRI lumbar spine with IV contrast	Usually Not Appropriate	O
Bone scan whole body with SPECT or SPECT/CT complete spine	Usually Not Appropriate	☢☢☢
CT lumbar spine with IV contrast	Usually Not Appropriate	☢☢☢
Discography and post-discography CT lumbar spine	Usually Not Appropriate	☢☢☢
CT lumbar spine without and with IV contrast	Usually Not Appropriate	☢☢☢☢
FDG-PET/CT whole body	Usually Not Appropriate	☢☢☢☢

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.**

Procedure	Appropriateness Category	Relative Radiation Level
Radiography lumbar spine	Usually Appropriate	☢☢☢
MRI lumbar spine without and with IV contrast	Usually Appropriate	O
MRI lumbar spine without IV contrast	Usually Appropriate	O
CT lumbar spine without IV contrast	May Be Appropriate	☢☢☢
CT myelography lumbar spine	May Be Appropriate	☢☢☢☢
MRI lumbar spine with IV contrast	Usually Not Appropriate	O
Bone scan whole body with SPECT or SPECT/CT complete spine	Usually Not Appropriate	☢☢☢
CT lumbar spine with IV contrast	Usually Not Appropriate	☢☢☢
Discography and post-discography CT lumbar spine	Usually Not Appropriate	☢☢☢
CT lumbar spine without and with IV contrast	Usually Not Appropriate	☢☢☢☢
FDG-PET/CT whole body	Usually Not Appropriate	☢☢☢☢

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.**

Procedure	Appropriateness Category	Relative Radiation Level
Radiography lumbar spine	Usually Appropriate	☢☢☢
MRI lumbar spine without IV contrast	Usually Appropriate	O
CT lumbar spine without IV contrast	Usually Appropriate	☢☢☢
MRI lumbar spine without and with IV contrast	May Be Appropriate	O
CT myelography lumbar spine	May Be Appropriate	☢☢☢☢
MRI lumbar spine with IV contrast	Usually Not Appropriate	O
Bone scan whole body with SPECT or SPECT/CT complete spine	Usually Not Appropriate	☢☢☢
CT lumbar spine with IV contrast	Usually Not Appropriate	☢☢☢
Discography and post-discography CT lumbar spine	Usually Not Appropriate	☢☢☢
CT lumbar spine without and with IV contrast	Usually Not Appropriate	☢☢☢☢
FDG-PET/CT whole body	Usually Not Appropriate	☢☢☢☢

Variant 7: **Low back pain with or without radiculopathy. One or more of the following: suspicion of cancer, infection, or immunosuppression. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI lumbar spine without and with IV contrast	Usually Appropriate	O
MRI lumbar spine without IV contrast	Usually Appropriate	O
Radiography lumbar spine	May Be Appropriate (Disagreement)	☢☢☢
CT lumbar spine with IV contrast	May Be Appropriate	☢☢☢
CT lumbar spine without IV contrast	May Be Appropriate	☢☢☢
CT myelography lumbar spine	May Be Appropriate	☢☢☢☢
MRI lumbar spine with IV contrast	Usually Not Appropriate	O
Bone scan whole body with SPECT or SPECT/CT complete spine	Usually Not Appropriate	☢☢☢
Discography and post-discography CT lumbar spine	Usually Not Appropriate	☢☢☢
CT lumbar spine without and with IV contrast	Usually Not Appropriate	☢☢☢☢
FDG-PET/CT whole body	Usually Not Appropriate	☢☢☢☢

LOW BACK PAIN

Expert Panel on Neurological Imaging: Troy A. Hutchins, MD[a]; Miriam Peckham, MD[b]; Lubdha M. Shah, MD[c]; Matthew S. Parsons, MD[d]; Vikas Agarwal, MD[e]; Daniel J. Boulter, MD[f]; Judah Burns, MD[g]; R. Carter Cassidy, MD[h]; Melissa A. Davis, MD, MBA[i]; Langston T. Holly, MD[j]; Christopher H. Hunt, MD[k]; Majid A. Khan, MBBS, BS[l]; Toshio Moritani, MD, PhD[m]; A. Orlando Ortiz, MD, MBA[n]; John E. O'Toole, MD, MS[o]; William J. Powers, MD[p]; Susan B. Promes, MD, MBA[q]; Charles Reitman, MD[r]; Vinil N. Shah, MD[s]; Simranjit Singh, MD[t]; Vincent M. Timpone, MD[u]; Amanda S. Corey, MD.[v]

Summary of Literature Review

Introduction/Background

In the United States, acute low back pain (LBP), with or without radiculopathy, is the leading cause of years lived with disability and the third ranking cause of disability-adjusted life years [1]. It is the fifth most common reason for a physician visit in the United States and accounts for approximately 3% of visits to the emergency department [2].

The American College of Physicians and the American Pain Society classify LBP into the following broad categories: nonspecific LBP, back pain potentially associated with radiculopathy or spinal stenosis, and back pain potentially associated with another specific spinal cause [3]. Additionally, guidelines from the American College of Physicians and the American Pain Society [3,4] emphasize a focused history and physical examination, reassurance, initial pain management medications if necessary, and consideration of physical therapies without routine imaging in patients with nonspecific LBP. Duration of symptoms also helps guide treatment algorithms in patients with acute, subacute, or chronic LBP. Additionally, assessment of psychosocial risk factors when obtaining patient history is a strong predictor of patients who are predisposed to developing chronic disabling LBP problems [3].

Although there is great variability in the definition of acute and subacute LBP, for the purposes of this guideline, we will use the Institute for Clinical Systems Improvement definitions of 0 to 4 weeks to define acute LBP, 4 to 12 weeks for subacute LBP, and >12 weeks for chronic LBP [5].

It is clear that uncomplicated acute LBP and/or radiculopathy is a benign, self-limited condition that does not warrant any imaging studies [4,6,7]. Imaging is considered in those patients who have had up to 6 weeks of medical management and physical therapy that resulted in little or no improvement in their back pain. It is also considered for those patients presenting with red flags, raising suspicion for a serious underlying condition, such as cauda equina syndrome (CES), malignancy, fracture, or infection (see Table 1).

[a]University of Utah Health, Salt Lake City, Utah. [b]Research Author, University of Utah Medical Center, Salt Lake City, Utah. [c]Panel Chair, University of Utah, Salt Lake City, Utah. [d]Panel Vice-Chair, Mallinckrodt Institute of Radiology, Saint Louis, Missouri. [e]University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania. [f]The Ohio State University Wexner Medical Center, Columbus, Ohio. [g]Montefiore Medical Center, Bronx, New York. [h]UK Healthcare Spine and Total Joint Service, Lexington, Kentucky; American Academy of Orthopaedic Surgeons. [i]Emory University, Atlanta, Georgia. [j]UCLA Medical Center, Los Angeles, California; Neurosurgery expert. [k]Mayo Clinic, Rochester, Minnesota. [l]Johns Hopkins Hospital, Baltimore, Maryland. [m]University of Michigan, Ann Arbor, Michigan. [n]Jacobi Medical Center, Bronx, New York. [o]Rush University, Chicago, Illinois; Neurosurgery expert. [p]University of North Carolina School of Medicine, Chapel Hill, North Carolina; American Academy of Neurology. [q]Pennsylvania State University College of Medicine, Hershey, Pennsylvania; American College of Emergency Physicians. [r]Medical University of South Carolina, Charleston, South Carolina; North American Spine Society. [s]University of California San Francisco, San Francisco, California. [t]Indiana University School of Medicine, Indianapolis, Indiana; American College of Physicians. [u]University of Colorado School of Medicine, Anschutz Medical Campus, Aurora, Colorado. [v]Specialty Chair, Atlanta VA Health Care System and Emory University, Atlanta, Georgia.

Table 1. Red Flags: Indications of a more complicated status include back pain/radiculopathy in the following settings (adapted from Bigos et al [8]).

Red Flag	Potential Underlying Condition as Cause of LBP
• History of cancer • Unexplained weight loss • Immunosuppression • Urinary infection • Intravenous drug use • Prolonged use of corticosteroids • Back pain not improved with conservative management	• Cancer or infection
• History of significant trauma • Minor fall or heavy lift in a potentially osteoporotic or elderly individual • Prolonged use of steroids	• Spinal fracture
• Acute onset of urinary retention or overflow incontinence • Loss of anal sphincter tone or fecal incontinence • Saddle anesthesia • Bilateral or progressive weakness in the lower limbs	• Cauda equina syndrome or other severe neurologic condition

Previous guidelines have suggested that imaging be performed in adults >50 years of age who present with LBP. When studied, there was no statistically significant difference in primary outcome after 1 year for patients aged 65 years or older who had spine imaging within 6 weeks after an initial visit for care for LBP versus similar patients who did not undergo early imaging [9]; thus, this document does not include >50 years of age as an independent red flag. However, an important age-related risk factor for spinal fracture presenting as LBP is osteoporosis. As bone mass decreases slowly over time, the prevalence of osteoporosis increases with age, and differs by sex, race, ethnicity [10], and comorbidities. In line with the US Preventive Services Task Force recommendations for patients ages 65 and older being screened for osteoporosis, patients >65 years of age may be considered at risk for osteoporotic fracture when presenting with LBP.

Additionally, for those patients without neurologic compromise and who present with minor risk factors for cancer, inflammatory back disease (eg, ankylosing spondylitis), vertebral compression fracture, or symptomatic spinal stenosis, imaging should be considered after a trial of therapy [4].

In the majority of patients, no specific pathology for LBP can be identified. Also, studies have shown imaging abnormalities in a substantial number of people without back pain [11-13]. The challenge for the clinician, therefore, is to distinguish the small segment within this large patient population that should be evaluated further because of suspicion of a more serious problem or identify pathology that requires intervention.

Other nonspine causes of LBP can have overlap in clinical presentation, including inflammatory arthritis and other systemic conditions, such as pelvic, renal, vascular, or gastrointestinal etiologies. If an inflammatory etiology is suspected as the cause of LBP, such as ankylosing spondylitis, psoriatic spondylitis, reactive arthritis, or inflammatory bowel disease–related spine disorders, please see the ACR Appropriateness Criteria® topic on "Inflammatory Back Pain: Known or Suspected Axial Spondyloarthropathy" [14].

Initial Imaging Definition

Initial imaging is defined as imaging at the beginning of the care episode for the medical condition defined by the variant. More than one procedure can be considered usually appropriate in the initial imaging evaluation when:

- There are procedures that are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care)

OR

- There are complementary procedures (ie, more than one procedure is ordered as a set or simultaneously where each procedure provides unique clinical information to effectively manage the patient's care).

Discussion of Procedures by Variant

Variant 1: Acute low back pain with or without radiculopathy. No red flags. No prior management. Initial imaging.

Imaging is typically not warranted in this setting. Acute (<4 weeks' duration) uncomplicated (no red flags) LBP, with or without radiculopathy, is considered a self-limiting condition that is responsive to medical management and physical therapy in most patients [4,6,7]. Numerous studies have shown that routine imaging provides no clinical benefit in this group [6,9]. Usually no specific pathology for LBP can be identified.

Nonspecific lumbar disc abnormalities are common in asymptomatic patients and can be demonstrated readily on MRI, CT, fluoroscopic myelography, and postmyelography CT of the lumbar spine [11]. Imaging abnormalities can be seen in a substantial number of people without back pain [11-13]. A prospective study by Carragee et al [13] found that among patients with lumbar imaging abnormalities before the onset of LBP, 84% had unchanged or improved findings after symptoms developed. A systematic review of 33 articles found an increasing prevalence of degenerative spine findings in asymptomatic patients of increasing age [12]. For example, disc protrusion prevalence increased from 29% of those 20 years of age to 43% of those 80 years of age in this asymptomatic population. A prospective cohort study of 20 patients showed no significant differences in MRI changes over 12 months in patients presenting with acute LBP compared with their asymptomatic counterparts, except in disc herniation, nerve root compression, and annular fissure [15]. Even in the setting of disc herniation, imaging may have limited role in management as the majority of disc herniations show some degree of reabsorption or regression by 8 weeks after symptom onset [16]. It is important to note that repeat imaging in patients with new episodes of LBP and previous MRI scans are unlikely to detect differences in disc protrusion, annular fissures, high-intensity zones, or end-plate signal changes [13].

Despite the lack of evidence to support imaging early or prior to conservative treatment for LBP, there is significant variation in the ordering practices of physicians, with nonadherance to guidelines leading to increased health care utilization [17,18]. A retrospective cohort study of 145,320 patients ≥66 years of age with acute nonspecific LBP, revealed 27.2% received radiography and 11.1% received CT or MRI within 4 weeks of the initial primary care provider visit [18]. A prospective population-based cohort study of 1,770 patients with acute occupational LBP showed that 336 (19.0%) received lumbar MRI within 6 weeks of presentation (nonadherent to guidelines). This nonadherent group had an increased likelihood of lumbosacral injections or surgery for outpatient, inpatient, and nonmedical services, and disability compensation [17]. Increased health care utilization with early imaging has also been demonstrated in nonworker populations [6].

Bone Scan Whole Body with SPECT or SPECT/CT Complete Spine

There is no relevant literature to support the use of bone scan with single-photon emission CT (SPECT) or SPECT/CT in the initial evaluation of acute uncomplicated LBP.

CT Lumbar Spine With IV Contrast

There is no relevant literature to support the use of CT lumbar spine with intravenous (IV) contrast in the initial evaluation of acute uncomplicated LBP.

CT Lumbar Spine Without and With IV Contrast

There is no relevant literature to support the use of CT lumbar spine without and with IV contrast in the initial evaluation of acute uncomplicated LBP.

CT Lumbar Spine Without IV Contrast

There is no relevant literature to support the use of CT lumbar spine without IV contrast in the initial evaluation of patients in this group. Acute (<4 weeks' duration) uncomplicated (no red flags) LBP, with or without radiculopathy, is considered a self-limiting condition, responsive to medical management and physical therapy in most patients [4,6,7]. Numerous studies have shown that routine imaging provides no clinical benefit in this group [6,9] and can lead to increased health care utilization [6,17].

CT Myelography Lumbar Spine

There is no relevant literature to support the use of lumbar spine CT myelography in the initial evaluation of acute uncomplicated LBP.

Discography and Post-Discography CT Lumbar Spine
There is no relevant literature to support the use of discography with post-discography CT in the initial evaluation of acute uncomplicated LBP.

FDG-PET/CT Whole Body
There is no relevant literature to support the use of whole-body fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG)-PET/CT in the initial evaluation of acute uncomplicated LBP.

MRI Lumbar Spine With IV Contrast
There is no relevant literature to support the use of MRI lumbar spine with IV contrast in the initial evaluation of acute uncomplicated LBP.

MRI Lumbar Spine Without and With IV Contrast
There is no relevant literature to support the use of MRI lumbar spine without and with IV contrast in the initial evaluation of patients in this group. Acute (<4 weeks' duration) uncomplicated (no red flags) LBP, with or without radiculopathy, is considered a self-limiting condition, responsive to medical management and physical therapy in most patients [4,6,7]. Numerous studies have shown that routine imaging provides no clinical benefit in this group [6,9] and can lead to increased health care utilization [6,17].

MRI Lumbar Spine Without IV Contrast
There is no relevant literature to support the use of MRI lumbar spine without IV contrast in the initial evaluation of patients in this group. Acute (<4 weeks' duration) uncomplicated (no red flags) LBP, with or without radiculopathy, is considered a self-limiting condition, responsive to medical management and physical therapy in most patients [4,6,7]. Numerous studies have shown that routine imaging provides no clinical benefit in this group [6,9] and can lead to increased health care utilization [6,17].

Radiography Lumbar Spine
There is no relevant literature to support the use of radiography in the initial evaluation of patients in this group. Acute (<4 weeks' duration) uncomplicated (no red flags) LBP, with or without radiculopathy, is considered a self-limiting condition, responsive to medical management and physical therapy in most patients [4,6,7]. Numerous studies have shown that routine imaging provides no clinical benefit in this group [6,9] and can lead to increased health care utilization [6,17].

Variant 2: Subacute or chronic low back pain with or without radiculopathy. No red flags. No prior management. Initial imaging.

As with acute LBP, imaging is typically not useful in this setting. Numerous studies have shown that routine imaging provides no clinical benefit in this group [6,9]. Usually, no specific pathology for LBP can be identified. For patients with subacute (4-12 weeks' duration) or chronic (>12 weeks' duration) LBP without red flags or prior management, first-line treatment remains conservative therapy with both pharmacologic and nonpharmacologic (eg, exercise, remaining active) therapy [19]. Please see Variant 1 above for synopsis of relevant literature.

Although MRI findings of disc degeneration and spondylolysis are more common in patients <50 years of age with LBP compared with those without symptoms [20], early imaging may not affect outcome. One study found no statistically significant difference in primary outcome after 1 year for patients ≥65 years of age who had spine imaging within 6 weeks after an initial visit for care for LBP versus similar patients who did not undergo early imaging [9]. Additionally, patients with new episodes of LBP and previous MRI scans are unlikely to detect changes in disc protrusion, annular fissures, high-intensity zones, or end-plate signal changes with repeated MRI [13].

Bone Scan Whole Body with SPECT or SPECT/CT Complete Spine
There is no relevant literature to support the use of bone scan with SPECT or SPECT/CT in the initial evaluation of subacute or chronic LBP without red flags or prior management.

CT Lumbar Spine With IV Contrast
There is no relevant literature to support the use of CT lumbar spine with IV contrast in the initial evaluation of subacute or chronic LBP without red flags or prior management.

CT Lumbar Spine Without and With IV Contrast
There is no relevant literature to support the use of CT lumbar spine without and with IV contrast in the initial evaluation of subacute or chronic LBP without red flags or prior management.

CT Lumbar Spine Without IV Contrast
There is no relevant literature to support the use of CT lumbar spine without IV contrast in the initial evaluation of patients in this group. Subacute to chronic uncomplicated (no red flags) LBP, with or without radiculopathy, is considered a self-limiting condition, responsive to medical management and physical therapy in most patients [4,6,7]. Numerous studies have shown that routine imaging provides no clinical benefit in this group [6,9] and can lead to increased health care utilization [6,17].

CT Myelography Lumbar Spine
There is no relevant literature to support the use of lumbar spine CT myelography in the initial evaluation of subacute or chronic LBP without red flags or prior management.

Discography and Post-Discography CT Lumbar Spine
There is no relevant literature to support the use of discography with post-discography CT in the initial evaluation of subacute or chronic LBP without red flags or prior management.

FDG-PET/CT Whole Body
There is no relevant literature to support the use of whole-body FDG-PET/CT in the initial evaluation of subacute or chronic LBP without red flags or prior management.

MRI Lumbar Spine With IV Contrast
There is no relevant literature to support the use of MRI lumbar spine with IV contrast in the initial evaluation of subacute or chronic LBP without red flags or prior management.

MRI Lumbar Spine Without and With IV Contrast
There is no relevant literature to support the use of MRI lumbar spine without and with IV contrast in the initial evaluation of patients in this group. Subacute to chronic uncomplicated (no red flags) LBP, with or without radiculopathy, is considered a self-limiting condition responsive to medical management and physical therapy in most patients [4,6,7]. Numerous studies have shown that routine imaging provides no clinical benefit in this group [6,9] and can lead to increased health care utilization [6,17].

MRI Lumbar Spine Without IV Contrast
There is no relevant literature to support the use of MRI lumbar spine without IV contrast in the initial evaluation of patients in this group. Subacute to chronic uncomplicated (no red flags) LBP, with or without radiculopathy, is considered a self-limiting condition responsive to medical management and physical therapy in most patients [4,6,7]. Numerous studies have shown that routine imaging provides no clinical benefit in this group [6,9] and can lead to increased health care utilization [6,17].

Radiography Lumbar Spine
There is no relevant literature to support the use of radiography in the initial evaluation of patients in this group. Subacute to chronic uncomplicated (no red flags) LBP, with or without radiculopathy, is considered a self-limiting condition responsive to medical management and physical therapy in most patients [4,6,7]. Numerous studies have shown that routine imaging provides no clinical benefit in this group [6,9] and can lead to increased health care utilization [6,17].

Variant 3: Subacute or chronic low back pain with or without radiculopathy. Surgery or intervention candidate with persistent or progressive symptoms during or following 6 weeks of optimal medical management. Initial imaging.

In the absence of red flags, first-line treatment for chronic LBP remains conservative therapy with both pharmacologic and nonpharmacologic (eg, exercise, remaining active) therapy [19]. However, patients presenting with subacute or chronic LBP, with or without radiculopathy, who have failed 6 weeks of conservative therapy should be imaged if they are believed to be candidates for surgery or intervention or if diagnostic uncertainty remains. The goal of imaging is to identify potential actionable pain generators that could be targeted for intervention or surgery. MRI of the lumbar spine has become the initial imaging modality of choice in these patients.

MRI has excellent soft-tissue contrast and accurately depicts lumbar pathology, including disc degeneration, as well as the thecal sac and neural structures [7]. However, it is well known that many MRI abnormalities can be seen in asymptomatic individuals and that imaging patients in this category is often not beneficial [7,11,13,21]. MRI may be helpful when there is LBP with radiculopathy or signs of spinal stenosis, which suggests the presence of demonstrable nerve root compression [13].

CT myelography of the lumbar spine can be useful in assessing the patency of the spinal canal/thecal sac and of the subarticular recesses and neural foramen [22]. It has safety advantages over MRI for patients who have implanted medical devices that are not MRI safe or conditional and can be useful in patients with significant artifact from metallic surgical hardware on MRI [23]. CT myelography has the disadvantage of requiring lumbar puncture for intrathecal injection of myelographic contrast [22].

Although radiography alone is not sufficient for guidance on surgical or interventional options without MRI and/or CT imaging, it can be seen as complementary. Upright radiographs provide useful functional information about axial loading. The ability to incorporate flexion and extension radiographs is essential to identify segmental motion, which is important in the surgical management of spondylolisthesis. Lateral bending images have been shown to be helpful in spinal deformity correction surgery [24,25].

CT lumbar spine without IV contrast may be useful for preoperative planning [26]. CT delineates osseous margins and aids in trajectory planning for hardware fixation. Additionally, CT lumbar spine without IV contrast can also be used to assess facets and neural foramina and is equal to MRI for predicting significant spinal stenosis and excluding cauda equina impingement [27].

Although evidence is limited, recent small studies have suggested SPECT/CT bone scan may help identify the source of LBP in some patients, particularly when related to facet arthropathy or sacroiliac joint dysfunction [28-30]. SPECT bone scan is the reference standard for detection of radiographically occult active spondylolysis in the young patient [31].

Although the utility of discography in patients with LBP remains controversial, a systematic review by Manchikanti et al [32] provides level III evidence that lumbar discography may be useful in patients with chronic discogenic LBP.

Bone Scan Whole Body with SPECT or SPECT/CT Complete Spine
Structures with abnormal morphology on conventional imaging may not be the cause of LBP. Limited evidence suggests possible utility of bone scan with SPECT or SPECT/CT as a functional modality to localize the source of LBP, particularly for facet arthropathy [28-30]. A prospective study of 99 patients with LBP evaluated with SPECT/CT demonstrated >40% of scintigraphically active facet joints did not correlate to degree of facet joint degeneration on CT, using standardized grading scales [29]. A randomized double-blinded controlled study of 80 patients showed >50% pain relief in patients who received diagnostic facet or sacroiliac joint anesthetic blocks based on clinical and SPECT/CT findings compared with those who received blocks based on clinical and conventional imaging findings [28]. SPECT bone scan is the reference standard for detection of radiographically occult active spondylolysis in the young patient [31].

CT Lumbar Spine With IV Contrast
There is no relevant literature to support the use of CT lumbar spine with IV contrast in the evaluation of a surgery or intervention candidate with persistent or progressive symptoms during or following 6 weeks of conservative management.

CT Lumbar Spine Without and With IV Contrast
There is no relevant literature to support the use of CT lumbar spine without and with IV contrast in the evaluation of a surgery or intervention candidate with persistent or progressive symptoms during or following 6 weeks of conservative management.

CT Lumbar Spine Without IV Contrast
CT lumbar spine without IV contrast may be useful for preoperative planning [26]. CT delineates osseous margins and aids in trajectory planning for hardware fixation. Additionally, CT lumbar spine without IV contrast can be used to assess facets and neural foramina in patients who cannot undergo MRI and is equal to MRI for predicting significant spinal stenosis and excluding cauda equina impingement [27].

CT Myelography Lumbar Spine
CT myelography of the lumbar spine can be useful in assessing the patency of the spinal canal/thecal sac and of the subarticular recesses and neural foramen [22]. It has safety advantages over MRI for patients who have implanted medical devices that are not MRI safe or conditional and can be useful in patients with significant artifact from metallic surgical hardware on MRI [23]. CT myelography has the disadvantage of requiring lumbar puncture for intrathecal injection of myelographic contrast [22].

Discography and Post-Discography CT Lumbar Spine
Although the utility of discography in patients with LBP remains controversial, a systematic review by Manchikanti et al [32] provides level III evidence that lumbar discography may be useful in patients with chronic discogenic LBP.

FDG-PET/CT Whole Body
There is no relevant literature to support the use of whole-body FDG-PET/CT in the evaluation of a surgery or intervention candidate with persistent or progressive symptoms during or following 6 weeks of conservative management [28-30].

MRI Lumbar Spine With IV Contrast
MRI lumbar spine with IV contrast is not typically performed independently as an initial study, as its interpretation is most informative when correlated with standard noncontrast sequences included in MRI lumbar spine with and without IV contrast [33].

MRI Lumbar Spine Without and With IV Contrast
MRI with IV contrast is typically not necessary in the evaluation of a surgical or interventional candidate with persistent or progressive symptoms during or following 6 weeks of conservative management but is sometimes useful if noncontrast MRI is nondiagnostic or indeterminate. Contrast can help distinguish residual/recurrent disc from fibrosis/scar in a postoperative patient (see Variant 5).

MRI Lumbar Spine Without IV Contrast
Patients presenting with subacute or chronic LBP or radiculopathy who have failed 6 weeks of conservative therapy, and with physical examination signs of nerve root irritation, should be imaged if they are believed to be candidates for surgery or intervention or if diagnostic uncertainty remains. Accurate diagnosis of disc disease can be provided by MRI [7].

Although disc abnormalities are common on MRI in asymptomatic patients, LBP with radiculopathy or clinical signs of spinal stenosis suggests the presence of demonstrable nerve root compression on MRI [13]. In a study of symptomatic patients, there was a higher prevalence of herniation. Fifty-seven percent of patients with LBP and 65% of patients with radiculopathy had disc herniation as compared with the 20% to 28% prevalence reported in the asymptomatic series [7]. Interestingly, the size and type of disc herniation and location and presence of nerve root compression were not related to patient outcome [7,34].

Kobayashi et al [35] have shown the utility of MRI in diagnosing active spondylolysis in radiographically occult spondylolysis.

Radiography Lumbar Spine
Although radiography alone is not sufficient for guidance on surgical or interventional options without MRI and/or CT imaging, it can be seen as complementary. Upright radiographs provide useful functional information about axial loading [36]. The ability to incorporate flexion and extension radiographs is essential to identify segmental motion, which is important in the surgical management of spondylolisthesis [24,37]. Lateral bending images have been shown to be helpful in spinal deformity correction surgery [25].

Variant 4: Low back pain with suspected cauda equina syndrome. Initial imaging.

CES is rare and results from dysfunction of the sacral and lumbar nerve roots within the vertebral canal secondary to cauda equina nerve root compression, producing impairment of the bladder, bowel, or sexual function and perianal or saddle numbness. Back pain with or without radicular symptoms, weakness in the lower limbs, sensory changes or numbness in the lower limbs, or absent lower limb reflexes are other symptoms that have been described [38]. A review of physical examination findings reported by Fairbanks et al [39] found LBP as the most common physical finding in patients with the diagnosis of CES. The most common cause of CES is lumbar disc herniation at the L4-L5 and L5-S1 levels. Other etiologies include neoplasm, infection/inflammation, spinal stenosis, and hemorrhage.

Multifocal deficits and progressive neurologic deficits can be caused by a number of other noncompressive etiologies with some overlapping clinical features. Please see the ACR Appropriateness Criteria® topic on "Myelopathy" for guidance [40].

The imaging study of choice in the evaluation of suspected CES, multifocal deficit, or progressive neurologic deficit is MRI because of its ability to accurately depict soft-tissue pathology, assess vertebral marrow, and assess the

spinal canal patency. MRI lumbar spine without IV contrast is most useful in the evaluation of suspected CES, multifocal deficit, or progressive neurologic deficit because of its ability to accurately depict soft-tissue pathology, assess vertebral marrow, and assess the spinal canal patency. A prospective cohort study by Bell et al [41] recommends urgent MRI assessment in all patients who present with new-onset urinary symptoms in the context of LBP or sciatica. Recently, a single 3-D heavily T2-weighted fat-saturated sequence protocol has been shown to be a rapid, highly sensitive tool for evaluating CES in the emergency department that can be utilized for improved efficiency and emergency department throughput [42].

Although MRI lumbar spine without IV contrast is the preferred initial study, MRI lumbar spine without and with IV contrast may be helpful to delineate etiology of CES when underlying malignancy, infection, or inflammation is clinically suspected (see Variant 7).

Although MRI is superior in soft-tissue contrast and characterizing the etiology of CES, CT lumbar spine without IV contrast can answer the question of whether or not cauda equina compression is present. A recent retrospective review of 151 patients with clinically suspected CES showed that ≥50% thecal sac effacement on CT predicted significant spinal stenosis, and <50% thecal sac effacement reliably excluded cauda equina impingement, using MRI as the reference standard [27].

CT myelography of the lumbar spine assesses the patency of the spinal canal/thecal sac and of the subarticular recesses and neural foramen [22]. It can be useful for surgical planning in patients with CES and in patients with significant spinal stenosis on CT lumbar spine without IV contrast.

Bone Scan Whole Body with SPECT or SPECT/CT Complete Spine
There is no relevant literature to support the use of bone scan with SPECT or SPECT/CT in the initial imaging of suspected CES.

CT Lumbar Spine With IV Contrast
There is no relevant literature to support the use of CT with IV contrast in the initial imaging of suspected CES.

CT Lumbar Spine Without and With IV Contrast
There is no relevant literature to support the use of CT without and with IV contrast in the initial imaging of suspected CES.

CT Lumbar Spine Without IV Contrast
Although MRI is superior in soft-tissue contrast and characterizing the etiology of CES, CT lumbar spine without IV contrast can answer the question of whether or not cauda equina compression is present. A recent retrospective review of 151 patients with clinically suspected CES showed that ≥50% thecal sac effacement on CT predicted significant spinal stenosis, and <50% thecal sac effacement reliably excluded cauda equina impingement, using MRI as the reference standard [27].

CT Myelography Lumbar Spine
CT myelography of the lumbar spine assess the patency of the spinal canal/thecal sac and of the subarticular recesses and neural foramen [22]. It can be useful for surgical planning in patients with CES. This modality has the disadvantage of lumbar puncture and injection of intrathecal contrast [22].

Discography and Post-Discography CT Lumbar Spine
There is no relevant literature to support the use of discography and post-discography CT lumbar spine in the initial imaging of suspected CES.

FDG-PET/CT Whole Body
There is no relevant literature to support the use of whole-body FDG-PET/CT in the initial imaging of suspected CES.

MRI Lumbar Spine With IV Contrast
MRI lumbar spine with IV contrast is not typically performed independently as an initial study, as its interpretation is most informative when correlated with standard noncontrast sequences included in MRI lumbar spine with and without IV contrast [33].

MRI Lumbar Spine Without and With IV Contrast
Although MRI lumbar spine without IV contrast is the preferred initial study, MRI lumbar spine without and with IV contrast may be helpful to delineate etiology of CES when clinical suspicion of underlying malignancy, infection, or inflammation (see Variant 7).

MRI Lumbar Spine Without IV Contrast
MRI lumbar spine without IV contrast is most useful in the evaluation of suspected CES, multifocal deficit, or progressive neurologic deficit because of its ability to accurately depict soft-tissue pathology, assess vertebral marrow, and assess the spinal canal patency. A prospective cohort study by Bell et al [41] recommends urgent MRI assessment in all patients who present with new-onset urinary symptoms in the context of LBP or sciatica. Recently, a single 3-D heavily T2-weighted fat-saturated sequence protocol has been shown to be a rapid, highly sensitive tool for evaluating CES in the emergency department that can be utilized for improved efficiency and emergency department throughput [42].

Radiography Lumbar Spine
There is no relevant literature to support the use of radiography in the initial imaging of 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.

There are many causes of back pain following surgery. Some of the more frequent etiologies diagnosed with imaging include free disc or bone fragments, postoperative scarring, failure of bone graft for fusion, and recurrent disc protrusion. MRI lumbar spine without and with IV contrast is useful, as it accurately distinguishes recurrent or residual disc herniations from scar, and can evaluate for nerve root compression or arachnoiditis in patients with new or progressive symptoms and previous lumbar surgery [43]. It can also help identify and evaluate extent of infection.

CT lumbar spine without IV contrast can be helpful in assessing osseous fusion. CT can detect potentially painful hardware failure including prosthetic loosening, malalignment, or metallic fracture [44]. Additionally, CT lumbar spine without IV contrast is equal to MRI for predicting significant spinal stenosis and excluding cauda equina impingement [27]. The addition of IV contrast is not necessary to evaluate bony fusion and hardware but may be useful to assess for epidural abscess in patients for this clinical scenario [45-47].

CT myelography of the lumbar spine can be useful in assessing the patency of the spinal canal/thecal sac and of the subarticular recesses and neural foramen [22]. It has safety advantages over MRI for patients who have implanted medical devices that are not MRI safe or conditional and can be useful in patients with significant artifact from metallic surgical hardware on MRI [23]. CT myelography is occasionally more accurate in diagnosing nerve root compression in the lateral recess [48,49] but has the disadvantages of requiring lumbar puncture for intrathecal injection of myelographic contrast[22].

In patients in whom anatomy is distorted secondary to artifacts from surgical hardware, CT myelography lumbar spine study is complementary to MRI and is occasionally more accurate in diagnosing nerve root compression in the lateral recess [48,49], but it suffers the disadvantage of requiring lumbar puncture and intrathecal contrast injection [22].

Radiography is complementary to MRI and/or CT imaging and is helpful to evaluate alignment and hardware integrity in patients with new or progressing symptoms and previous lumbar fusion. Upright radiographs provide useful functional information about axial loading. Flexion and extension radiographs can be used to look for abnormal motion/increased dynamic mobility [50].

SPECT or SPECT/CT are not the initial imaging modality but may be an adjunct in cases of painful pseudoarthrosis or periprosthetic loosening in patients with previous lumbar fusion [51-54].

Bone Scan Whole Body with SPECT or SPECT/CT Complete Spine
SPECT or SPECT/CT are not the initial imaging modality but may be an adjunct in cases of painful pseudoarthrosis or periprosthetic loosening in patients with previous lumbar fusion [51-54].

CT Lumbar Spine With IV Contrast
CT lumbar spine with IV contrast to is not necessary to evaluate bony fusion and hardware but may be useful to assess for epidural abscess in patients for this clinical scenario and for patients with suspected infection [45-47].

CT Lumbar Spine Without and With IV Contrast
CT lumbar spine without and with IV contrast is not typically performed as there is no diagnostic advantage to performing a single study with or without IV contrast.

CT Lumbar Spine Without IV Contrast
CT lumbar spine without IV contrast can be helpful in assessing osseous fusion. CT can detect potentially painful hardware failure, including prosthetic loosening, malalignment, or metallic fracture [44]. Additionally, CT lumbar spine without IV contrast is equal to MRI for predicting significant spinal stenosis and excluding cauda equina impingement [27].

CT Myelography Lumbar Spine
CT myelography of the lumbar spine can be useful in assessing the patency of the spinal canal/thecal sac and of the subarticular recesses and neural foramen [22]. It has safety advantages over MRI for patients who have implanted medical devices that are not MRI safe or conditional and can be useful in patients with significant artifact from metallic surgical hardware on MRI [23]. CT myelography is occasionally more accurate in diagnosing nerve root compression in the lateral recess [48,49], but it has the disadvantage of requiring lumbar puncture for intrathecal injection of myelographic contrast [22].

Discography and Post-Discography CT Lumbar Spine
There is no relevant literature to support the use of discography and post-discography CT lumbar spine in the evaluation of new or progressing symptoms in patients with previous lumbar surgery.

FDG-PET/CT Whole Body
There is no relevant literature to support the use of whole-body FDG-PET/CT in the evaluation of new or progressing symptoms in patients with previous lumbar surgery.

MRI Lumbar Spine With IV Contrast
MRI lumbar spine with IV contrast is not typically performed independently as an initial study, as its interpretation is most informative when correlated with standard noncontrast sequences included in MRI lumbar spine with and without IV contrast [33].

MRI Lumbar Spine Without and With IV Contrast
MRI lumbar spine without and with IV contrast is useful as it accurately distinguishes recurrent or residual disc herniations from scar, and can evaluate for nerve root compression or arachnoiditis in patients with new or progressive symptoms and previous lumbar surgery [43]. It can also help identify and evaluate extent of infection.

MRI Lumbar Spine Without IV Contrast
MRI lumbar spine without IV contrast can be useful in this clinical scenario. It is inferior to MRI lumbar spine without and with IV contrast for evaluating extent of infection and for differentiating postoperative epidural fibrosis (scar) from residual or recurrent disc herniations [43].

Radiography Lumbar Spine
Radiography is helpful to evaluate alignment and hardware integrity in patients with new or progressing symptoms and previous lumbar fusion. Upright radiographs provide useful functional information about axial loading. Flexion and extension radiographs can be used to look for abnormal motion/increased dynamic mobility [50].

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.

Radiography with anteroposterior and lateral radiographs is the initial imaging study of choice for assessing LBP in patients with a low suspicion of trauma or minor trauma and patients suspected of possible vertebral compression fracture, history of osteoporosis, or steroid use [55]. For patients meeting the high-risk criteria for spinal trauma, please see the ACR Appropriateness Criteria® topic on "Suspected Spine Trauma" for guidance [56].

Upright radiographs provide useful functional information about axial loading. Flexion and extension views can be performed to evaluate for spine stability. However, evaluation of the extent of vertebral body comminution is limited on radiography, particularly in patients with osteoporosis.

CT provides a detailed analysis of fractures extending to the posterior column of the vertebra or for evaluating the integrity of pedicles and the posterior cortex. It has been shown to be equal to MRI for predicting significant spinal stenosis and excluding cauda equina impingement [27].

MRI lumbar spine without IV contrast is useful in determining the acuity of a vertebral fracture, as evidenced by bone marrow edema and in demonstrating spinal canal compromise, for example from displaced or retropulsed fractures. For imaging evaluation and management of vertebral compression fractures, please see the ACR Appropriateness Criteria® topic on "Management of Vertebral Compression Fractures" for guidance [57]. Additionally, the distinction between malignant and benign compression fractures can be assessed on MRI. The visualization of the convex posterior vertebral body border, extension into the posterior elements, and abnormal marrow signal are suggestive of pathologic fracture [58].

CT myelography of the lumbar spine assess the patency of the spinal canal/thecal sac and of the subarticular recesses and neural foramen [22]. It can be useful in patients with osteoporotic fracture with neurologic deficit. This modality has the disadvantage of lumbar puncture and injection of intrathecal contrast [22].

Bone scan with SPECT/CT is usually not used for initial imaging but can be useful for radiographically occult fractures and can be used to evaluate acuity of vertebral fracture. [59].

Whole-body FDG-PET/CT is typically not an initial imaging study, but as a follow-up study, it can help distinguish between benign and pathologic compression fractures when other imaging modalities are indeterminate [60].

Bone Scan Whole Body with SPECT or SPECT/CT Complete Spine
Bone scan with SPECT/CT is usually not used for initial imaging but can be useful for radiographically occult fractures and can be used to evaluate acuity of vertebral fracture [59].

CT Lumbar Spine With IV Contrast
CT with IV contrast does not provide additional information to CT lumbar spine without IV contrast for evaluation of spinal fractures and alignment.

CT Lumbar Spine Without and With IV Contrast
CT without and with IV contrast of the lumbar spine is not typically performed as there is no diagnostic advantage to performing a single study with or without IV contrast.

CT Lumbar Spine Without IV Contrast
CT provides a detailed analysis of fractures extending to the posterior column of the vertebra or for evaluating the integrity of pedicles and the posterior cortex. It has been shown to be equal to MRI for predicting significant spinal stenosis and excluding cauda equina impingement [27]. For patients meeting the high-risk criteria for spinal trauma, please see the ACR Appropriateness Criteria® topic on "Suspected Spine Trauma" for guidance [56].

CT Myelography Lumbar Spine
CT myelography of the lumbar spine assesses the patency of the spinal canal/thecal sac and of the subarticular recesses and neural foramen [22]. It can be useful in patients with osteoporotic fracture with neurologic deficit. This modality has the disadvantage of lumbar puncture and injection of intrathecal contrast [22].

Discography and Post-Discography CT Lumbar Spine
There is no relevant literature to support the use of discography and post-discography CT lumbar spine in this clinical scenario.

FDG-PET/CT Whole Body
Whole-body FDG-PET/CT is typically not an initial imaging study, but as a follow-up study it can help distinguish between benign and pathologic compression fractures when other imaging modalities are indeterminate [60].

MRI Lumbar Spine With IV Contrast
MRI lumbar spine with IV contrast is not typically performed independently as an initial study, as its interpretation is most informative when correlated with standard noncontrast sequences included in MRI lumbar spine with and without IV contrast [33].

MRI Lumbar Spine Without and With IV Contrast
Although MRI lumbar spine without IV contrast is the preferred initial study, MRI lumbar spine without and with IV contrast may be helpful to delineate etiology of fracture when clinical suspicion of underlying malignancy, infection, or inflammation (see Variant 7).

MRI Lumbar Spine Without IV Contrast
MRI lumbar spine without IV contrast is useful in determining the acuity of a vertebral fracture, as evidenced by bone marrow edema and in demonstrating spinal canal compromise, for example from displaced or retropulsed

fractures. Additionally, the distinction between malignant and benign compression fractures can be assessed on MRI. The visualization of the convex posterior vertebral body border, extension into the posterior elements, and abnormal marrow signal are suggestive of pathologic fracture [58].

Radiography Lumbar Spine

In patients with history of osteoporosis or steroid use, initial evaluation with radiography is useful [55]. Radiography with anteroposterior and lateral radiographs is useful for assessing LBP in patients with low suspicion of trauma or minor trauma and patients suspected of having possible vertebral compression fracture. Upright radiographs provide useful functional information about axial loading. Flexion and extension views can be performed to evaluate for spine stability. Evaluation of the extent of vertebral body comminution is limited on radiography, particularly in patients with osteoporosis.

Variant 7: Low back pain with or without radiculopathy. One or more of the following: suspicion of cancer, infection, or immunosuppression. Initial imaging.

A systematic review examining studies that used red flags as an indication for screening found that of all the red flags, only a history of cancer has been shown to increase the probability of finding spinal malignancy [61]. In a patient suspected of having cancer, MRI without and with IV contrast is considered superior in evaluation of localizing disease (intramedullary, intradural-extramedullary, and extradural) as well as assessing extent of the lesion. For malignant/metastatic disease, both bony/marrow involvement and neural compression from epidural tumor are visualized with high spatial resolution [62]. Although CT lumbar spine without IV contrast can be performed to evaluate osseous integrity (eg, pathologic fracture) when involved with tumor, intradural and spinal cord pathologies are poorly depicted on CT. Bone scan remains invaluable when a survey of the entire skeleton is indicated (eg, for metastatic disease); however, MRI offers greater specificity than bone scan, with comparable sensitivity and the added advantage of providing anatomic detail [63]. Although osseous destruction, as well as identifying lytic or sclerotic lesions can be detected on radiography, at least half of the bone must be eroded before there is a noticeable change on radiographs [64]. Whole-body FDG-PET/CT is typically not an initial imaging study but can be used to evaluate for widespread metastatic disease and can distinguish benign versus malignant compression fractures [65,66].

In a patient with suspected spinal infection, MRI without and with IV contrast is preferred because of its high sensitivity and specificity. MRI can localize the site of infection and assess the extent of extradural/epidural and paravertebral involvement. The addition of IV contrast with fat suppression is invaluable in identifying epidural and paraspinal abscess [65] and helps distinguish abscess from phlegmon [67]. Again, MRI allows the diagnosis of infection before bone destruction is evident on either CT or radiography. Noncontrast 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 [68].

Although less sensitive and specific than MRI for evaluation for infection or neoplasm, CT lumbar spine without IV contrast can be obtained to evaluate for associated osseous abnormalities (eg, pathologic fracture, bony destructive change). In some cases, addition of IV contrast may be useful to assess for epidural abscess in such patients [45-47].

CT myelography of the lumbar spine assesses the patency of the spinal canal/thecal sac and of the subarticular recesses and neural foramen [22]. It can be useful in patients with suspected neoplasm and neurologic deficit. This modality has the disadvantage of lumbar puncture and injection of intrathecal contrast [22].

Bone Scan Whole Body with SPECT or SPECT/CT Complete Spine

SPECT or SPECT/CT is not the initial imaging study but can be used to evaluate for widespread osseous metastatic disease.

CT Lumbar Spine With IV Contrast

CT lumbar spine with IV contrast can be performed to evaluate osseous integrity (eg, pathologic fracture) when involved with tumor. However, intradural and spinal cord pathologies are poorly depicted on CT, so MRI without and with IV contrast is preferred. Addition of IV contrast may be useful to assess for epidural abscess in patients for this clinical scenario and for patients with suspected infection [45-47].

CT Lumbar Spine Without and With IV Contrast

CT without and with IV contrast of the lumbar spine is not typically performed as there is no diagnostic advantage to performing a single study with or without IV contrast.

CT Lumbar Spine Without IV Contrast
CT lumbar spine without IV contrast can be performed to evaluate osseous integrity (eg, pathologic fracture) when involved with tumor. However, intradural and spinal cord pathologies are poorly depicted on CT, so MRI without and with IV contrast is preferred. Addition of IV contrast may be useful to assess for epidural abscess in patients for this clinical scenario and for patients with suspected infection. [45-47].

CT Myelography Lumbar Spine
CT myelography of the lumbar spine assesses the patency of the spinal canal/thecal sac and of the subarticular recesses and neural foramen [22]. It can be useful in patients with suspected neoplasm and neurologic deficit. This modality has the disadvantage of lumbar puncture and injection of intrathecal contrast [22].

Discography and Post-Discography CT Lumbar Spine
There is no relevant literature to support the use of discography and post-discography CT lumbar spine in this clinical scenario.

FDG-PET/CT Whole Body
Whole-body FDG-PET/CT is typically not an initial imaging study but can be used to evaluate for widespread metastatic disease and can distinguish benign versus malignant compression fractures [65,66].

MRI Lumbar Spine With IV Contrast
MRI lumbar spine with IV contrast is not typically performed independently as an initial study, as its interpretation is most informative when correlated with standard noncontrast sequences included in MRI lumbar spine with and without IV contrast [33].

MRI Lumbar Spine Without and With IV Contrast
MRI lumbar spine without and with IV contrast is useful for this group. For malignant/metastatic disease, MRI is preferred as both bony/marrow involvement and neural compression from epidural tumor are visualized with high spatial resolution [62]. In a patient with suspected spinal infection, MRI without and with IV contrast is preferred because of its high sensitivity and specificity. MRI can localize the site of infection and assess the extent of extradural/epidural and paravertebral involvement [65,67], and is helpful to distinguish abscess from phlegmon [67].

MRI Lumbar Spine Without IV Contrast
MRI lumbar spine without IV can be a sufficient imaging study if there is low risk of epidural and/or intraspinal disease. It is highly sensitive for bone marrow abnormalities, and with a combination of noncontrast T1-weighted and short tau inversion recovery sequences it can distinguish whether they are benign or malignant [62].

Radiography Lumbar Spine
Sensitivity of radiography is markedly limited for metastases [64]. MRI is preferred to radiography because of its higher sensitivity and specificity for osseous lesions and for its ability to assess soft-tissue abnormalities [69,70].

Summary of Recommendations

- **Variant 1:** Imaging is usually not appropriate for the initial imaging of patients with acute LBP with or without radiculopathy, no red flags, and no prior management.
- **Variant 2:** Imaging is usually not appropriate for the initial imaging of patients with subacute or chronic LBP with or without radiculopathy, no red flags, and no prior management.
- **Variant 3:** MRI lumbar spine without IV contrast is usually appropriate as the initial imaging of patients with subacute or chronic LBP with or without radiculopathy and who are candidates for surgery or intervention with persistent or progressive symptoms during or following 6 weeks of optimal medical management.
- **Variant 4:** MRI lumbar spine without and with IV contrast or MRI lumbar spine without IV contrast is usually appropriate as the initial imaging of patients with LBP with suspected CES. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).
- **Variant 5:** Radiography lumbar spine or MRI lumbar spine without and with IV contrast or MRI lumbar spine without IV contrast is usually appropriate as the initial imaging of patients with LBP with history of prior lumbar surgery and with or without radiculopathy and new or progressing symptoms or clinical findings. These procedures are complementary (ie, both should be performed).

- **Variant 6:** Radiography lumbar spine or MRI lumbar spine without IV contrast or CT lumbar spine without IV contrast is usually appropriate as the initial imaging of patients with LBP with or without radiculopathy and one or more of the following: low-velocity trauma, osteoporosis, elderly individual, or chronic steroid use. These procedures are complementary (ie, both should be performed).
- **Variant 7:** MRI lumbar spine without and with IV contrast or MRI lumbar spine without IV contrast is usually appropriate as the initial imaging of patients with LBP with or without radiculopathy and one or more of the following: suspicion of cancer, infection, or immunosuppression. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care). The panel did not agree on recommending radiography lumbar spine for this clinical scenario. There is insufficient medical literature to conclude whether or not these patients would benefit from radiography lumbar spine. This procedure in this patient population is controversial but may be appropriate.

Supporting Documents

The evidence table, literature search, and appendix for this topic are available at https://acsearch.acr.org/list. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents go to www.acr.org/ac.

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

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 (RRL) indication has been included for each imaging examination. The RRLs 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. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared with those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document [71].

Relative Radiation Level Designations		
Relative Radiation Level*	**Adult Effective Dose Estimate Range**	**Pediatric Effective Dose Estimate Range**
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv
*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."		

References

1. Murray CJ, Lopez AD. Measuring the global burden of disease. N Engl J Med 2013;369:448-57.
2. Johnson SM, Shah LM. Imaging of Acute Low Back Pain. Radiol Clin North Am 2019;57:397-413.
3. Chou R, Qaseem A, Snow V, et al. Diagnosis and treatment of low back pain: a joint clinical practice guideline from the American College of Physicians and the American Pain Society. Ann Intern Med 2007;147:478-91.
4. Chou R, Qaseem A, Owens DK, Shekelle P, Clinical Guidelines Committee of the American College of P. Diagnostic imaging for low back pain: advice for high-value health care from the American College of Physicians. Ann Intern Med 2011;154:181-9.
5. Institute for Clinical Systems Improvement. Low Back Pain, Adult Acute and Subacute. Revision Date: March 2018/Sixteenth Edition. Available at: https://www.icsi.org/guideline/low-back-pain/. Accessed March 26, 2021.
6. Jarvik JG, Hollingworth W, Martin B, et al. Rapid magnetic resonance imaging vs radiographs for patients with low back pain: a randomized controlled trial. JAMA 2003;289:2810-8.
7. Modic MT, Obuchowski NA, Ross JS, et al. Acute low back pain and radiculopathy: MR imaging findings and their prognostic role and effect on outcome. Radiology 2005;237:597-604.
8. Bigos SJ, Bowyer OR, Braen GR, et al. Acute Low Back Problems in Adults. Clinical Practice Guideline No. 14. AHCPR Publication No. 95-0642. Rockville, MD: Agency for Health Care Policy and Research, Public Health Service, U.S. Department of Health and Human Services. December 1994. Available at: http://d4c2.com/d4c2-000038.htm.
9. Jarvik JG, Gold LS, Comstock BA, et al. Association of early imaging for back pain with clinical outcomes in older adults. JAMA 2015;313:1143-53.
10. Looker AC, Borrud LG, Dawson-Hughes B, Shepherd JA, Wright NC. Osteoporosis or low bone mass at the femur neck or lumbar spine in older adults: United States, 2005-2008. NCHS Data Brief 2012:1-8.
11. Boden SD, Davis DO, Dina TS, Patronas NJ, Wiesel SW. Abnormal magnetic-resonance scans of the lumbar spine in asymptomatic subjects. A prospective investigation. J Bone Joint Surg Am 1990;72:403-8.
12. Brinjikji W, Luetmer PH, Comstock B, et al. Systematic literature review of imaging features of spinal degeneration in asymptomatic populations. AJNR Am J Neuroradiol 2015;36:811-6.
13. Carragee E, Alamin T, Cheng I, Franklin T, van den Haak E, Hurwitz E. Are first-time episodes of serious LBP associated with new MRI findings? Spine J 2006;6:624-35.
14. Bernard SA, Kransdorf MJ, Beaman FD, et al. ACR Appropriateness Criteria® Chronic Back Pain Suspected Sacroiliitis-Spondyloarthropathy. J Am Coll Radiol 2017;14:S62-S70.
15. Panagopoulos J, Magnussen JS, Hush J, et al. Prospective Comparison of Changes in Lumbar Spine MRI Findings over Time between Individuals with Acute Low Back Pain and Controls: An Exploratory Study. AJNR Am J Neuroradiol 2017;38:1826-32.
16. Autio RA, Karppinen J, Niinimaki J, et al. Determinants of spontaneous resorption of intervertebral disc herniations. Spine (Phila Pa 1976) 2006;31:1247-52.
17. Graves JM, Fulton-Kehoe D, Jarvik JG, Franklin GM. Health care utilization and costs associated with adherence to clinical practice guidelines for early magnetic resonance imaging among workers with acute occupational low back pain. Health Serv Res 2014;49:645-65.

18. Tan A, Zhou J, Kuo YF, Goodwin JS. Variation among Primary Care Physicians in the Use of Imaging for Older Patients with Acute Low Back Pain. J Gen Intern Med 2016;31:156-63.
19. Last AR, Hulbert K. Chronic low back pain: evaluation and management. Am Fam Physician 2009;79:1067-74.
20. Brinjikji W, Diehn FE, Jarvik JG, et al. MRI Findings of Disc Degeneration are More Prevalent in Adults with Low Back Pain than in Asymptomatic Controls: A Systematic Review and Meta-Analysis. AJNR Am J Neuroradiol 2015;36:2394-9.
21. Suri P, Boyko EJ, Goldberg J, Forsberg CW, Jarvik JG. Longitudinal associations between incident lumbar spine MRI findings and chronic low back pain or radicular symptoms: retrospective analysis of data from the longitudinal assessment of imaging and disability of the back (LAIDBACK). BMC Musculoskelet Disord 2014;15:152.
22. Bartynski WS, Lin L. Lumbar root compression in the lateral recess: MR imaging, conventional myelography, and CT myelography comparison with surgical confirmation. AJNR Am J Neuroradiol 2003;24:348-60.
23. Nazarian S, Beinart R, Halperin HR. Magnetic resonance imaging and implantable devices. Circ Arrhythm Electrophysiol 2013;6:419-28.
24. Tarpada SP, Cho W, Chen F, Amorosa LF. Utility of Supine Lateral Radiographs for Assessment of Lumbar Segmental Instability in Degenerative Lumbar Spondylolisthesis. Spine (Phila Pa 1976) 2018;43:1275-80.
25. Yao G, Cheung JPY, Shigematsu H, et al. Characterization and Predictive Value of Segmental Curve Flexibility in Adolescent Idiopathic Scoliosis Patients. Spine (Phila Pa 1976) 2017;42:1622-28.
26. Senoglu M, Karadag A, Kinali B, Bozkurt B, Middlebrooks EH, Grande AW. Cortical Bone Trajectory Screw for Lumbar Fixation: A Quantitative Anatomic and Morphometric Evaluation. World Neurosurg 2017;103:694-701.
27. Peacock JG, Timpone VM. Doing More with Less: Diagnostic Accuracy of CT in Suspected Cauda Equina Syndrome. AJNR Am J Neuroradiol 2017;38:391-97.
28. Jain A, Jain S, Agarwal A, Gambhir S, Shamshery C, Agarwal A. Evaluation of Efficacy of Bone Scan With SPECT/CT in the Management of Low Back Pain: A Study Supported by Differential Diagnostic Local Anesthetic Blocks. Clin J Pain 2015;31:1054-9.
29. Russo VM, Dhawan RT, Baudracco I, Dharmarajah N, Lazzarino AI, Casey AT. Hybrid Bone SPECT/CT Imaging in Evaluation of Chronic Low Back Pain: Correlation with Facet Joint Arthropathy. World Neurosurg 2017;107:732-38.
30. Russo VM, Dhawan RT, Dharmarajah N, Baudracco I, Lazzarino AI, Casey AT. Hybrid Bone Single Photon Emission Computed Tomography Imaging in Evaluation of Chronic Low Back Pain: Correlation with Modic Changes and Degenerative Disc Disease. World Neurosurg 2017;104:816-23.
31. Matesan M, Behnia F, Bermo M, Vesselle H. SPECT/CT bone scintigraphy to evaluate low back pain in young athletes: common and uncommon etiologies. J Orthop Surg Res 2016;11:76.
32. Manchikanti L, Benyamin RM, Singh V, et al. An update of the systematic appraisal of the accuracy and utility of lumbar discography in chronic low back pain. Pain Physician 2013;16:SE55-95.
33. Colosimo C, Cianfoni A, Di Lella GM, Gaudino S. Contrast-enhanced MR imaging of the spine: when, why and how? How to optimize contrast protocols in MR imaging of the spine. Neuroradiology 2006;48 Suppl 1:18-33.
34. el Barzouhi A, Vleggeert-Lankamp CL, Lycklama a Nijeholt GJ, et al. Influence of low back pain and prognostic value of MRI in sciatica patients in relation to back pain. PLoS One 2014;9:e90800.
35. Kobayashi A, Kobayashi T, Kato K, Higuchi H, Takagishi K. Diagnosis of radiographically occult lumbar spondylolysis in young athletes by magnetic resonance imaging. Am J Sports Med 2013;41:169-76.
36. Butt S, Saifuddin A. The imaging of lumbar spondylolisthesis. Clin Radiol 2005;60:533-46.
37. Cabraja M, Mohamed E, Koeppen D, Kroppenstedt S. The analysis of segmental mobility with different lumbar radiographs in symptomatic patients with a spondylolisthesis. Eur Spine J 2012;21:256-61.
38. Fraser S, Roberts L, Murphy E. Cauda equina syndrome: a literature review of its definition and clinical presentation. Arch Phys Med Rehabil 2009;90:1964-8.
39. Fairbank J, Hashimoto R, Dailey A, Patel AA, Dettori JR. Does patient history and physical examination predict MRI proven cauda equina syndrome? Evid Based Spine Care J 2011;2:27-33.
40. American College of Radiology. ACR Appropriateness Criteria®: Myelopathy. Available at: https://acsearch.acr.org/docs/69484/Narrative/. Accessed March 26, 2021.
41. Bell DA, Collie D, Statham PF. Cauda equina syndrome: what is the correlation between clinical assessment and MRI scanning? Br J Neurosurg 2007;21:201-3.

42. Koontz NA, Wiggins RH, 3rd, Mills MK, et al. Less Is More: Efficacy of Rapid 3D-T2 SPACE in ED Patients with Acute Atypical Low Back Pain. Acad Radiol 2017;24:988-94.
43. Bundschuh CV, Modic MT, Ross JS, Masaryk TJ, Bohlman H. Epidural fibrosis and recurrent disk herniation in the lumbar spine: MR imaging assessment. AJR Am J Roentgenol 1988;150:923-32.
44. Hayashi D, Roemer FW, Mian A, Gharaibeh M, Muller B, Guermazi A. Imaging features of postoperative complications after spinal surgery and instrumentation. AJR Am J Roentgenol 2012;199:W123-9.
45. Ko CC, Tsai HW, Huang WC, et al. Screw loosening in the Dynesys stabilization system: radiographic evidence and effect on outcomes. Neurosurg Focus 2010;28:E10.
46. Wu JC, Huang WC, Tsai HW, et al. Pedicle screw loosening in dynamic stabilization: incidence, risk, and outcome in 126 patients. Neurosurg Focus 2011;31:E9.
47. Darouiche RO. Spinal epidural abscess. N Engl J Med 2006;355:2012-20.
48. Park CK, Lee HJ, Ryu KS. Comparison of Root Images between Post-Myelographic Computed Tomography and Magnetic Resonance Imaging in Patients with Lumbar Radiculopathy. J Korean Neurosurg Soc 2017;60:540-49.
49. Splettstosser A, Khan MF, Zimmermann B, et al. Correlation of lumbar lateral recess stenosis in magnetic resonance imaging and clinical symptoms. World J Radiol 2017;9:223-29.
50. Harada GK, Siyaji ZK, Younis S, Louie PK, Samartzis D, An HS. Imaging in Spine Surgery: Current Concepts and Future Directions. Spine Surg Relat Res 2020;4:99-110.
51. Damgaard M, Nimb L, Madsen JL. The role of bone SPECT/CT in the evaluation of lumbar spinal fusion with metallic fixation devices. Clin Nucl Med 2010;35:234-6.
52. Peters MJM, Bastiaenen CHG, Brans BT, Weijers RE, Willems PC. The diagnostic accuracy of imaging modalities to detect pseudarthrosis after spinal fusion-a systematic review and meta-analysis of the literature. Skeletal Radiol 2019;48:1499-510.
53. Rager O, Schaller K, Payer M, Tchernin D, Ratib O, Tessitore E. SPECT/CT in differentiation of pseudarthrosis from other causes of back pain in lumbar spinal fusion: report on 10 consecutive cases. Clin Nucl Med 2012;37:339-43.
54. Sumer J, Schmidt D, Ritt P, et al. SPECT/CT in patients with lower back pain after lumbar fusion surgery. Nucl Med Commun 2013;34:964-70.
55. Jarvik JG, Deyo RA. Diagnostic evaluation of low back pain with emphasis on imaging. Ann Intern Med 2002;137:586-97.
56. Beckmann NM, West OC, Nunez D, Jr., et al. ACR Appropriateness Criteria® Suspected Spine Trauma. J Am Coll Radiol 2019;16:S264-S85.
57. Shah LM, Jennings JW, Kirsch CFE, et al. ACR Appropriateness Criteria® Management of Vertebral Compression Fractures. J Am Coll Radiol 2018;15:S347-S64.
58. Jung HS, Jee WH, McCauley TR, Ha KY, Choi KH. Discrimination of metastatic from acute osteoporotic compression spinal fractures with MR imaging. Radiographics 2003;23:179-87.
59. Karam M, Lavelle WF, Cheney R. The role of bone scintigraphy in treatment planning, and predicting pain relief after kyphoplasty. Nucl Med Commun 2008;29:247-53.
60. Cho WI, Chang UK. Comparison of MR imaging and FDG-PET/CT in the differential diagnosis of benign and malignant vertebral compression fractures. J Neurosurg Spine 2011;14:177-83.
61. Henschke N, Maher CG, Ostelo RW, de Vet HC, Macaskill P, Irwig L. Red flags to screen for malignancy in patients with low-back pain. Cochrane Database Syst Rev 2013;2:CD008686.
62. Shah LM, Salzman KL. Imaging of spinal metastatic disease. Int J Surg Oncol 2011;2011:769753.
63. Algra PR, Bloem JL, Tissing H, Falke TH, Arndt JW, Verboom LJ. Detection of vertebral metastases: comparison between MR imaging and bone scintigraphy. Radiographics 1991;11:219-32.
64. Edelstyn GA, Gillespie PJ, Grebbell FS. The radiological demonstration of osseous metastases. Experimental observations. Clin Radiol 1967;18:158-62.
65. Bredella MA, Essary B, Torriani M, Ouellette HA, Palmer WE. Use of FDG-PET in differentiating benign from malignant compression fractures. Skeletal Radiol 2008;37:405-13.
66. He X, Zhao L, Guo X, et al. Differential diagnostic value of (18)F-FDG PET/CT for benign and malignant vertebral compression fractures: comparison with magnetic resonance imaging. Cancer Manag Res 2018;10:2105-15.
67. Hong SH, Choi JY, Lee JW, Kim NR, Choi JA, Kang HS. MR imaging assessment of the spine: infection or an imitation? Radiographics 2009;29:599-612.

68. Jarvik JG. Imaging of adults with low back pain in the primary care setting. Neuroimaging Clin N Am 2003;13:293-305.
69. Evans AJ, Robertson JF. Magnetic resonance imaging versus radionuclide scintigraphy for screening in bone metastases. Clin Radiol 2000;55:653; author reply 53-4.
70. Schmidt GP, Schoenberg SO, Schmid R, et al. Screening for bone metastases: whole-body MRI using a 32-channel system versus dual-modality PET-CT. Eur Radiol 2007;17:939-49.
71. American College of Radiology. ACR Appropriateness Criteria® Radiation Dose Assessment Introduction. Available at: https://www.acr.org/-/media/ACR/Files/Appropriateness-Criteria/RadiationDoseAssessmentIntro.pdf. Accessed March 26, 2021.