

**American College of Radiology  
ACR Appropriateness Criteria®**

**Clinical Condition:** Myelopathy

**Variant 1:** Traumatic.

Radiologic Procedure	Rating	Comments	RRL*
CT spine without IV contrast	9	This procedure is the first test for acute management.	☼☼☼
MRI spine without IV contrast	8	This procedure can be used for problem solving or operative planning. It is most useful when injury is not explained by bony fracture.	O
X-ray spine	7	This procedure can be the first test in multisystem trauma, especially when CT is delayed. Flexion and extension views can be used to evaluate instability only if patient is not obtunded.	☼☼☼
X-ray myelography and post myelography CT spine	5	MRI is preferable.	☼☼☼☼
MRI spine without and with IV contrast	2		O
CT spine with IV contrast	2		☼☼☼
Tc-99m bone scan with SPECT spine	2		☼☼☼
CT spine without and with IV contrast	1		☼☼☼☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Variant 2:** Painful.

Radiologic Procedure	Rating	Comments	RRL*
MRI spine without IV contrast	8		O
MRI spine without and with IV contrast	7	This procedure can be used if infection or neoplastic disorder is suspected.	O
CT spine without IV contrast	7	This procedure is most useful for spondylosis.	☼☼☼
X-ray myelography and post myelography CT spine	5	This procedure can be used for problem solving or if MRI is unavailable or contraindicated.	☼☼☼☼
Tc-99m bone scan with SPECT spine	4	This procedure can be used to search for associated extraspinal disease.	☼☼☼
X-ray spine	3	This procedure can be used with flexion and extension views to evaluate instability.	☼☼☼
CT spine with IV contrast	3	Consider this procedure for infection or neoplasm or if MRI is unavailable or contraindicated.	☼☼☼
CT spine without and with IV contrast	1		☼☼☼☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Clinical Condition:** Myelopathy

**Variant 3:** Sudden onset or slowly progressive.

Radiologic Procedure	Rating	Comments	RRL*
MRI spine without IV contrast	9		O
MRI spine without and with IV contrast	9		O
X-ray myelography and post myelography CT spine	6		⚠⚠⚠⚠
CT spine without IV contrast	5		⚠⚠⚠
Arteriography spine	5		Varies
CTA spine with IV contrast	4		⚠⚠⚠
MRA spine without and with IV contrast	4	This procedure can be used when vascular pathology is suspected in advance of spinal catheterization.	O
MRA spine without IV contrast	4	This procedure can be used when vascular pathology is suspected in advance of spinal catheterization when gadolinium-based agents are contraindicated.	O
X-ray spine	3	This procedure may be useful for fracture progression follow-up.	⚠⚠⚠
CT spine with IV contrast	3		⚠⚠⚠
Tc-99m bone scan with SPECT spine	3		⚠⚠⚠
CT spine without and with IV contrast	1		⚠⚠⚠⚠
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

## MYELOPATHY

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### **Summary of Literature Review**

#### **Introduction/Background**

The term myelopathy is used to describe any neurological deficit related to the spinal cord itself [1]. Most frequently, myelopathy is due to compression of the spinal cord by osteophytes or extruded disc material in the cervical spine. Osteophytic spurring and disc herniation may also produce myelopathy localized to the thoracic spine, though this is less common. The next most common causes of myelopathy are spinal cord compression due to extradural masses caused by bone metastases and blunt or penetrating trauma. Many primary neoplastic, infectious, inflammatory, neurodegenerative, vascular, nutritional, and idiopathic disorders can also result in myelopathy, though these are much less common than discogenic disease, metastases, and trauma. A variety of cysts and benign neoplasms can also compress the cord; they tend to arise intradurally. The most common of these are meningiomas, nerve sheath tumors, epidermoid cysts, and arachnoid cysts [2-6].

In general, disorders of the spinal cord itself are uncommon and difficult to treat effectively. Therefore, most attention in the radiological evaluation of myelopathy is focused on extrinsic compression of the spinal cord.

Historically, radiological evaluation of myelopathic patients consisted of positive-contrast myelography. Later, this evaluation was supplemented by computed tomography (CT) and CT myelography, and then magnetic resonance imaging (MRI) became the mainstay in the evaluation of myelopathy [2]. Newer investigations of spinal cord diffusion tensor imaging in the setting of myelopathy from trauma, demyelination, and spondylosis appear promising to further interrogate spinal cord injury [7-16].

Despite the wide variety of causes of myelopathy, diagnosis and treatment rest on demonstration of mechanical stability of the spine, particularly in the cervical region and when history of tumor, trauma, or prior surgery is present. Depiction of direct neural involvement by a pathologic process is then required for more refined diagnosis and specific treatment decisions. Anatomical diagnosis of myelopathy rests principally on the distinction between extradural, intradural, and intramedullary lesions.

Clinically, the diagnosis of myelopathy depends on the neurological localization of the finding to the spinal cord, rather than the brain or peripheral nervous system, and then to a particular segment of the spinal cord. The antecedent clinical syndrome and other details of the patient's course help to refine diagnosis, but imaging plays a crucial role. Occasionally, symptoms referable to a specific localizing level of the spinal cord can be mimicked by lesions more proximal in the neuroaxis [17]. In general, myelopathy is clinically divided into categories based on the presence or absence of significant trauma, the presence or absence of pain, and the progression of onset (slowly progressive versus a sudden onset). In oncologic patients and those in whom infectious disease is likely, additional imaging tests may be helpful in determining the source and extent of compressive components; however, MRI remains the first-line imaging test for the evaluation of myelopathic symptoms.

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## **Discussion of Imaging Modalities by Variant**

### **Variant 1: Traumatic**

In the patient with traumatic myelopathy, the first priority for the spine is assessing its mechanical stability. Radiographs are useful for this purpose, though flexion and extension should be performed only in alert patients and may underestimate the degree of instability, in particular in patients with muscle spasm [18]. Generally, CT is the preferred test when a high probability of bony injury or ligamentous injury is present. At some centers, routine multidetector CT with sagittal and coronal reconstructions is supplanting the role of radiographs, especially in the setting of multiple trauma, in particular when spinal reconstructions are generated from chest, abdomen, and pelvis CT imaging without additional radiation exposure to the patient (see the ACR Appropriateness Criteria<sup>®</sup> “[Suspected Spine Trauma](#)” [19]).

MRI is widely considered the study of choice when paralysis is incomplete or under other circumstances where direct visualization of neural or ligamentous structures is clinically necessary. If surgery for herniated disc, hematoma, or other cause of incomplete paralysis is planned, MRI best depicts the relation of pathology to the cord, and it can help predict which patients may benefit from surgery [20-26].

### **Variant 2: Painful**

Cervical, thoracic, and lumbar spine central stenosis is a common cause of myelopathy. Factors contributing to spinal stenosis as a cause for myelopathy most frequently include disc spondylosis, vertebral spondylolisthesis, degenerative facet disease, ligamentum flavum hypertrophy, and congenitally short pedicles. Tumors or infections are uncommon causes of spinal stenosis. Clinical myelopathic symptoms of leg weakness alongside low back pain, saddle anesthesia, and urinary retention may indicate lumbosacral cauda equina syndrome (see the ACR Appropriateness Criteria<sup>®</sup> “[Low Back Pain](#)” [27]).

Radiographs may depict osteophytic narrowing of the spinal canal or bone destruction. CT improves the depiction of both bony encroachment on the spinal canal in cases of fracture or spondylolisthesis and compression of neural structures by herniated disc material that is occult on plain radiographic evaluation. Bone destruction and soft-tissue masses are also better seen. MRI has largely replaced CT scanning in the noninvasive evaluation of patients with painful myelopathy because of its superior soft-tissue resolution and multiplanar capability. CT myelography may be supplemental when visualization of neural structures is required for surgical planning or other specific problem solving, though this is less frequent [2,28-37].

Although painful myelopathy is most commonly due to spondylosis and disc herniation, a significant proportion is caused by tumor, infection, demyelinating disease, and syringomyelia. The superior ability of MRI to depict the spinal cord directly and to assess its contour and internal signal characteristics reliably and noninvasively has resulted in general acceptance of MRI as the study of choice in evaluating cervical myelopathy when spondylosis or disc herniation is the most likely cause; intramedullary cord signal changes and diffusivity in spondylotic myelopathy patients represent prognostic factors for neurosurgical outcome [38-49]. CT myelography may be useful when MRI is contraindicated or not available or to answer specific questions before surgical intervention [50-53]. In some circumstances involving myelopathy in young children and infants, ultrasound examination of the spine may be useful [54,55]. Finally, early studies of intraoperative CT scan during cervical decompressive surgery in myelopathic patients show benefit toward ensuring adequate surgical appearance; however, intraoperative CT imaging is not widely available [56,57].

### **Variant 3: Sudden onset or slowly progressive**

If myelopathy is painless and slowly progressive, the differential diagnosis is quite broad. Neoplastic disease of the spinal cord and extrinsic compression by epidural or intradural tumors may present in this manner. Demyelinating diseases, degenerative diseases, and metabolic or deficiency diseases may also present this way. Spondylosis may present painlessly as well, particularly in the elderly. In these cases, visualization of the spine as well as the spinal cord is useful, and this is best accomplished noninvasively by MRI [58-60].

Vascular processes can present with both sudden onset and slowly progressive myelopathy [61-63]. Vascular malformations, spinal cord infarct, and epidural hematoma account for most of the vascular lesions of the cord. In practice, they are difficult to distinguish clinically from other nontraumatic causes of myelopathy because the classic history is frequently absent or difficult to elicit from a seriously ill patient.

If arteriovenous malformation (AVM) is considered clinically likely, gadolinium-enhanced MRI or MR angiography (MRA) to demonstrate abnormal vasculature may be useful to guide spinal arteriography and

intervention, prioritizing and potentially limiting the number of direct vascular injections [64]. More recently, progress in CT angiography (CTA) has led to its use in preangiographic evaluation of patients with suspected spinal vascular abnormalities [65]. In particular, a search for dural AVMs of the spine can be rewarding, as successful treatment may be achieved using endovascular techniques [66].

In slowly progressive myelopathy, the ability of MRI to depict the spinal cord noninvasively is most valuable. Some bony anatomy questions and specifically treatable disorders, such as larger intramedullary masses, can be depicted quite well by means of CT myelography [67]. These techniques, however, are less useful than MRI because the distinction between solid and cystic masses is usually not possible, even when delayed examination is performed. The distinction of syrinx from tumor, location of small tumor nodules, extent of cyst, and distinction of nodule and cyst from edema are crucial in treatment planning for intramedullary disease and virtually necessitate MRI. In some cases, vascular imaging by means of MRA or CTA may be indicated if spinal AVMs or dural arteriovenous fistulae are considered to be likely causes [68]; often MRA or CTA would be performed prior to spinal catheter angiography for feeding and draining small vessel localization [69,70].

As multiple sites of involvement are possible in oncology and infectious disease patients, it is often beneficial to study the entire spine or skeleton even in the setting of a localized myelopathic level. MRI remains the recommended first-line study for the evaluation and confirmation of myelopathy; however, radionuclide bone scanning can be useful in these patient groups.

### **Clinical Correlation with Radiologic Findings**

An important limitation of MRI in the diagnosis of myelopathy is its low specificity. The ease with which the study depicts expansion and compression of the spinal cord in the myelopathic patient can lead to false-positive examinations and inappropriately aggressive therapy if findings are interpreted incorrectly. For example, transverse myelitis due to demyelinating disease can demonstrate cord enlargement and be mistaken for tumor. Spondylosis, which occurs with normal aging, can be mistaken for clinically significant osteophytic compression of the spinal cord in a patient who is myelopathic for other reasons. These problems are minimized by experienced observers and meticulous clinical correlation with radiologic findings. Similar problems are present in the interpretation of any anatomical study of the spinal cord and are not unique to MRI. Careful patient selection and clinical correlation are essential in interpretation of imaging findings [2,71-78].

### **Summary of Recommendations**

- CT is usually the preferred first test in suspected spinal trauma.
- MRI is usually the preferred first test in nontraumatic myelopathy. Imaging should be limited to appropriate spinal levels by clinical judgment and physical examination.
- Gadolinium contrast administration is preferred in oncology, infection, inflammation, and suspected vascular causes of myelopathy.
- Spinal angiography (invasive and/or CTA/MRA) is crucial in the evaluation of selected patients with suspected treatable causes of vascular myelopathy.
- In oncologic patients and those in whom infectious disease is likely, additional imaging tests may be helpful in determining the source and extent of compressive components; however, MRI remains the first-line imaging test for the evaluation of myelopathic symptoms.
- No high-quality evidence supports the use of discography, thermography, epidural venography, ultrasound, or cerebrospinal fluid flow studies in the evaluation of myelopathy.

### **Summary of Evidence**

Of the 78 references cited in *the ACR Appropriateness Criteria® Myelopathy* document, all of them are categorized as diagnostic references including 4 well designed studies, 9 good quality studies, and 16 quality studies that may have design limitations. There are 48 references that may not be useful as primary evidence. There is one reference that is a meta-analysis study.

The 78 references cited in the *ACR Appropriateness Criteria® Myelopathy* document were published from 1986-2013.

While there are references that report on studies with design limitations, 13 well designed or good quality studies provide good evidence.

## 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, both because of 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 to 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.

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”.

## Supporting Documents

For additional information on the Appropriateness Criteria methodology and other supporting documents go to [www.acr.org/ac](http://www.acr.org/ac).

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The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). 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 treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent 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 FDA have not been considered in developing these criteria; however, 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.