American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: **Myelopathy**

Variant 1: **Traumatic.**

Radiologic Procedure	Rating	Comments	RRL*
CT spine without contrast	9	First test for acute management.	Med
MRI spine without contrast	8	Problem solving or operative planning. Most useful when injury not explained by bony fracture.	None
X-ray spine	7	May be first test in multisystem trauma, especially when CT is delayed. To assess stability.	Med
Myelography and postmyelography CT spine	5	MRI preferable.	High
X-ray myelography	3	Usually performed in conjunction with CT.	Med
MRA spine with or without contrast	3	For suspected vascular trauma. Use of contrast may vary depending on technique used.	None
CTA spine	3	For suspected vascular trauma.	Med
INV arteriography spine	2		IP
MRI spine without and with contrast	2		None
CT spine with contrast	2		Med
NUC Tc-99m bone scan with SPECT spine	2		Med
NUC In-111 WBC scan spine	2		Med
INV epidural venography	1		IP
US spine	1		None
X-ray discography	1		Med

Rating Scale: **1=Least appropriate, 9=Most appropriate** ***Relative Radiation Level**

Clinical Condition: **Myelopathy**

Variant 2: **Painful.**

Radiologic Procedure	Rating	Comments	RRL*
MRI spine without contrast	8		None
MRI spine without and with contrast	7	If infection or neoplastic disorder suspected. See comments regarding contrast in text under "Anticipated Exceptions."	None
CT spine without contrast	7	Most useful for spondylosis.	Med
Myelography and postmyelography CT spine	5	Problem solving or if MRI unavailable or contraindicated.	High
NUC Tc-99m bone scan with SPECT spine	4	Search for associated extraspinal disease.	Med
X-ray spine	3	To assess stability.	Med
CT spine with contrast	3	Consider for infection, neoplasm or if MRI unavailable or contraindicated.	Med
X-ray myelography	2	Usually performed in conjunction with CT.	Med
MRI spine flow	2		None
INV arteriography spine	2		IP
NUC In-111 WBC scan spine	2		Med
CTA spine	2	Problem solving.	Med
US spine	1		None
X-ray discography	1		Med
INV epidural venography	1		IP
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Clinical Condition: **Myelopathy**

Variant 3: **Sudden onset.**

Radiologic Procedure	Rating	Comments	RRL*
MRI spine without contrast	9		None
MRI spine without and with contrast	8	See comments regarding contrast in text under "Anticipated Exceptions."	None
Myelography and postmyelography CT spine	6	Problem solving or if MRI unavailable or contraindicated.	High
X-ray myelography	6	Usually performed in conjunction with CT.	Med
CT spine without contrast	5	Problem solving or if MRI unavailable or contraindicated.	Med
CTA spine	5	If AVM is suspected.	Med
INV arteriography spine	4	If AVM is suspected.	IP
MRA spine with or without contrast	4	If AVM is suspected. Use of contrast may vary depending on technique used. See comments regarding contrast in text under "Anticipated Exceptions."	None
X-ray spine	3	To assess stability.	Med
CT spine with contrast	3		Med
NUC Tc-99m bone scan with SPECT spine	2		Med
NUC In-111 WBC scan spine	2		Med
X-ray discography	1		Med
US spine	1		None
INV epidural venography	1		IP
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Clinical Condition: **Myelopathy**

Variant 4: **Stepwise progressive.**

Radiologic Procedure	Rating	Comments	RRL*
MRI spine without contrast	9		None
MRI spine without and with contrast	8	See comments regarding contrast in text under "Anticipated Exceptions."	None
INV arteriography spine	6	If AVM is suspected.	IP
X-ray myelography	6	Usually performed in conjunction with CT. If AVM is suspected.	Med
Myelography and postmyelography CT spine	6	Problem solving or if MRI unavailable or contraindicated.	High
CT spine without contrast	5	Problem solving or if MRI unavailable or contraindicated.	Med
CTA spine	5		Med
MRA spine with or without contrast	4	Use of contrast may vary depending on technique used. See comments regarding contrast in text under "Anticipated Exceptions."	None
CT spine with contrast	3		Med
X-ray spine	3		Med
NUC Tc-99m bone scan with SPECT spine	2		Med
NUC In-111 WBC scan spine	2		Med
X-ray discography	1		Med
US spine	1		None
INV epidural venography	1		IP
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Clinical Condition: **Myelopathy**

Variant 5: **Slowly progressive.**

Radiologic Procedure	Rating	Comments	RRL*
MRI spine without contrast	8		None
MRI spine without and with contrast	7	See comments regarding contrast in text under "Anticipated Exceptions."	None
CT spine without contrast	6	Most useful for spondylosis.	Med
Myelography and postmyelography CT spine	5	Problem solving or if MRI unavailable or contraindicated.	High
X-ray myelography	5	If MRI is not possible or for preoperative planning and problem solving. Usually performed in conjunction with CT.	Med
INV arteriography spine	4		IP
NUC Tc-99m bone scan with SPECT spine	4		Med
X-ray spine	3	To assess stability.	Med
CT spine with contrast	3	Infection or neoplasms suspected, or if MRI unavailable or contraindicated.	Med
NUC In-111 WBC scan spine	2		Med
MRA spine with or without contrast	2	Use of contrast may vary depending on technique used.	None
CTA spine	2		Med
US spine	1		None
INV epidural venography	1		IP
X-ray discography	1		Med
Rating Scale: **1=Least appropriate, 9=Most appropriate**			***Relative Radiation Level**

Clinical Condition: **Myelopathy**

Variant 6: **Infectious disease patient.**

Radiologic Procedure	Rating	Comments	RRL*
MRI spine without and with contrast	9	See comments regarding contrast in text under "Anticipated Exceptions."	None
MRI spine without contrast	8		None
CT spine without contrast	6	If MRI unavailable or contraindicated.	Med
X-ray myelography	5	If MRI not feasible. Usually performed in conjunction with CT.	Med
CT spine with contrast	5		Med
Myelography and postmyelography CT spine	5	Problem solving or if MRI unavailable or contraindicated.	High
NUC In-111 WBC scan spine	4	May be combined with bone scan to diagnose osteomyelitis.	Med
X-ray spine	3	To assess stability.	Med
MRA spine with or without contrast	2	Use of contrast may vary depending on technique used.	None
INV arteriography spine	2		IP
CTA spine	2		Med
X-ray discography	1		Med
INV epidural venography	1		IP
US spine	1		None
NUC Tc-99m bone scan with SPECT spine	1	Indicated if multifocal disease is suspected.	Med
Rating Scale: **1=Least appropriate, 9=Most appropriate**			***Relative Radiation Level**

Clinical Condition: **Myelopathy**

Variant 7: **Oncology patient.**

Radiologic Procedure	Rating	Comments	RRL*
MRI spine without contrast	9		None
MRI spine without and with contrast	8	See comments regarding contrast in text under "Anticipated Exceptions."	None
CT spine without contrast	6	Problem solving or if MRI unavailable or contraindicated.	Med
NUC Tc-99m bone scan with SPECT spine	6	Search for extraspinal disease.	Med
Myelography and postmyelography CT spine	5	If MRI is not feasible.	High
X-ray myelography	5	If MRI is not feasible. Usually performed in conjunction with CT.	Med
CT spine with contrast	4		Med
X-ray spine	3	Assess stability or for treatment planning.	Med
INV arteriography spine	2		IP
MRA spine with or without contrast	2	Use of contrast may vary depending on technique used.	None
NUC In-111 WBC scan spine	2		Med
CTA spine	2	Treatment planning or problem solving.	Med
INV epidural venography	1		IP
US spine	1		None
X-ray discography	1		Med

Rating Scale: **1=Least appropriate, 9=Most appropriate** ***Relative Radiation Level**

MYELOPATHY

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Summary of Literature Review

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 osteophyte 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 sources of myelopathy are spinal cord compression due to extradural mass caused by carcinoma metastatic to bone, and blunt or penetrating trauma. Many primary neoplastic, infectious, inflammatory, neurodegenerative, vascular, nutritional, and idiopathic disorders may also result in myelopathy, though these are very much less common than discogenic disease, metastases, and trauma. A variety of cysts and benign neoplasms may also compress the cord; these tend to arise intradurally. The most common of these are meningiomas, nerve sheath tumors, epidermoid cysts, and arachnoid cysts [2-5].

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. Classically, 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]. More recently, imaging of the spinal cord has improved to the point that reliable diagnosis of nonexpansile spinal cord lesions is routinely possible.

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 tumor or trauma history 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. 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 mode of onset (slowly progressive or insidious onset vs a stepwise progression vs a sudden onset). Patients with known tumor history and those in whom infectious disease is likely may also be considered separately [1].

In the patient with traumatic myelopathy, the first priority for the spine is assessing its mechanical stability. Plain radiographs are useful for this purpose, but CT may be more useful 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 plain radiographs, especially in the setting of multiple trauma.

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 [6-14].

When local or radicular pain accompanies myelopathy, the most likely diagnoses are spondylosis, tumor, or infection. Plain radiographs may depict osteophytic narrowing of the spinal canal or bone destruction. CT improves the depiction of both bony encroachment on the spinal canal and compression of neural structures by herniated disc material that is occult to 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. Invasive evaluation by means of myelography and 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 [2,15-29].

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Although painful myelopathy is most commonly due to spondylosis and disc herniation, a significant proportion is caused by tumor or infection. Demyelinating disease may present with pain symptoms as well. Occasionally, syringomyelia may present with the anesthetica dolorosa syndrome. The 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. When MRI is not available, or to answer specific questions before surgical intervention, myelography and CT myelography may be useful [30-36].

In slowly progressive myelopathy, the ability of MRI to depict the spinal cord noninvasively is most valuable. Some specifically treatable disorders may be localized and depicted quite well by means of myelography followed by CT myelography. However, the occasional complication of myelography in cases of spinal block, difficulty in visualizing the upper extent of lesions, and relative "blind spots" at the cervical thoracic and craniocervical junctions limit the utility of myelography. CT myelographic techniques may help avoid these pitfalls and may be useful to answer specific preoperative questions about bony anatomy [37].

Enlargement of the spinal cord by intramedullary mass is well depicted by myelography only when large masses are present. CT myelography can be extremely useful in supplementing the plain radiographic examination. 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 tumor nodule, extent of cyst, and distinction of nodule and cyst from edema are crucial in treatment planning for intramedullary disease and virtually necessitate MRI [38-40].

When myelopathy progresses stepwise or is of sudden onset, vascular processes become significant diagnostic possibilities. 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 [41].

If AVM is considered clinically likely, gadolinium-enhanced MRI, MR angiography, and myelography to demonstrate abnormal vasculature may be useful adjuncts to guide spinal arteriography. More recently, progress in CT angiography has led to its use in preangiographic evaluation of patients with suspected spinal vascular abnormalities [42].

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 tumor may present in this manner. Demyelinating disease, degenerative diseases, and metabolic or deficiency diseases may also present in this fashion. 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 [43-46].

In oncology and infectious disease patients, multiple sites of involvement are possible. In these patients it is often necessary to study the entire spine or even the entire skeleton despite a specifically localized myelopathic level. MRI is considered more sensitive at an individual site, but the convenience of radionuclide bone scanning makes it useful in this setting as well. AIDS patients may present with myelopathy due to primary cord disease caused by HIV infection [47-55]. No high-quality evidence supports the use of discography, thermography, epidural venography, ultrasound, or central spinal fluid (CSF) flow studies in the evaluation of myelopathy. Radionuclide bone scan may play an adjunctive role–for example, to locate a safer biopsy site in patients with suspected metastatic cord compression.

An important limitation of MRI in the diagnosis of myelopathy is its high sensitivity. The ease with which the study depicts expansion and compression of the spinal cord in the myelopathic patient may lead to false positive examinations and inappropriately aggressive therapy if findings are interpreted incorrectly. For example, transverse myelitis due to demyelinating disease may demonstrate cord enlargement and be mistaken for tumor. Spondylosis, which occurs with normal aging, may 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 everywhere [2,56-58].

Anticipated Exceptions

Nephrogenic systemic fibrosis (NSF), also known as nephrogenic fibrosing dermopathy) was first identified in 1997 and has recently generated substantial concern among radiologists, referring doctors and lay people. Until the last few years, gadolinium-based MR contrast agents were widely believed to be almost universally well tolerated, extremely safe and non-nephrotoxic, even when used in patients with impaired renal function. All available experience suggests that these agents remain generally very safe, but recently some patients with renal failure who have been exposed to gadolinium contrast

agents (the percentage is unclear) have developed NSF [59-61], a syndrome that can be fatal. Further studies are necessary to determine what the exact relationships are between gadolinium-containing contrast agents, their specific components and stoichiometry, patient renal function and NSF. Current theory links the development of NSF to the administration of relatively high doses (eg, >0.2mM/kg) and to agents in which the gadolinium is least strongly chelated. The FDA has recently issued a "black box" warning concerning these contrast agents (http://www.fda.gov/cder/drug/InfoSheets/HCP/gcca_200705HCP.pdf).

This warning recommends that, until further information is available, gadolinium contrast agents should not be administered to patients with either acute or significant chronic kidney disease (estimated GFR <30 mL/min/1.73m^2), recent liver or kidney transplant or hepato-renal syndrome, unless a risk-benefit assessment suggests that the benefit of administration in the particular patient clearly outweighs the potential risk(s) [60].

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. 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*	**Effective Dose Estimate Range**
None	0
Minimal	< 0.1 mSv
Low	0.1-1 mSv
Medium	1-10 mSv
High	10-100 mSv
*RRL assignments are not included for some examinations. The RRL assignments for the IP (in progress) exams will be available in future releases.	

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